Effect of GA_3 and Potassium Nitrate in Different Dates on Fruit Set, Yield and Splitting of Washington Navel Orange

*Abd El-Rahman, G.F.; Hoda, M.Mohamed and Ensherah, A.H.Tayh

Citrus Department, Hort. Res. Instit., Agric. Res. Center, Giza, Egypt
*gamalelashmanty@yahoo.com

Abstract: Two concentrations of GA_3 were used alone or with 0.5% urea i.e. (50 and 100 ppm) and three levels of potassium nitrate (KNO_3) 2 ‹4 and 6% were tested as foliar sprays at different times i.e. first time application at full bloom stage , the second time application was at fruit diameter from 1.5-2.0 cm and (first and second time of application) for investigation their effects on fruit set, yield, fruit quality and splitting of 40-years-old Washington navel orange(*Citrus Sinensis*), trees budded on Sour Orange (*Citrus aurantium*, L.Obseck) rootstock during 2008 and 2009 seasons. Data indicated that, all treatments increased fruit set, yield and fruit quality and decreased fruit splitting as compared with control treatment. Data also revealed that, foliar sprays of trees by (GA_3 at 50 ppm) with or without 0.5% urea were superior for inducing the highest increase of fruit set and yield, in addition KNO_3 at 4% comparing with 2% and 6%. Also, KNO_3 treatments increased fruit size, peel thickness and juice acidity especially with high concentrations; on the other hand, the use of GA_3 at 50 or 100 ppm alone or with 0.5% urea increased fruit T.S.S and reduced nitrite and nitrate contents in fruit juice as compared with KNO_3 treatments. Moreover, it is noticed that trees sprayed at first application or first and second time of application gave the best results, while second application was the best for reducing fruit splitting. It could be recommended the best treatment for increasing yield and gave high fruit quality is GA_3 at 50 ppm with or without 0.5% urea at full bloom stage especially in respect with reducing nitrite and nitrate in fruit juice, and use KNO_3 4% at the second time of application to reduce fruit splitting.

[Abd El-Rahman, G.F.; Hoda, M.Mohamed and Ensherah, A.H. Tayh. **Effect of GA_3 and Potassium Nitrate in Different Dates on Fruit Set, Yield and Splitting of Washington Navel Orange.** Nature and Science 2012;10(1): 148-157]. (ISSN: 1545-0740). http://www.sciencepub.net. 19

Key word: GA_3, Navel Orange, KNO_3, Fruit Set, Yield

1. Introduction

Navel orange is a popular fresh fruit due to its seedless, large size, characteristic flavor and aroma (Wardowski, *et al*., 1985). Also, navels orange are in important source of early season income for citrus growers in some commercial citrus areas of the world. Yields are erratic and usually low in many areas due to lack functional pollen, rarely produce viable ovules and in addition, are weakly parthenocarpic (Krezdorn, 1965). Flower and fruit drop of navel orange occurred in three phases and amount to a total 91%, giving a fruit set of 9% (Villafane, *et al*., 1989). Gibberellic acid (GA_3) and potassium nitrate have a board range of uses in citriculture; Gibberellins have been used in citrus production with several objectives including bloom reduction, increased fruit setting, improvement of fruit quality and improved maturation control (Agustí and Almela, 1991). The application of gibberellic acid soon after flowering at doses between 10 and 15 ppm can result in delayed abscission and increased fruit set, mainly in Clementine tangerines (Fornes *et al*., 1992; El-Otmani, 1992). However, the increase in fixing and productivity does not happen frequently and depends on factors including variety, plant status and time of application (Davies, 1987; Talón et al., 1997).Also, GA_3 increased fruit set in navels orange (Smith, 1993; Babu and Lavania, 1985), in tangerine hybrids (Brosh and Monselise, 1977) and increased the yield either as number or weight of fruits per tree of Washington navel orange (Ibrahim, *et al*., 1994). Positive results have been obtained with potassium nitrate supplementation even with good plant nutritional status, which is possibly related to the lower ability to mobilize mineral reserves necessary for the period (Ruiz *et al*., 2001). On the other hand, potassium decreases the loss of fruit from splitting (Lavon, *et al*., 1992); also, GA_3 reduces fruit splitting when applied shortly after the end of the June drop in "Nova" hybrid mandarin (Garcia, *et. al.* 1994). GA_3 application improved fruit quality (Davies, *et al*., 1999 and 2001), while KNO_3 increased fruit size and juice acidity for Shamuti and Valencia oranges (Erner *et. al.* 1993).

The purpose of this work is to study the effect of Gibberellic acid (GA_3) and potassium nitrate (KNO3) sprays at different times and concentrations on fruit set, yield, fruit splitting and fruit quality on Washington navel orange trees. Hence, to identify the best treatments for achieve the highest return for the growers.

2. Material and Methods

The experiment was carried out in the private orchard belonged for Mr. Hassan Marie in Benha, El-Kalubiah Governorate, Egypt, in 2008 and 2009 seasons on forty-years-old of "Washington navel" (*Citrus Sinensis*) orange trees grafted on Sour orange rootstock (*Citrus aurantium*, L.Obseck) and were planted at 5×5 m spacing in clay soil. Ninety-six "Washington navel" orange trees were divided into twenty four groups according to vigor and number of flowers and used for data collection. The design was a randomized block with 4 single-tree replicates and 8 treatments with 3 time intervals of spray all treatments. The experiment involved the following eight treatments. GA_3 at 50 ppm and 100 ppm plus the same concentrations of GA3 with 0.5% urea; potassium nitrate treatments was used at three levels 2, 4 and 6%; the control trees untreated. Trees were sprayed on full bloom stage (first application), fruit diameter from 1.5-2.0 cm (second application) and both (first and second time of application). The total number of flowers was counted before treatments and commercially available urea containing 46% N and Berlex (containing 92% GA_3 and 8% of other gibberellins) were used in the trials. Triton B at 0.1% was used as a wetting agent for all spraying solutions. In addition foliar spray of potassium treated as KNO_3 98%. All trees generally received adequate organic and inorganic fertilization. Irrigation was given at intervals of about 10-15 days in summer and 15-21 days in winter. However, a balanced foliar fertilization of all microelements was adopted three times yearly (February, May and August). The following parameters of the studied treatments were carried out.

Percentage of fruit set.

Fruitlets and fruits drop were expressed as an accumulative percentage per tree. Percentage of fruit set = number of fruit set during a given interval × 100/ number of fruit at the beginning of the interval.

Yield

Weight (kg) and number of mature fruits per tree were recorded at late November of each season.

Fruit splitting percentage

Determination dates of beginning primary symptoms of splitting for each treatment were observed and recorded. Total number of fruits was counted for each tree at the end of July to end of October 2008 and 2009. Percentage of fruit splitting was calculated using the following equation. Fruit splitting percentage = number of splitting fruits × 100/ Total number of fruits.

Nitrite and nitrate contents in fruit juice

A sample of 10 ml of fruit juice was taken from each replicate to determine nitrite and nitrate according to the methods outlined by (Sen and Donaldson, 1978).

Physical properties of fruits

Fruit weight, fruit size, fruit length and diameter and peel thickness for each fruit were measured by using the varinier caliper. Juice volume, also Juice weight percentage was calculated by using the following equation. Juice weight % = average juice weight (gm.) / fruit × 100 / average fruit weight (gm.).

Chemical properties of fruits

Total soluble solids (T.S.S %) was determined by using Zeiss hand refractometer, total acidity was determined according (A.O.A.C., 1995), also T.S.S/Acid was calculated.

Statistical analysis

The experiment was designed in completely randomized block design with four replicates for each treatment and each replicate was represented by one tree. The obtained data of both seasons were subjected to analysis of variance according to (Clark and Kempson, 1977) and the means were differentiated using Duncan multiple range test at 5% level (Duncan, 1955).

3. Results and Discussion

Fruit set percentage

It is obvious from Tables (1&2) that the difference between the use of gibberellic acid and potassium nitrate on fruit set of Washington navel orange were significant. The results revealed that, trees spraying with both GA_3 and KNO_3 enhanced fruit set, whereas trees treated by GA_3 50ppm + 0.5% urea gave significantly the highest fruit set percentage at (30, 60,165 and 205 days) after full blooming followed by trees sprayed with GA_3 50ppm alone, while the lowest values of fruit set percentage were obtained by trees treated by KNO_3 2% and control treatment meanwhile, the other treatments gave the intermediate values in this regard during the two seasons. On the other hand, concerning the time intervals of spray for all treatments, data revealed that, trees sprayed at (first application+ second application) had the highest significant values for fruit set followed by (first application) while (second application) gave the lowest significant values during two seasons. Several scientific trials show that the gibberellins increase the cell wall flexibility by stimulating the synthesis of new cellulose polymers (Richards et al., 2001). The present results are a general in harmony with (Davies, 1987) who stated that, gibberellins could reduce the senescence of leaves and fruits. Also; (Brosh, *et al,* 1975 and Tominaga, 1998) reported that, GA_3 and KNO_3 decreased abscission of fruitlets in navel oranges and grapefruit. In addition, potassium nitrate (KNO_3) enhanced fruit set and increased yield of orange and mandarin trees (El-Deeb, 1989; El-Fangary, 1998 and Mostafa, *et al*., 2005).

Fruit weight (gm)

Results in Table (3) showed that no constant trend during two studied seasons for fruit weight due to different treatments was noticed on Washington navel orange. Whereas, foliar sprays of trees by KNO3 2% scored the highest significant values for fruit weight at the (first and second time of application) in the first season, while trees sprayed with GA3 50ppm gave the maximum values at full bloom stage in the second season. On the other hand, trees treated by GA_3 100 ppm gave the lowest significant values for fruit weight at (second time of application) and (first and second time of application) in the first season. Meanwhile, the lowest values were on KNO_3 4% treatment at full bloom stage in the second season. Anyhow, the differences between all treatments were high to be significant.

Fruit number/tree

Data in the Table (3) revealed that, all treatments increased fruit number with some fluctuations as compared with control treatment .On the other hand, it was noticed that the maximum fruit number were obtained during foliar sprays of trees at full bloom stage (first application) and (first and second time of application) while (second application) gave the lowest significant values of fruit number in the first and second season.

Yield

Yield as weight (Kg/tree or ton/fed.) are shown in Table (4) yield was significantly increased by all treatments either with spraying gibberellic acid or with KNO_3 at any concentrations as compare to the control treatment. However, yield was gradually increased by spraying of KNO_3 2% than the control then the range of increase was higher when trees treated by KNO_3 at 6% then 4 % concentrations and reached the maximum with gibberellic acid (GA_3) treatments especially (GA_3 50ppm + 0.5%urea) which gave the highest yield (yield Kg/tree and ton/fed.) for the first and second seasons. Also, data revealed that trees sprayed at (first application) and (first and second time of application) scored the higher averages as compared with those sprayed at (second application). From the above results, it is interest to notice that, GA_3 and KNO_3 at different rates spraying increased the yield of Washington navel orange trees. These results are in the same line with those obtained by (Smith, 1993; Babu and Lavania, 1985) in navel orange and (Brosh and Monselise, 1977) in tangerine hybrids; they found that gibberellic acid (GA_3) increased fruit set. Also, (Ibrahim, *et al*. 1994) reported that, trees spraying with GA_3 increased the yield of Washington navel orange. Likewise, (El-Fangary, 1998 and Mostafa, *et al*., 2005) found that, KNO_3 enhanced fruit set and increased yield of orange and mandarin trees.

Fruit splitting percentage

It is evident from the results shown in Fig. (1 & 2) that gibberellic acid and potassium nitrate treatments decreased fruit splitting percentage as compared with control treatment especially trees treated by KNO3 6% gave the lowest significant values of fruit splitting due to the peel thickness of fruits which increased with increasing the concentration of potassium nitrate Table (8). This finding is in parallel with the finding of (Josan *et al*., 1995) in Lemon who reported that the thicker peel helps to resist fruit puncture. While the other treatments gave the intermediate values during two seasons (2008 & 2009). Also, it can be noticed that, the splitting tendency is greatly depended on the stage of development of the fruit whereas, full bloom stage (first application) scored the maximum significant average for fruit splitting while, trees treated at (second application) or (first and second time of application) had the minimum significant averages of fruit splitting, although GA_3 treatments scored decreasing of fruit peel thickness, these results may be due to the elastic walls of fruit cells as a result of spraying with GA_3 in these stages .This explanation can be agreed with (Richards et al., 2001) they found that, the gibberellins increase the cell wall flexibility by stimulating the synthesis of new cellulose polymers.

Nitrite and nitrate content in fruit juice

As shown in Tables (5 & 6) results revealed that, nitrite and nitrate contents in fruit juice were affected by different treatments in the two seasons. It is clear that, trees sprayed with (KNO_3) gave the highest values for nitrite and nitrate in their fruit juice especially with high concentrations, while, trees sprayed with gibberellic acid (GA_3) either 50 ppm alone or plus 0.5 % urea gave the lowest values in fruit juice than the other treatments. This means that, the beneficial effect of spraying GA_3 either 50 ppm or plus 0.5% urea was mainly on reducing nitrite and nitrate in fruit juice. Also, it is noticed from Table (5 & 6) that the time of applications did not show any distinctive effect on nitrite and nitrate contents in fruit juice in the first and second seasons. In this respect, (Ibraheem, 1994 and Abd El-Migeed, *et al*., 2007) mentioned that, mineral nitrogen fertilization easily forms nitrate in fruit juice as compare with using organic fertilizers.

Table (1) Fruit set percentage (after 30 & 60 days) of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 and 2009 seasons.

	Fruit set % (after 30days)								Fruit set % (after 60days)							
	2008, Season				2009, Season				2008, Season				2009, Season			
Treatments(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2))	Mean(T)
Control	64.80j	64.80j	64.80j	**64.80E**	66.65i	66.65i	66.65i	**66.65E**	27.09i	27.09i	27.09i	**27.09D**	28.06k	28.06k	28.06k	**28.06F**
GA_3 50ppm	74.0cde	66.45hij	77.2abc	**72.55B**	75.3cd	69.15ghi	79.75a	**74.73B**	33.10c	29.16defg	35.74a	**32.67A**	34.81cd	29.42ik	36.69ab	**33.64B**
GA_3 100ppm	69.90fg	66.20hij	75.0bcd	**70.37C**	72.6def	67.00i	76.10bc	**71.90C**	30.92d	28.10ghi	33.60c	**30.87B**	32.86fg	28.56k	35.16cd	**32.19CD**
$GA_3$50ppm+0.5%urea	76.8abc	69.30fgh	79.40a	**75.17A**	78.5ab	72.33def	81.20a	**77.34A**	35.57ab	30.79d	37.48abc	**33.61A**	37.01ab	31.47hi	37.80a	**35.43A**
$GA_3$100ppm+0.5%urea	71.70ef	67.5ghij	77.90ab	**72.37B**	73.5cde	68.70hi	79.0ab	**73.73B**	30.91d	28.22fghi	34.45abc	**31.19B**	33.33ef	28.56k	35.99bc	**32.63C**
KNO_3 2%	65.35ij	64.90j	65.10ij	**65.12E**	67.25hi	66.82i	67.0i	**67.02E**	27.40hi	27.11i	27.54hi	**27.30D**	28.08k	28.05k	28.41k	**28.33F**
KNO_3 4%	68.2ghi	67.0ghij	73.20de	**69.47CD**	70.10fgh	68.25hi	74.30cde	**70.88CD**	30.08def	28.80efgh	33.74bc	**30.87B**	31.65ghi	28.87k	34.40de	**31.64D**
KNO_3 6%	67.45ghi	66.70hij	69.0fgh	**67.59D**	69.0ghi	66.90i	71.75efg	**69.22D**	29.58defg	27.79ghi	30.53de	**29.29C**	30.71ij	28.27k	32.29fgh	**30.42E**
Mean (Time)	**69.78B**	**66.56C**	**72.70A**		**71.61B**	**68.23C**	**74.47A**		**30.57B**	**28.37C**	**32.15A**		**32.06B**	**28.96C**	**33.60A**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (2) Fruit set percentage (after 165 & 205 days) of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 and 2009 seasons.

	Fruit set % (after 165days – color break)								Fruit set % (after 205days)							
	2008, Season				2009, Season				2008, Season				2009, Season			
Treatments(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)
Control	5.97g	5.97g	5.97g	**5.97E**	6.30h	6.30h	6.30h	**6.30E**	2.04g	2.04g	2.04g	**2.04D**	2.18j	2.18j	2.18j	**2.18D**
GA_3 50ppm	7.85b	7.0bcd	8.69a	**7.92B**	8.38c	6.57gh	9.02b	**7.99B**	2.77b	2.32def	3.09a	**2.73B**	2.99cde	2.22ij	3.25bc	**2.82B**
GA_3 100ppm	6.7def	6.59efg	7.46bcd	**6.92CD**	7.31ef	6.56gh	7.98cd	**7.28C**	2.33def	2.10fg	2.6bcd	**2.34C**	2.57fgh	2.23ij	2.84def	**2.54C**
$GA_3$50ppm+0.5%urea	8.69a	7.69bc	9.45a	**8.61A**	9.45b	7.89cd	10.03a	**9.12A**	3.12a	2.61bcd	3.39a	**3.04A**	3.44ab	2.76def	3.70a	**3.30A**
$GA_3$100ppm+0.5%urea	6.91cde	6.56efg	7.81b	**7.09C**	7.53de	6.75gh	8.36c	**7.55C**	2.42cde	2.16efg	2.73bc	**2.44C**	2.68fg	2.29hij	2.99cde	**2.65BC**
KNO_3 2%	6.07g	6.05g	6.10g	**6.07E**	6.31h	6.36h	6.36h	**6.34E**	2.09fg	2.04g	2.09fg	**2.07D**	2.18j	2.19j	2.22ij	**2.20D**
KNO_3 4%	6.75def	6.19fg	7.69bc	**6.88CD**	7.50def	6.45h	8.30c	**7.42C**	2.39def	2.17efg	2.76b	**2.44C**	2.68fg	2.26ij	3.00cd	**2.65C**
KNO_3 6%	6.64efg	6.00g	7.02cde	**6.55D**	7.02fg	6.38h	7.55de	**6.98D**	2.31def	2.15efg	2.5bcd	**2.32C**	2.49ghi	2.27ij	2.70efg	**2.49C**
Mean (Time)	**6.95B**	**6.54C**	**7.52A**		**7.48B**	**6.66C**	**7.99A**		**2.43B**	**2.20C**	**2.65A**		**2.65B**	**2.30C**	**2.86A**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (3) Fruit weight and number of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 and2009 seasons.

	Fruit weight (gm.)								Fruit number / tree							
	2008, Season				2009, Season				2008, Season				2009, Season			
Treatments(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)
Control	232gh	232gh	232gh	**232D**	268g	268g	268g	**268D**	310g	310.g	310.0g	**310.0D**	290.0j	290.0j	290j	**290.0E**
GA_3 50ppm	248d	222jk	220jk	**230D**	310a	294cd	298c	**300.7A**	510d	517d	580abc	**535.7B**	436de	350.0i	440de	**408.7C**
GA_3 100ppm	225ij	210L	210L	**215F**	304b	284e	292d	**293.3B**	580abc	535cd	636a	**538.7A**	400.7fg	370hi	434.3de	**401.7C**
$GA_3$50ppm+0.5%urea	230hi	224j	217k	**223.7E**	278f	280ef	292d	**283.3C**	555bcd	541cd	610ab	**568.7A**	503.3a	385gh	460bcd	**449.4A**
$GA_3$100ppm+0.5%urea	208L	240ef	218k	**222E**	272g	282ef	298c	**284C**	600ab	510d	620a	**576.7A**	471.7bc	380gh	430ef	**427.2B**
KNO_3 2%	206L	254c	272a	**244B**	210n	220m	233kl	**220.9G**	387f	293.3g	330g	**336.8D**	375ghi	350.0i	400g	**375.0D**
KNO_3 4%	262b	248d	236fg	**248.7A**	232L	252h	245i	**243E**	442.7ef	400ef	440ef	**427.6C**	488ab	395gh	471bc	**451.3A**
KNO_3 6%	238ef	242e	238ef	**239.3C**	237jk	238j	231L	**235.3F**	440e	400ef	430ef	**424.8C**	445cde	394gh	451cde	**430.0B**
Mean (Time)	**231.1B**	**234.0A**	**230.4B**		**263.9B**	**264.7B**	**269.6A**		**478.6A**	**438.3B**	**494.5A**		**426.2A**	**364.3B**	**422A**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (4) Yield (Yield Kg. /tree and ton / fed.) of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 and 2009 seasons.

	Yield Kg. /tree							
	2008, Season				2009, Season			
Treatments(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)
Control	72.02j	72.02j	71.02j	**71.90C**	77.54k	77.54k	77.54k	**77.54G**
GA_3 50ppm	127abcd	115cdef	127.6abcd	**123.2A**	133.4abc	102.5hi	130.95bc	**122.2B**
GA_3 100ppm	130.6abc	111.9defg	136.39a	**126.3A**	121.7de	105.1hi	126.7cd	**117.8C**
$GA_3$50ppm+0.5%urea	127.5abcd	121.2abcd	132.4ab	**127.0A**	139.95a	107.75gh	134.29ab	**127.3A**
$GA_3$100ppm+0.5%urea	124.7abcd	122.3abcd	135.23a	**127.4A**	128.3bcd	107.13gh	128.07bcd	**121.2BC**
KNO_3 2%	79.86ij	74.87ij	90.11hi	**81.61C**	78.62k	76.95k	93.01j	**82.86F**
KNO_3 4%	115.7bcde	98.83fgh	102.7fgh	**105.7B**	113.2fg	99.33ij	115.18ef	**109.2D**
KNO_3 6%	105.8efgh	97.31gh	102.3fgh	**101.8B**	105.6hi	93.69j	103.69hi	**101.0E**
Mean (Time)	**110.4A**	**101.7B**	**112.3A**		**112.3A**	**96.21B**	**113.7A**	

	Yield ton / fed.							
	2008, Season				2009, Season			
Treatments(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)
Control	11.52j	11.52j	11.52j	**11.52C**	12.44k	12.44k	12.44k	**12.44G**
GA_3 50ppm	20.3abcd	18.39cdef	20.42abc	**19.71A**	21.35abc	16.40hi	20.95bc	**19.57B**
GA_3 100ppm	20.9abc	17.91defg	21.82a	**20.21A**	19.48de	16.81hi	20.28cd	**18.86C**
$GA_3$50ppm+0.5%urea	20.4abcd	19.4abcd	21.18ab	**20.32A**	22.39a	17.24gh	21.49ab	**20.37A**
$GA_3$100ppm+0.5%urea	19.95abcd	19.57abcd	21.64a	**20.39A**	20.53bcd	17.14gh	20.49bcd	**19.39BC**
KNO_3 2%	12.78ij	11.98ij	14.42hi	**13.06C**	12.58k	12.31k	14.88j	**13.26F**
KNO_3 4%	18.51bcde	15.81fgh	16.42fgh	**16.92B**	18.11fg	15.89ij	18.43ef	**17.48D**
KNO_3 6%	16.92efgh	15.57gh	16.36fgh	**16.29B**	16.89hi	14.99j	16.59hi	**16.16E**
Mean (Time)	**17.66A**	**16.27B**	**17.97A**		**17.97A**	**15.41B**	**18.19A**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

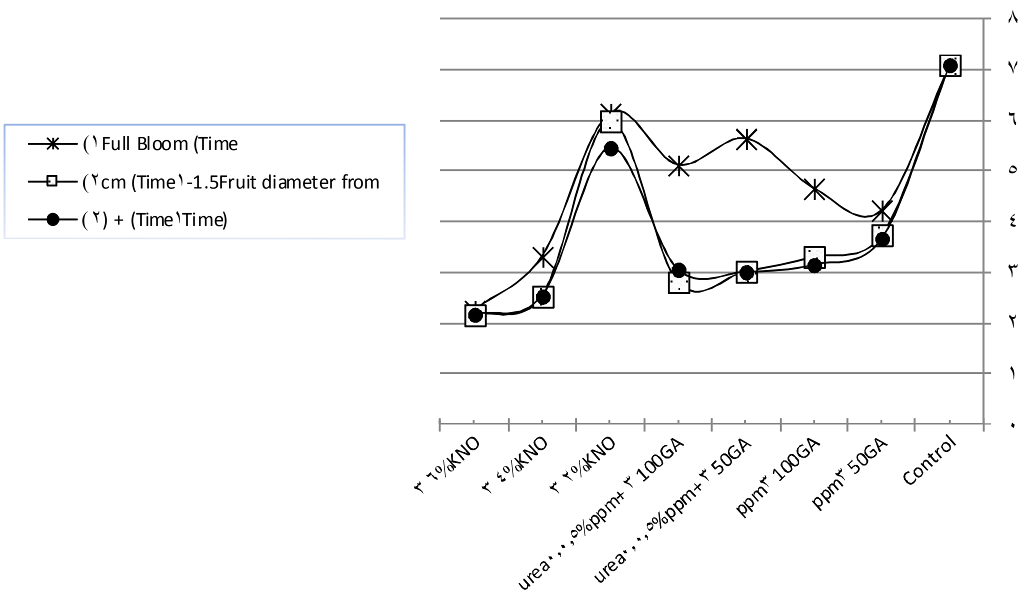

Fig. (2) Fruit splitting percentage of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 season.

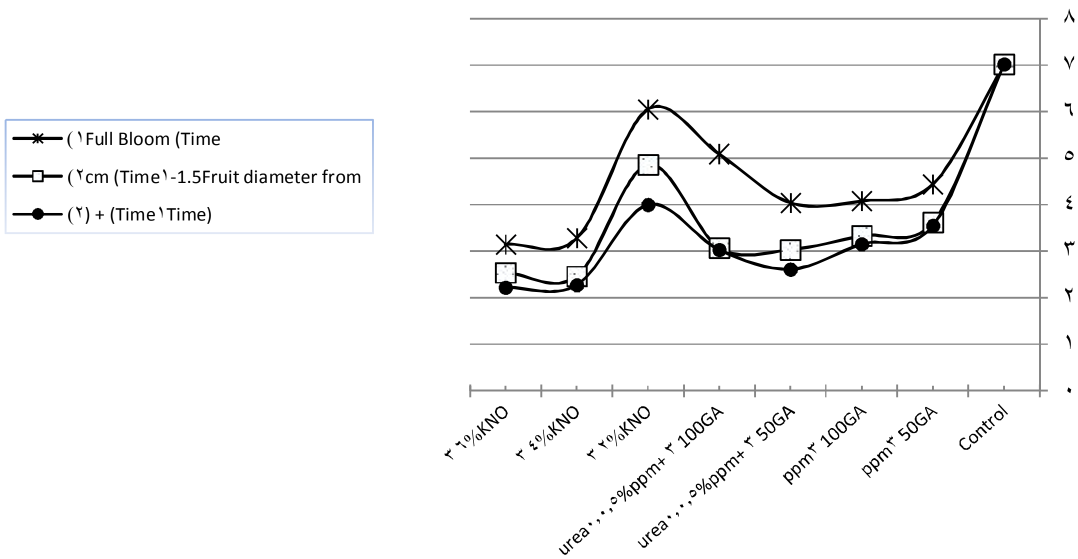

Fig. (2) Fruit splitting percentage of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2009 season.

Table (5) Nitrite in fruit juice of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 and2009 seasons.

	NO2 (ppm							
	2008, Season				**2009, Season**			
Treatments(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	**Mean(T)**	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	**Mean(T)**
Control	2.51cdef	2.51cdef	2.51cdef	**2.51CD**	2.53fg	2.53fg	2.53fg	**2.53C**
GA_3 50ppm	2.51cdef	2.49def	2.50def	**2.50CD**	2.51g	2.53fg	2.54fg	**2.53C**
GA_3 100ppm	2.48ef	2.51cdef	2.47f	**2.49D**	2.54fg	2.54fg	2.53fg	**2.54BC**
$GA_3$50ppm + .0.5%urea	2.52cdef	2.54cd	2.52cdef	**2.53C**	2.56defg	2.57cdef	2.56defg	**2.56B**
$GA_3$100ppm + 0.5%urea	2.51cdef	2.50def	2.53cde	**2.51CD**	2.58bcde	2.56defg	2.55efg	**2.56B**
KNO_3 2%	2.61ab	2.56bc	2.60ab	**2.59AB**	2.60abcd	2.62abc	2.61abc	**2.61A**
KNO_3 4%	2.52cdef	2.64a	2.60ab	**2.58B**	2.61abcd	2.63ab	2.62abc	**2.62A**
KNO_3 6%	2.60ab	2.60ab	2.65a	**2.62A**	2.63ab	2.64a	2.65a	**2.64A**
Mean (Time)	**2.53 A**	**2.54 A**	**2.55 A**		**2.57 A**	**2.58 A**	**2.58 A**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (6) Nitrate in fruit juice of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 and2009 seasons.

	NO3 (ppm)							
	2008, Season				2009, Season			
Treatments(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	**Mean(T)**	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	**Mean(T)**
Control	46.40efg	46.40efg	46.40efg	**46.40C**	43.38fg	43.38fg	43.38fg	**43.38D**
GA_3 50ppm	40.52jkl	42.65ij	44.66ghi	**42.61D**	38.41i	39.53hi	44.66f	**40.83E**
GA_3 100ppm	40.51jkl	40.49jkl	40.49jkl	**40.50E**	43.35fg	42.56fg	44.57f	**43.49D**
GA_3 50ppm + 0.5%urea	38.24L	39.61kl	40.71jk	**39.53E**	38.61i	39.72hi	41.61gh	**39.98E**
GA_3 100ppm + 0.5%urea	40.60jkl	43.67hi	46.54efg	**43.60D**	48.41e	48.52e	54.52bc	**50.48C**
KNO_3 2%	47.41def	48.56cde	45.30fgh	**47.09C**	53.55bcd	48.79e	51.75d	**51.36C**
KNO_3 4%	47.29ef	48.66cde	49.72bcd	**48.55B**	52.53cd	52.36cd	55.72b	**53.54B**
KNO_3 6%	50.94abc	51.14ab	52.54a	**51.54A**	54.47bc	55.59b	59.62a	**56.56A**
Mean (Time)	**43.99 B**	**45.15 A**	**45.80 A**		**46.59 B**	**46.31 B**	**59.62 A**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different

Physical properties of fruits

Fruit diameter and length (mm)

Data in Table (7) indicated that the statistical analysis showed no significant differences between all treatments on Washington navel orange fruits in the first season, while trees sprayed with GA_3 100 ppm enhanced significant increased fruit diameter and length (mm) in the second season. Anyhow, the differences between all treatments were low to be significant.

Fruit size (mL)

It is clear from Table (8) that, all treatments increased fruit size as comparing with control especially with high concentration of potassium nitrate in the first and second season (2008 &2009 may be due to increasing of fruit peel thickness. The present results are in a general harmony with (Okada, et al., 1994) on Satsuma mandarin they mentioned that fruit size increased as K fertilization increased, also (Abd El-Rahman, 2005) found that spraying with promalin at 45 ppm and GA_3 at 50 ppm increased fruit size on navel orange fruits.

Peel thickness (mm)

Data in Table (8) showed that, peel thickness was affected by different treatments in the first and second seasons, and it is clear that, GA_3 treatments reduced significant values for fruit peel thickness, on the other hand, it is noticed that, peel thickness increased with increasing the concentration of potassium nitrate. The same observation was reported by (Zaied, *et al.*, 2006) on Washington navel orange.

Juice weight percentage of fruits is shown in Table (9); the changes of juice weight percentage were slightly fluctuated during two seasons. No obvious trend could be detected between all treatments. These results agree with the finding of (Abd El-Rahman, 2005) on navel orange trees, who mentioned that spraying gibberellic acid had no significant effect on juice weight percentage. In the same direction (Davies et al., 1999) stated that, effects of GA_3 on juice fruits were variable, this inconsistency may be related to time of application.

Chemical properties

T.S.S percentage:

Table (9) clearly showed that all treatments did not show a constant trend during two seasons for T.S.S percentage in fruit juice of Washington navel orange. Data also indicated that, spraying trees with KNO3 at 4% gave the lowest significant values for T.S.S % comparing with other treatments. Anyhow, the differences between all treatments were low to be significant.

A similar trend was obtained with navel orange (Ibrahim, *et al.* 1994 and Abel El-Rahman, 2005). On the other hand, (Mostafa and Saleh 2006) found that T.S.S content in the fruit juice increased with potassium sprays on Balady mandarin trees.

Acidity

Table (10) reflects that trees sprayed with GA_3 50 ppm had the highest significant acidity for Washington navel orange fruits in the first season, while, trees treated by potassium nitrate treatments gave the maximum acidity for their fruits in the second seasons especially with higher concentration. Meanwhile, the other treatments scored the intermediate significant values in this regard for two seasons.These results are in the same line with those obtained by (Ibrahim, et al., 1994) who found that total acidity were no significant effected by GA_3 treatment. Also, (Erner, *et al.* 1993) reported that trees spraying with KNO_3 increased juice acidity on Shamouti and Valencia oranges.

Table (7) Fruit diameter and length of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 and 2009 seasons.

Treatments(T)	Fruit diameter (mm) 2008, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Fruit diameter (mm) 2009, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Fruit length (mm) 2008, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Fruit length (mm) 2009, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)
Control	75.6abc	75.6abc	75.6abc	**75.6A**	79.6abcd	79.6abcd	79.6abcd	**79.6AB**	79.65a	79.65a	79.65a	**79.65A**	81.8abc	81.8abc	81.8abc	**81.8BC**
GA_3 50ppm	77.3abc	74.4abc	71.43 c	**74.38A**	79.6abcd	80.99abc	83.44a	**79.6AB**	81.46a	79.19a	80.90a	**80.52A**	81.2abc	84.88ab	83.1abc	**83.1ABC**
GA_3 100ppm	75.2abc	74.4abc	74.2abc	**74.62A**	82.95ab	82.50ab	82.69ab	**82.71A**	79.58a	81.28a	77.56a	**79.47A**	85.11ab	85.56a	85.94a	**85.54A**
$GA_3$50ppm+0.5%urea	74.9abc	76.6abc	73.6abc	**75.00A**	81.48ab	81.53ab	82.54ab	**81.5AB**	79.04a	80.57a	79.54a	**79.72A**	82.7abc	82.1abc	82.1abc	**82.3BC**
$GA_3$100ppm+0.5%urea	74.4abc	72.33bc	74.2abc	**73.62A**	80.2abcd	81.40ab	82.54ab	**81.4AB**	79.32a	78.47a	79.39a	**79.20A**	83.4abc	84.75ab	84.2abc	**84.1AB**
KNO_3 2%	72.6abc	77.6abc	79.85a	**76.68A**	75.38cd	79.5abcd	80.38abc	**78.40B**	77.67a	80.56a	83.42a	**80.55A**	79.38c	82.4abc	81.3abc	**81.02C**
KNO_3 4%	78.91ab	77.4abc	75.4abc	**77.25A**	80.58abc	79.6abcd	77.36bcd	**79.16B**	80.96a	80.94a	82.48a	**81.46A**	81.5abc	82.6abc	80.38bc	**81.5BC**
KNO_3 6%	77.0abc	77.1abc	77.1abc	**77.06A**	79.3abcd	78.4abcd	79.3abcd	**78.99B**	79.77a	79.43a	82.46a	**80.55A**	82.5abc	81.5abc	81.5abc	**81.85BC**
Mean (Time)	**75.73A**	**75.68A**	**75.15A**		**79.24A**	**80.42A**	**80.85A**		**79.68A**	**80.07A**	**80.68A**		**82.21a**	**83.21a**	**82.55a**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (8) Fruit size and Peel thickness of Washington navel orange trees as affected by gibberellic acid and potassium nitrate during 2008 and09seasons.

Treatments(T)	Fruit size (ml) 2008, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Fruit size (ml) 2009, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Peel thickness (mm) 2008, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Peel thickness (mm) 2009, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)
Control	248i	248i	248i	**248FG**	296g	296g	296g	**296E**	4.46i	4.46i	4.46i	**4.46D**	4.10g	4.10g	4.10g	**4.10C**
GA_3 50ppm	275d	250i	250i	**258.3D**	346abcd	330bcde	332bcde	**336BC**	3.49p	3.61O	3.79n	**3.63H**	3.90i	3.70k	3.10O	**3.57G**
GA_3 100ppm	260g	250i	242j	**250.7F**	320cdef	310efg	320cdef	**316.7D**	3.85m	4.83d	4.28j	**4.32G**	3.27m	3.63L	4.03h	**3.64F**
$GA_3$50ppm+0.5%urea	255h	270e	236k	**253.7E**	300fg	325cdef	320cdef	**315D**	3.99L	4.63g	4.65g	**4.42E**	3.10O	3.15no	3.20n	**3.15H**
$GA_3$100ppm+0.5%urea	240jk	252hi	248i	**246.7G**	320cdef	317defg	330bcde	**323.3CD**	4.9bc	4.11k	4.06k	**4.35F**	3.60L	3.84j	3.70k	**3.71E**
KNO_3 2%	285c	270e	265f	**273.3C**	335bcde	350abc	345abcd	**343.3AB**	4.71f	4.87bcd	4.53h	**4.70C**	4.10g	4.20f	3.80j	**4.03D**
KNO_3 4%	290b	270e	270e	**276.7B**	330bcde	360ab	350abc	**346.7AB**	4.29j	5.10a	4.84cd	**4.74B**	3.70k	4.30e	4.44d	**4.15B**
KNO_3 6%	295a	275de	275d	**281.6A**	360ab	338abcd	368a	**355.3A**	4.77e	4.66fg	4.92b	**4.78A**	4.60b	4.51C	5.80a	**4.97A**
Mean (Time)	**268.5A**	**260.6B**	**254.3C**		**325.9A**	**328.3A**	**332.6A**		**4.31C**	**4.53A**	**4.44B**		**3.80C**	**3.93B**	**4.02A**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (9) Juice weight and T.S.S percentage in Washington navel orange fruits as affected by gibberellic acid and potassium nitrate during 2008 and2009 seasons.

Treatments(T)	Juice weight (%) 2008, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Juice weight (%) 2009, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	T.S.S (%) 2008, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	T.S.S (%) 2009, Season: Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)
Control	56.0efg	56.0efg	56.0efg	**56.0C**	53.7hijk	53.7hijk	53.7hijk	**53.7C**	10.5abc	10.5abc	10.5abc	**10.5ABC**	11.00a	11.00a	11.00a	**11.00A**
GA_3 50ppm	59.7bc	61.3ab	62.73a	**61.2A**	51.9k	56.5efg	54.4ghij	**54.3C**	10.5abc	10.abcd	10.5abc	**10.3ABC**	10.5ab	10.5ab	10.00ab	**10.3ABC**
GA_3 100ppm	61.3ab	60.0bc	58.1cde	**59.8B**	55.3fghi	54.9fghi	53.4ijk	**54.5C**	10.0abcd	11.00a	10.0abcd	**10.3ABC**	11.00a	11.00a	10.00ab	**10.67AB**
$GA_3$50ppm+0.5%urea	60.0bc	63.40a	55.3fgh	**59.6B**	56.1def	52.8jk	53.4ijk	**54.4C**	9.8bcd	9.50cd	10.25abc	**9.86BC**	10.5ab	9.50b	10.25ab	**10.08BC**
$GA_3$100ppm+0.5%urea	56.7defg	53.3hi	56.9def	**55.7C**	52.9jk	53.9hijk	56.0efg	**54.3C**	11.00a	10.83ab	10.0abcd	**10.61A**	11.00a	10.5ab	10.5ab	**10.67AB**
KNO_3 2%	56.3efg	55.1fgh	54.4gh	**55.3C**	55.7efgh	57.7cde	60.9ab	**58.1B**	11.00a	10.3abc	10.0abcd	**10.42AB**	10.5ab	11.00a	10.8ab	**10.77AB**
KNO_3 4%	58.0cde	51.6lj	56.8def	**55.5C**	59.4abc	62.5a	62.5a	**61.5A**	10.0abcd	9.7cd	9.50cd	**9.73C**	10.0ab	9.50b	9.80ab	**9.77C**
KNO_3 6%	59.7bc	50.41j	58.8cd	**56.3C**	59.4bc	58.6cd	59.7bc	**59.2B**	11.00a	9.00d	10.0abcd	**10.0ABC**	9.90ab	10.0ab	10.5ab	**10.13BC**
Mean (Time)	**58.47A**	**56.39C**	**57.38B**		**55.65B**	**56.32AB**	**56.74A**		**10.48A**	**10.10A**	**10.09A**		**10.55A**	**10.38A**	**10.36A**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (10) Acidity percentage and T.S.S / Acid ratio in Washington navel orange fruits as affected by gibberellic acid and potassium nitrate during 2008 and 2009 seasons.

	Acidity (%)								T.S.S / Acid ratio							
	2008, Season				2009, Season				2008, Season				2009, Season			
Treatments(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)	Full Bloom (Time1)	Fruit diameter from 1.5-2.0cm (Time2)	(Time1) + (Time2)	Mean(T)
Control	1.07efg	1.07efg	1.07efg	**1.07CD**	0.96fg	0.96fg	0.96fg	**0.96B**	9.81d	9.81d	9.81d	**9.81C**	11.5ef	11.5ef	11.5ef	**11.5CD**
GA_3 50ppm	1.25a	1.16c	1.22ab	**1.21A**	0.84ijk	0.84ijk	0.79k	**0.82D**	8.40j	8.6hij	8.61ij	**8.55F**	12.5cd	12.5cd	12.66c	**12.55B**
GA_3 100ppm	1.07efg	1.12cde	1.14cd	**1.11B**	0.92gh	0.88hij	0.96fg	**0.92C**	9.35ef	9.82d	8.8ghij	**9.31D**	12.0de	12.5cd	10.42h	**11.63C**
$GA_3$50ppm+0.5%urea	1.08ef	1.05fg	1.14cd	**1.09BC**	0.99ef	0.84ijk	0.89hi	**0.91C**	9.1efg	9.1efg	9.0fgh	**9.05E**	10.61h	11.3fg	11.5ef	**11.15D**
$GA_3$100ppm+0.5%urea	1.09def	0.96i	1.07efg	**1.04E**	0.82k	0.73L	0.83jk	**0.79E**	10.1cd	11.28b	9.35ef	**10.24B**	13.41b	14.38a	12.65c	**13.48A**
KNO_3 2%	1.12cde	0.86j	0.96i	**0.98F**	1.08ab	1.07abc	1.0def	**1.05A**	9.82d	11.92a	10.41c	**10.72A**	9.72i	10.27h	10.8gh	**10.26E**
KNO_3 4%	0.96i	1.09def	0.96i	**1.00F**	1.10a	0.99ef	1.0cde	**1.04A**	10.4bc	8.9ghi	9.90d	**9.74C**	9.09j	9.60ij	9.62ij	**9.44F**
KNO_3 6%	1.17bc	0.99hi	1.02gh	**1.06DE**	1.1abcd	1.04bcde	1.1abcd	**1.05A**	9.40e	9.1efg	9.81d	**9.43D**	9.47ij	9.58ij	9.52ij	**9.52F**
Mean (Time)	**1.10A**	**1.04C**	**1.07B**		**0.97A**	**0.92B**	**0.94B**		**9.55B**	**9.81A**	**9.46B**		**11.03B**	**11.45A**	**10.08B**	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

T.S.S acid ratio

It is evident from Table (10) that T.S.S acid ratio did not show any obvious trend in the first and second season. Concerning the time of foliar spraying, the results indicated that trees sprayed at second time (fruit diameter from 1.5-2.0 cm) recorded the highest significant values for T.S.S. acid ratio with KNO_3 2% followed by GA_3 100 ppm + 0.5% urea on Washington navel orange fruits than the other times of applications in the first season (2008).While, GA_3 100 ppm + 0.5% urea gave the highest significant values for T.S.S. acid ratio in (second application and first application) respectively in the second season (2009). Also, it could be noticed that, the differences between all treatments were high to be significant.

Conclusion

From the above mentioned results, it could be concluded that, fruit set, yield as weight ton/fed., and fruit quality especially in respect with reducing nitrite and nitrate in fruit juice of Washington navel orange were greatly improved with spraying trees GA_3 50 ppm with or without 0.5 % urea. Concerning the application times it could be noticed that, both full bloom (first application) or full bloom + fruit diameter from 1.5-2.0 cm (first and second time of application) gave the best results so, we could be recommended to use (first application) to reduce the costs for growers and giving the best yield and fruit quality. Treatments that increase brix and reduce acid early in the season provide two benefits. Growers can gain the economic advantage of harvesting early and can avoid the economic loss due worsening crease as harvest is delayed as mentioned by (Carol J. Lovatt, 2000).

Corresponding author
Abd El-Rahman, G.F.
Citrus Department, Hort. Res. Instit., Agric. Res. Center, Giza, Egypt
gamalelashmanty@yahoo.com

References:

1. **A.O.A.C., (1995).** Official methods of analysis of A.O.A.C. Pub.By official A.O.A.C. chapter 4, p.18-20, 37, p. 10, 44 p.8-9.
2. **Abd El-Rahman, G.F. (2005).** Physiological and anatomical studies on fruit drop in navel orange trees. Ph.D. Thesis, Fac. Agric,.Al Azhar Univ.
3. **Abde El-Migeed, M.M.M.; Saleh, M.M.S. and Mostafa, E.A.M. (2007).** The beneficial effect of minimizing mineral nitrogen fertilization on Washington navel orange trees by using organic and bio-fertilizers, World Journal of Agric. Sci. 3 (1): 80-85.
4. **Agustí, M.F and V.O. Almela. (1991).** Aplicación de fitorreguladores em citricultura. Barcelona, Aedos., pp. 261.
5. **Babu, -Ghur and Lavania, ML. (1985).** Effect of plant growth regulators on fruit set and fruit drop of plant lemon-1 (*Citrus limon Burn*). Indian Journal of Horticulture, 42 (3/4) 237-240.
6. **Brosh, P. and Monselise, S.P. (1977).** Increasing yields of "Topaz" mandarin by gibberellin and girdling in the presence of "Minneola" Pollinizers. Scientia Hort. 7:369-372.
7. **Brosh, P.; Oren, Y. and Shani, M. (1975).** Preharvest autumn drop of grapefruit in central area. Alon ha Notea, 29: 506-509 (Hebrew).
8. **Carol J. Lovatt. (2000)**. Use of Urea and Growth Regulators to Increase Fruit Set and/or Size and Quality of Citrus.Citrus_Research Board 2000 Annual Report. Department of Botany and Plant Sciences, University of California at Riverside
9. **Clarke, G.M.and Kempson, R.E. (1977).** Introduction to the design and analysis of

experiments. Arnold, A. Member of the Holder-Headline Group. I[st] Edt. London, UK.

10. **Davies, F.S.; Campbell, C.A. and Fidelibus, M.W. (2001).** Gibberellic acid tank mix and adjuvant effects on peel quality and juice yield of "Hamlin" oranges. Hort Technology 11:171-174.
11. **Davies, F.S.; Campbell, C.A.; Zalman, G. and Fidelibus, M. (1999).** Gibberellic acid application timing effects on juice yield and peel quality of "Hamlin" oranges, Proc. Fla. State Hort. Soc. 112: 22-24.
12. **Davies, P.J., (1987).** Plant hormones and their role in plant growth and development. Martinus Nijhoff Publishers, Dordrecht, p. 681.
13. **Duncan, D.B. (1955).** Multiple ranges and multiple F-tests. Biometrics, 11: 1-42.
14. **El-Deeb, M.D.E. (1989).** Studies on the nutritional status of citrus in some areas of Kaliobyia, Ph.D. Thesis. Fac.of Agric., Moshtohor, Zagazig Univ.
15. **El-Fangary, M.A. (1998).** Physiological studies on growth and fruiting of citrus trees. Ph.D. Thesis, Fac. Agric. Moshtohor, Zagazig Univ.
16. **El-Otmani, M. (1992).** Principal growth regulator uses in citrus production. Proc. 2nd. Seminar on Citrus Physiology. Bebedouro. Ed. Cargill. pp. 55-69.
17. **Erner, Y.; Kaplany.; Artzi, B. and Hamou, M. (1993).** Increasing citrus fruit size using auxins and potassium. Acta Horticulturae, No. 329, 112-119.
18. **Fornes, F., P.J.J. Van-Rensburg, M. Sánches-Perales and J.L. Guardiola. (1992).** Fruit setting treatments effects on two Clementine mandarin cultures. Proc. in. Soc. Citric. 1:489-492.
19. **Garcia, L.; Duarte, A.M.M.; Porras, I.; Garcia, A. and Guardiola, J.L. (1994).** Fruit splitting in "Nova" hybrid mandarin in relation to the anatomy of the fruit and fruit set treatments. Scientia Horticulturae Volume 57, Issue 3, April 215-231.
20. **Ibrahim, T. (1994).** Water pollution, Part I. Science and life series, Egyptian organization for Books, Cairo, Egypt, pp. 58-61.
21. **Ibrahim, T.A.; Salem, S.E. and Guindy, L.F. (1994).** The influence of gibberellic acid and promalin on the yield and fruit quality of Washington Navel orange. Bulletin, Fac. Agric. Univ. Cairo, 45: 711-722.
22. **Josan, J.S., Sandhu, A.S. and Jasbir, K. (1995).** Pericarp anatomy in relation to fruit cracking in Lemon (Citrus Limon) .Indian Journal of agricultural Science, 65 (6), 410- 430.
23. **Krezdorn, A.H. (1965).** Fruit setting problems in citrus Proc. Carib. Reg. Amer. Soc. Hort. Sci. 9:85-92.
24. **Lavon, R.; Shapchiski, S., Mohel, E. and Zur.N.(1992).** Nutritional and hormonal sprays decreased fruit splitting and fruit creasing of "Nova" Hasade, 72: 1252-1257 (Hebrew).
25. **Mostafa, E.A.M.; Hassan, H.S.A. and El-Sabag, A.S. (2005).** Influence of spraying GA_3 and KNO_3 on yield, (2005).Influence of spraying GA_3 and KNO_3 on yield, fruit quality and leaf mineral contents of Balady mandarin trees. Minufiya J. Agric. Res. 30 (1):283-295.
26. **Richards, D.E., K.E. King, T. Ait-ali and N. Harberd. (2001).**How gibberellin regulates plant growth and development: A molecular genetic analysis of gibberellin signaling. Annu. Rev. Plant. Physiol. Plant. Mol. Biol. 52: 67-88.
27. **Ruiz, R., A. García-Luiz, C. Monerri and J.L. Guardiola. (2001).** Carbohydrate availability in relation to fruit-set abscission in Citrus**. Annals of Botany. 87:805-812.**
28. **Sen, N.P. and Donaldson, B.D (1978).** Improved colorimetric method for determining nitrate and nitrite.Food J. Assoc. Anal. Chem., 6: 1389-1395.
29. **Smith, C.J. (1993).** Improving of fruit set of navels in the citrusdal area. In ligtings bulletin. Institute – Vir- Tropiese-en, subtropiese-Gewasse. No. 240, 27-32.
30. **Talón, M., F.R. Radeo, A. Gómez-Cadena and E. Primo-Millo. (1997).** Regulación hormonal de la caída de frutos inducida por defoliaciones en mandarinos Satsuma. Agric. Vergel 186:334-350.
31. **Tominaga, S. (1998).** GA sprays delay and reduce physiological fruit drop in Ponkan mandarin (*Citrus reticulate Blanco*), Acta Horticulturae, 463: V. III International symposium on plant bio-regulation in fruit production.
32. **Villafane, VE.; Munoze, F. JE and Torres, HR. (1989).** Flowering growth and ripening of the orange Washington Valley Citrus, Acts. Agronomica, Universidad-Nacional de Colombia 39: (3-4) 142-149.
33. **Wardowski, W.F.; Nagy, S. and Grierson,W. (1985).** Fresh citrus fruits. Avi. Publ. Co., Inc. Westport, USA, pp. 79-83.
34. **Zaied, S.; Khafagy, S.A.A. and Saleh, M.A. (2006).** Effect of nitrogen and potassium fertilization on vegetative growth, fruit set and quality of Washington navel orange trees. Journal of Applied Sciences Research, 2 (11): 851-857.

12/12/2011