Zagazig J. Agric. Res., Vol. 38 No. (3) 2011 545-562

EFFECT OF NITROGEN APPLICATION DOSES AND SPRAYING UREA, GA_3 AND NAA ON FLOWERING, FRUIT SET AND FRUIT DROP PERCENTAGES OF WASHINGTON NAVEL ORANGE TREES

Mohamed M. Ibrahim*, R.A. AL-Ashkar, A.A. Tawfik and K.M. Abdalla

Hort. Dept., Fac. Agric., Zagazig Univ., Egypt

ABSTRACT

The effect of GA_3, NAA and urea as well as the time of N application (Feb., May and August) three doses or (early Dec., Feb., May and August) four doses were studied on fruit set, fruit drop and fruit retention percentages. Fifteen-years-old Washington navel orange trees grown in a private citrus orchard at Minia El-Kamh, Sharkia Governorate, Egypt during three seasons 2008, 2009 and 2010 were used for this study.

Spraying GA_3 three times a year at 10 ppm (beginning of flowering, full bloom and fruit set), four N applications (early Dec., Feb., May and August) and their interactions gave the maximum fruit set, fruit retention percentages and reduced total drop percentage. Four N applications reduced June drop and primary fruitletss drop percentages, but primary fruitlets and June fruit drop percentages were higher under GA_3 spraying treatments. Earliness of flowering in spring was affected by some factors; i.e., N fertilization, temperature and water stress. Nitrogen application four times/ year gave early flowering (about one week earlier). However, the interaction between four doses and urea sprays at 2% three times a year gained similar results.

Keywords: Citrus, navel orange, nitrogen, fertilization, growth regulators.

---

* **Corresponding author:** Mohamed M. Ibrahim, **Tel.:** +20105456118
E-mail address: mmnasr@zu.edu.eg.com.

INTRODUCTION

Washington navel orange trees (*C. sinensis* (L.) Osbeck) is one of the most important citrus varieties grown in Egypt. It confronts two serious problems of poor fruit set and heavy fruit drop.

Fertilizer placement and timing of application are managed to improve nutrient uptake efficiency and minimize N loses. A combination of optimal irrigation and management was considered important to improve N uptake efficiency, maintain optimal crop yield and minimize NO_3 leaching below the root zone of the trees (Alva *et al.*, 2001).

Iwasaki and Owada (1960) stated that late autumn N application gave a considerable yield increase in Japanese satsuma orange. Citrus trees were able to accumulate reserves of nitrogen in the autumn and early winter mainly in the bark, wood and roots. These reserves were very important for early spring tree and fruit growth. Moreover, El-Nabawy *et al.* (1975) found that higher rate of nitrogen added early in November caused about 26% and 41% increases in fruit set in the first and second seasons, respectively. Depending on the trees N content and balance of growth regulators floral development may continue or shift to vegetative flush (Protacio, 2000). Application of N later during the growing period will have minimal impact on the fruit yield. However, it could contribute to N reserve in the tree, which may be utilized for fruit production in the following year (Alva *et al.*, 2001).

Many questions have arisen about the use of winter foliar applications of low-biuret urea. Several investigators reported that spraying urea at different rates was of announced effect on increasing the yield of the sprayed trees in terms of weight and number of fruits (Darwish *et al.*, 1992; Ali and Lovatt 1994; El-Otmani *et al.*, 2000; Albrigo, 2000; Malik *et al.*, 2000).

Plant growth regulators play an important role in the growth, flowering and fruit set of different crops, particularly gibberellic Acid and naphthline acetic acid, since it encourage fruit set and reduce fruit drop in many citrus species and varieties (Babu and Lavania, 1986; Ghosh and Chattopadhyay, 1994;

Josan *et al.*, 1997; Patil *et al.*, 2002; Almeida *et al.*, 2004; Thirugnanavel *et al.*, 2007; Mansour and Eissa 2008; Saleem *et al.*, 2008). Therefore, the present study was undertaken to investigate the effect of N application, urea, GA_3 and NAA on fruit set, fruit drop and fruit retention percentages in Navel orange trees under Minia El-Kamh orchardes, Sharkia Governorate, Egypt.

MATERIALS AND METHODS

The present work was conducted on thirty two Washington navel orange trees (*C. sinensis* (L.) Osbeck). The experimental trees (15-year-old) were budded on sour orange rootstock and planted at 5 m apart in clay soil during three successive seasons of 2008-2010 under flood irrigation system. The trees were of uniform vigor and growth and kept under uniform conditions of soil and orchard management.

The experiment included two factors: the first was consisted of spraying urea at 2% three times a year (1st Dec., 1st Jan. and 1st Feb.), GA_3 or NAA at 10 ppm three times/ year (beginning of flowering, full bloom and fruit set), beside water spray as a control. The second factor was adding N at 1000 g N/ tree/ year (819.5 kg ammonium sulfate 20.5% /fed.) at 3 or 4 doses. The first N dose was added at 100 kg ammonium sulfate/ fed. at early Dec. in four doses treatment. The three doses either in three or four doses treatments were equally added at (Feb., May and August).

Earliness of flowering (days) counted for control trees at full bloom recorded zero then calculate the difference between it and the other treatments.

To determine fruit set, fruit drop and fruit retention percentages along the growth season, the emerged flowers on four branches at the different tree directions were counted at the balloon stage by the end of March of each season. After fruit set, the setted fruitletss were counted on the same branches at the end of April (25 – 30 April in the three seasons). Fruit set percentage and consequently the percentage of the dropped flowers (flower drop percentage) were calculated. The remaining fruitletss on the previous branches were counted. Fruitlets drop percentage (primary

fruit drop) was then calculated. Thereafter, the remaining fruits were recounted by the end of June and December of each season to estimate June and preharvest fruit drop percentages as well as fruit retention percentage, respectively.

The obtained data were statistically analysed according to split plot design with four replicates containing one tree for each replicate. The individual comparisons between the obtained values were carried out using LSD at 5 % level according to (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

Effect of GA_3, NAA, Urea and Number of N Applications on Flowering Date of Washington Navel Orange Trees

Data in Table 1 show that flowering date of Washington navel orange trees was significantly affected by the tested treatments in the three seasons. However, trees sprayed with urea at (1st Dec., 1st Jan. and 1st Feb.) flowered earlier than the other treatments.

Trees fertilized four times a year flowered earlier than those received N three times/ year by 6.44, 6.69 and 6.56 days in the first, second and third seasons, respectively.

The first spray of GA_3 and NAA did not show the earliest days for flowering.

The interaction between the two tested factors was significant in the three seasons and revealed that sprayed trees with urea and N fertilized for four times a year were the earliest in flowering by (7.75, 7.75 and 7.50 days) in the three seasons, respectively.

The obtained herein results are in line with Salazar-Garcia *et al.* (2000) working on mango verities. They found that the three biweekly sprays of NH_4NO_3 2% or 4% beginning in November caused full bloom (anthesis) of 'Manila' mango to occur 37 and 34 days ahead of control, respectively. Also, urea (containing 46%N) was applied as a foliar spray to fully mature trees during the periods of flowers initiation differentiation, fruit set and 'June drop'. Urea was used at the rate of 1 kg/100 L and trees were sprayed to the point of run-off (El-Otmani *et al.*, 2004). They found that more fruit of Clementine mandarin were of export grade by the first harvest date indicating an indirect effect of urea on earliness.

Table 1: Effect of GA_3, NAA, urea and number of N applications on earliness of flowering (days) of Washington navel orange trees (2008, 2009 and 2010 seasons)

Spraying materials (A)	2008 season			2010 season			Third season		
	Number of N applications (B)			Number of N applications (B)			Number of N applications (B)		
	3	4	Av.	3	4	Av.	3	4	Av.
Water (cont.)	0.00	5.75	2.88	0.00	6.25	3.13	0.00	6.25	3.13
Urea	0.00	7.75	3.88	0.00	7.75	3.88	0.00	7.50	3.75
GA_3	0.00	6.25	3.13	0.00	6.25	3.13	0.00	6.00	3.00
NAA	0.00	6.00	3.00	0.00	6.50	3.25	0.00	6.50	3.25
Average	0.00	6.44		0.00	6.69		0.00	6.56	
NewL.S.D. 0.05									
A		0.50			0.43			0.43	
B		0.32			0.28			0.34	
A x B		0.65			0.57			0.69	

Table 2: Effect of GA_3, NAA, urea and number of N applications on fruit set percentage of Washington navel orange trees (2008, 2009 and 2010 seasons)

Spraying materials (A)	First season			Second season			Third season		
	Number of N applications (B)			Number of N applications (B)			Number of N applications (B)		
	3	4	Av.	3	4	Av.	3	4	Av.
Water (cont.)	20.37	23.03	21.70	24.65	27.61	26.13	26.97	30.15	28.56
Urea	26.56	27.09	26.82	29.95	32.49	31.22	30.38	33.69	32.04
GA_3	32.59	36.01	34.30	34.61	37.58	36.10	35.26	38.59	36.92
NAA	28.61	30.02	29.31	32.34	35.15	33.74	31.69	34.84	33.26
Average	27.03	29.04		30.39	33.21		31.07	34.32	
NewL.S.D. 0.05									
A		0.71			1.42			2.16	
B		0.49			1.09			0.66	
A x B		0.98			2.18			1.32	

Chermahini *et al.* (2011) stated that spraying urea at three rates: 0, 0.5% and 1% just 9 weeks before full bloom promoted flowering formation, while 6 weeks before full bloom resulted in thicker ovary with higher percentage of fruit set compared to the control trees. Winter application of low-biuret urea significantly improved the leaf age, tree vigour and production of 'Blood Red' sweet oranges through improving flowering without any improvement in fruit setting (Saleem *et al.*, 2011).

Effect on Fruit Set Percentage

Data in Table 2 show that spraying GA_3, NAA or urea significantly affected fruit set percentage of Washington navel orange trees in the three seasons. However, water sprayed trees (control treatment) gained the lowest fruit set percentage (21.70, 26.13 and 28.56 %) compared to those sprayed with GA_3 (34.30, 36.10 and 36.92 %) which recorded the highest fruit set percentage in the three seasons, respectively. The other spraying treatments (urea and NAA) resulted inbetween fruit set percentages.

Generally, the above mentioned results indicated that GA_3, NAA and urea treatments significantly increased fruit set percentage in descending order during the three seasons. This increase might be due to the effect of GA_3, NAA and urea on preventing the formation of abscission zone as indicated by Davies (1987).

Concerning the effect of number of nitrogen doses, the data show that trees fertilized four times (early application in Dec.) yielded higher fruit set percentages (29.04, 33.21 and 34.32 %) compared with three does (27.03, 30.39 and 31.07 %) in the three seasons, respectively. Fruit set percentage was markedly increased with the increase of nitrogen application doses.

The interaction between spraying treatments and number of nitrogen doses was significant in the three seasons. Higher fruit set percentages (36.01, 37.58 and 38.59 %) were recorded for tress sprayed with GA_3 and received four N doses compared with water sprayed trees and fertilized three times (20.37, 24.65 and 26.97 %) in the three seasons, respectively. The other combinations produced inbetween percentage.

In this respect, numerous investigators found that increasing number of nitrogen doses associated with early application prior to or during flowering time markedly increased fruit set percentage (Reuther *et al.*, 1957; El-Hennawy, 1975; El-Nabawy *et al.*, 1975; Govind and Prasad 1983; Tayeh *et al.*, 2003). They reported that the greatest increase in fruit set percentage was correlated with the increase in number of nitrogen doses which produced the best tree condition. In the meantime, Rabe and Rensburg (1996), Xin and Lin (2000), El-Rahman (2003), Thirugnanavel *et al.* (2007) and Mansour and Eissa (2008), found that spraying GA_3 and urea caused a marked increase in fruit set.

In a study on nitrogen fertilizing of Mlyagawa satsuma trees carried out between 1990-1992, by Mooney *et al.* (1991) and Mooney and Richardson, (1992) showed that nitrogen applied in late autumn was more efficieniant than nitrogen applied at the traditional time of early spring.

Effect on Primary Fruitlets Drop Percentage

Data in Table 3 show that spraying GA_3, NAA and urea significantly affected primary fruitlets drop percentage of Washington navel orange trees during the three seasons. Water sprayed trees in the first two seasons and GA_3 sprayed trees in the third season showed the lowest furitlet drop percentage (15.67 and 21.01 and 23.27 %), respectively compared to those sprayed with GA_3, NAA and urea (16.32, 24.34 and 24.67 %) which exhibited the highest fruitlets drop percentage in the first, second and third seasons, respectively, without significant differences between among them and other treatments in each season.

The effect of number of nitrogen doses was significant in the three studied seasons. However, the highest primary fruitlets drop percentage (16.33, 24.33 and 24.68 %) were recorded for trees fertilized by 3 N doses compared to those treated with 4 doses (15.83, 22.09 and 23.58 %) in the three seasons, respectively.

The interaction between the two tested factors was also significant in the three seasons. The highest primary fruitlets drop percentages (17.20, 25.97 and 25.22 %) were recorded for trees sprayed with (NAA, GA_3 and urea and fertilized three times a year), while the lowest percentages (15.02, 20.22 and 22.05 %) were exhibited by (NAA × 4, control × 4 and GA_3

x 4 doses) treatments in the three seasons, respectively. The other combinations produced intermediate primary fruitlets drop percentages.

Observations reported by Francisco and Miguel (1998) indicated that GA_3 generates histological changes in the pedicel and that these changes correspond to increases in the number of cells of cortex, xylem and pith. Also, Mansour and Eissa (2008) found that most GA_3 and urea treatments were accompanied with increasing initial fruit setting and primary fruitlets drop percentage.

Effect on June Drop Percentage

Data in Table 4 reveal that spraying GA_3, NAA and urea significantly affected June drop or physiological fruit drop percentage throughout the studied seasons. However, trees of the control treatment induced the lowest June drop percentage (2.76, 2.75 and 1.40%) in the three seasons, respectively. Trees sprayed with NAA and urea gave inbetween percentages (6.72 and 6.30%) and (2.93 and 2.92%) without significant differences between them in the first and second seasons, respectively. The highest June drop percentage was recorded for trees sprayed with GA_3 (9.19 and 3.19%) in the first two seasons and NAA (3.19%) in the third one without significant difference between NAA and GA_3 sprayed trees in the third season.

June fruit drop percentage of Washington navel orange trees was significantly affected by the number of nitrogen doses in the three seasons. Anyhow, trees received four doses/ year showed the lower June drop percentages (5.74, 2.48 and 2.25%) compared with those treated by three doses which gave higher percentages (6.73, 3.41 and 2.72%) in the first, second and third seasons, respectively.

The interaction was also significant in the three seasons. The lowest June fruit drop percentages (2.31, 2.23 and 1.34%) were recorded for trees treated by (water sprayed trees x 4 doses), while the highest percentages (9.32 and 3.60%) were produced from trees treated with (GA_3 x 3 doses) without significant differences between (GA_3 x 3 doses) and (GA_3 x 4 doses) in the first and second seasons, respectively. On the other hand, trees treated with (NAA x 3 doses) gave the highest June drop percentage (3.58%) in the third season. The other combinations produced inbetween June fruit drop percentages.

Table 3: Effect of GA_3, NAA, urea and number of N applications on primary fruitlets drop percentage of Washington navel orange trees (2008, 2009 and 2010 seasons)

Spraying materials (A)	First season			Second season			Third season		
	Number of N applications (B)			Number of N applications (B)			Number of N applications (B)		
	3	4	Av.	3	4	Av.	3	4	Av.
Water (cont.)	15.55	15.78	15.67	21.79	20.22	21.01	24.27	24.49	24.38
Urea	16.40	16.04	16.22	24.33	22.19	23.26	25.22	24.11	24.67
GA_3	16.18	16.46	16.32	25.97	22.49	24.23	24.49	22.05	23.27
NAA	17.20	15.02	16.11	25.22	23.45	24.34	24.73	23.66	24.20
Average	16.33	15.83		24.33	22.09		24.68	23.58	
NewL.S.D. 0.05									
A		0.57			1.78			0.99	
B		0.37			1.24			0.67	
A x B		0.74			2.48			1.34	

Table 4: Effect of GA3, NAA, urea and number of N applications on June fruit drop percentage of Washington navel orange trees (2008, 2009 and 2010 seasons)

Spraying materials (A)	First season			Second season			Third season		
	Number of N applications (B)			Number of N applications (B)			Number of N applications (B)		
	3	4	Av.	3	4	Av.	3	4	Av.
Water (cont.)	3.21	2.31	2.76	3.27	2.23	2.75	1.46	1.34	1.40
Urea	7.60	5.00	6.30	3.38	2.46	2.92	2.53	2.34	2.44
GA_3	9.32	8.99	9.19	3.60	2.78	3.19	3.30	2.51	2.91
NAA	6.77	6.66	6.72	3.40	2.45	2.93	3.58	2.80	3.19
Average	6.73	5.74		3.41	2.48		2.72	2.25	
NewL.S.D. 0.05									
A		0.69			0.43			0.47	
B		0.72			0.45			0.18	
A x B		1.44			0.89			0.35	

Generally, four N applications reduced June drop and primary fruitletss drop percentages, but the GA_3 gained adverse effect of June drop and primary fruitletss in the first and second seasons only. It was found ineffective due to fruit set increase and the competition between fruitletss on nutrients especially nitrogen.

On the other hand, Atawia and Desouky (1997); Patil *et al.*, (2002) and El-Rahman (2003), who found that spraying GA_3 and NAA reduced June drop percentage compared with the control.

Effect on Preharvest Fruit Drop Percentage

As shown in Table 5, the preharvest fruit drop percentage was significantly affected by the tested GA_3, NAA and urea treatments in the first and third seasons only. However, water sprayed trees gave the highest preharvest fruit drop percentage (0.70 and 0.42 %), whereas the lowest percentage was recorded for trees sprayed with NAA (0.42 and 0.22 %) in the first and third seasons, respectively. The other spraying treatments (urea and GA_3) produced intermediate preharvest fruit drop percentages without significant differences between them in the first and third seasons only.

Regarding the number of nitrogen doses effect, the data show that preharvest fruit drop percentage was significantly affected in the three seasons. Anyhow, the uppermost percentages (0.57, 0.25 and 0.36 %) were recorded for three doses treatments, while the lowermost percentages (0.49, 0.19 and 0.25 %) were recorded for four N doses treatment during the three seasons, respectively.

The interaction between spraying treatments and number of nitrogen doses were significant in the three studied seasons. The highest preharvest fruit drop percentages (0.71, 0.27 and 0.51 %) were recorded for water sprayed trees received three doses compared with those sprayed with GA_3 in the first and NAA in the last two seasons and received four doses which produced the lowest percentages (0.33, 0.16 and 0.18 %) in the three seasons, respectively. Trees received four N doses and sprayed with NAA or GA_3 gave statistically equal preharvest fruit drop percentages in the second and third seasons. The other combinations produced inbetween percentages.

These results are in line with those of Rahemi and Moghaddas (2003) and Almeida *et al.* (2004) who indicated that spraying NAA at 30 mg/litre (at fruit set) reduced preharvest fruit drop by 56% compared with the untreated control. On the other hand, Mansour and Eissa (2008) found that most GA_3 and urea treatments were accompanied with increasing preharvest fruit drop percentage.

Effect on Total Drop Percentage

Concerning the total drop percentage, it is obvious from data in Table 6 that spraying GA_3, NAA and urea exhibited significant effect on total fruit drop percentage in the three tested seasons. The highest total fruit drop percentages (97.43, 97.85 and 97.65 %) were recorded for water sprayed trees (control), compared to those sprayed with GA_3 (91.64, 91.54 and 89.52 %) which gave the lowest total drop percentage in the three seasons, respectively. Trees sprayed with each of urea and NAA produced inbetween percentages without significant differences in the third season only.

The number of nitrogen doses affected total fruit drop percentage significantly in the three seasons. Trees received four N doses (first application in early Dec.) produced the lowest values (93.02, 91.94 and 91.76 %) compared with those received three doses (traditional application) which gained the highest values (96.59, 97.21 and 96.68 %) in the three season, respectively.

The interaction between the two tested factors was significant in the three seasons. The uppermost total drop percentage (99.10, 99.11 and 99.28 %) were recorded for the control × three doses, compared with those treated by GA_3 × four doses (89.78, 87.87 and 86.20 %) which produced the lowermost percentage in the three seasons, respectively. The other combinations produced intermediate total drop percentages.

Similar results were found by Shukla *et al.* (2004). They indicated that application of 400 g of nitrogen (N) along with 256 g of phosphorus (P) at different intervals was most effective in reducing total fruit drop in Kinnow mandarin budded on Troyer citrange rootstock. Maji and Ghosh (2007) found that the minimum flower drop (68.25%), total fruit drop (76.0%) and the maximum fruit set (31.75%) were observed when N was applied at 500 g N/plant/year).

Table 5: Effect of GA_3, NAA, urea and number of N applications on pre-harvest fruit drop percentage of Washington navel orange trees (2008, 2009 and 2010 seasons)

Spraying materials (A)	First season			Second season			Third season		
	Number of N applications (B)			Number of N applications (B)			Number of N applications (B)		
	3	4	Av.	3	4	Av.	3	4	Av.
Water (cont.)	0.71	0.69	0.70	0.27	0.19	0.23	0.51	0.33	0.42
Urea	0.54	0.52	0.53	0.25	0.22	0.23	0.36	0.27	0.31
GA_3	0.59	0.33	0.46	0.24	0.18	0.21	0.30	0.23	0.27
NAA	0.43	0.41	0.42	0.23	0.16	0.19	0.26	0.18	0.22
Average	0.57	0.49		0.25	0.19		0.36	0.25	
NewL.S.D. 0.05									
A		0.09			NS			0.19	
B		0.04			0.03			0.09	
A x B		0.08			0.06			0.19	

Table 6: Effect of GA3, NAA, urea and number of N applications on total fruit drop percentage of Washington navel orange trees (2008, 2009 and 2010 seasons)

Spraying materials (A)	First season			Second season			Third season		
	Number of N applications (B)			Number of N applications (B)			Number of N applications (B)		
	3	4	Av.	3	4	Av.	3	4	Av.
Water (cont.)	99.10	95.75	97.43	99.11	96.60	97.85	99.28	96.02	97.65
Urea	97.98	94.47	96.23	98.01	92.39	95.20	97.73	93.02	95.37
GA_3	93.50	89.78	91.64	95.20	87.87	91.54	92.84	86.20	89.52
NAA	95.79	92.07	93.93	96.51	90.91	93.71	96.88	91.80	94.34
Average	96.59	93.02		97.21	91.94		96.68	91.76	
NewL.S.D. 0.05									
A		1.16			0.41			1.19	
B		0.76			0.39			0.63	
A x B		1.53			0.78			1.27	

Effect on Fruit Retention Percentage

It is clear from Table 7 that differences among the tested GA_3, NAA and urea treatments in fruit retention percentage were significant in the three studied seasons. The obtained results show that spraying GA_3 recorded the maximum fruit retention percentages (5.81, 3.14 and 5.41 %) in the three seasons, respectively. Also, sprayed trees with NAA gave higher fruit retention percentages (4.36, 1.27 and 3.63 %) than those sprayed with urea (3.41, 1.07 and 3.01 %) in the three seasons, respectively. The minimum fruit retention percentages (1.31, 0.92 and 1.48 %) were recorded for water sprayed trees (control) in the three seasons, respectively.

The number of nitrogen doses affected significantly fruit retention percentage in the three seasons. Fruit retention percentage was increased with increasing number of N doses. So, the higher percentages (4.07, 1.91 and 4.05%) were recorded for tress received four N doses compared with three N doses received trees which revealed lower fruit retention percentages (3.38, 1.29 and 2.72%) in the three seasons, respectively.

The interaction between the two tested factors was significant in the three seasons. The highest fruit retention percentages (6.10, 3.96 and 6.54 %) were recorded for trees sprayed with GA_3 and received four doses in the three seasons, respectively, without significant differences between them and (GA_3 × three doses and NAA × four doses) in the first season only. The lowest fruit retention percentages were obtained by the water sprayed trees received either (3 or 4 doses) in the three seasons. The other combinations showed inbetween fruit retention percentage values.

These findings are in agreement with those reported by Arora and Yamadagni (1986) who found that a dose of 750 and 1000 gm N/tree and double Zn sprays at 0.5% on Sweet lime (C. limettiods Tanaka) increased each of number of flowers/shoot, percentage of hermaphrodite flowers, initial fruit set and final fruit retention percentages.

From the above findings, it may be concluded that spraying GA_3 at 10 ppm three times a year (beginning of flowering, full bloom and fruit set) and N application at four doses resulted in the highest fruit set and fruit retention percentages and reduced fruit drop ones.

Table 7: Effect of GA_3, NAA, urea and number of N applications on fruit retention percentage of Washington navel orange trees (2008, 2009 and 2010 seasons)

Spraying materials (A)	First season			Second season			Third season		
	Number of N applications (B)			Number of N applications (B)			Number of N applications (B)		
	3	4	Av.	3	4	Av.	3	4	Av.
Water (cont.)	1.29	1.33	1.31	0.85	0.99	0.92	1.04	1.93	1.48
Urea	3.01	3.80	3.41	0.90	1.23	1.07	2.44	3.58	3.01
GA_3	5.52	6.10	5.81	2.32	3.96	3.14	4.27	6.54	5.41
NAA	3.68	5.05	4.36	1.09	1.45	1.27	3.12	4.13	3.63
Average	3.38	4.07		1.29	1.91		2.72	4.05	
NewL.S.D. 0.05									
A		0.62			0.19			0.39	
B		0.64			0.08			0.34	
A x B		1.28			0.15			0.69	

REFERENCES

Albrigo, L. G. (2000). Effects of foliar applications of urea or nutriphite on flowering and yields of Valencia orange trees. Proceedings of the Florida Horticultural Society No. 112, 1-4 (C.F. Hort. Abstr., 2001 Vol. 71 No. 1).

Ali, A. G. and C. J. Lovatt (1994). Winter application of low-biuret urea to the foliage of 'Washington' navel orange increased yield. J. Amer. Soc. Hort. Sci., 119(6): 1144-1150.

Almeida, I. M., J. D. Rodrigues and E. O. Ono (2004). Application of plant growth regulators at pre-harvest for fruit development of 'Pera' oranges. Brazilian-Archives of Biology and Technology, 47(4): 511-520 .

Alva, A. K., S. Paramasivam, K. H. Hostler, G. W. Easterwood and J. E. Southwell (2001). Effects of nitrogen rates on dry matter and nitrogen accumulation in citrus fruits and fruit yield. Journal of Plant Nutrition, 24(3): 561-572.

Arora, R. K. and R. Yamadagni (1986). Effect of different doses of nitrogen and zinc sprays on flowering, fruit set and final fruit retention in sweet lime (*C. limettioides* Tanaka). Haryana

Agricultural University Journal of Research, 16 (3): 233-239.

Atawia, A. A. R. and S. A. El-Desouky (1997). Trials for improving fruit set, yield and fruit quality of Washington navel orange by application of some growth regulators and yeast extract as a natural source of phytohormones. Ann. Agric. Sci. Moshtohor, 35(3): 1613-1632.

Babu, GH. and ML. Lavania (1986). A note on fruit maturity and colour development in lemon as affected by plant growth regulator sprays. Haryana J. Hort. Sci., 15(1/2): 59-61.

Chermahini, S. A., N.Moallemi, D. A. Nabati and A. R. Shafieizargar (2011). Winter application of foliar urea can promote some quantitative and qualitative characters of flower and fruit set of Valencia orange trees. J. Food, Agric. and Environ., 9 (1): 252-255.

Darwish, O. H., F. F. Ahmed, M. A. El-Sayed and M. A. Mohamed (1992). Foliar and soil application of urea and their effects on growth, yield and fruit quality of Balady orange trees. Minia J. Agric. Res. and Dev. (Accepted for publication).

Davies, P. J. (1987). Plant hormones and their role in plant growth and development. Martinus Nijhoff Publishers, Dordrecht, 614 – 636.

El-Hennawy, H. M. (1975). Effect of rate and date of nitrogen fertilization on yield of Navel orange trees. M. Sc. Thesis, Ain Shams Univ., Egypt.

El-Nabawy, S. M., I. M. Desouky and H. M. El-Hennawy (1975). Effect of nitrogen rate and time of application on fruit set and drop of Washington navel orange. Ann. Agric. Sci., Ain Shams Univ., 20 (2): 167- 170.

El-Otmani, M., A. Ait-Oubahou, F. Z. Taibi, B. Imoufid and M. El-Hila (2000). Problem foliar-applied urea and efficient way to increases fruit set, fruit size and yield of Clementine mandarin. Proc. Int. Soc. Citriculture,: 215-218.

El-Otmani, M., F. Z. Taibi, B. Lmoufid, A. Ait-Oubahou and C.J. Lovatt (2004). Improved use of foliar on clementine mandarin to manipulate cropping in a sustainable production system. Acta Horticulturae, 632:167-175.

El-Rahman, A. M. A. (2003). Effects of some nutrients and growth substances application on fruiting, yield and fruit quality of Navel orange trees. Bull. Fac. Agric., Cairo Univ., 54(2): 175-187.

Francisco, J. P. and G. Miguel (1998). Gibberellic acid stimulation of isoperoxidase from pedicel of grape. Phytochermistry, 48 (3): 411-414.

Ghosh, S. N. and N. Chattopadhyay (1994). Effect of growth regulators on fruit retention, yield and quality of Nagpur Santra. Hort. J., 7(1): 59-62.

Govind, S. and A. Prasad (1983). Effect of nitrogen nutrition on fruit set, fruit drop and yield in sweet orange. Punjab Hort. J., 22 (1/2): 15-20 (C. F. Hort. Abstr., 28 (3): 2972).

Iwasaki, T. and A. Owada (1960). Studies on the control of alternate bearing in citrus. 111. The effect of fertilizing in late autumn on the number of flowers and growth of shoots. J. Hort. Ass. Japan, 29: 101-106 (C.F. Hort. Abstr., 31 (2972).

Josan, J. S., A. S. Sandhu and Zora-Singh (1997). Effect of plant growth regulators sprays on the endogenous level of phytohormones and splitting of lemon fruit. Recent Horticulture, 4: 19-21.

Malik, R. P., V. P. Ahlawat and A. S. Nain (2000). Effect of foliar spray of urea and zinc sulphate on yield and fruit quality of Kinnow (mandarin hybrid). Haryana J. Hort. Sci., 29 (1/2): 37-38 (C.F. CAB Abstr., 2000).

Maji, S. and S. N.Ghosh (2007). Different nitrogen levels on flowering and fruiting behavior of pummelo (*Citrus grandis* L.). Environment and Ecology, 25 (4): 1212-1213.

Mansour, A. E. M. and R. A. R. Eissa (2008). Behaviour of flowering, dropping and fruit setting, of Washington navel and Pineapple oranges in relation to spraying GA_3 and urea. Res. J. Agric. Biol. Sci., 4 (6): 773-783.

Mooney P.A., A. Richardson and A. Harty (1991). Citrus nitrogen nutrition - A fundamental approach. Proc. Citrus Res. Seminar, NZ. June: 69-88.

Mooney P.A. and A.C. Richardson (1992). Seasonal trends in the uptake and distribution of ^{15}N in

satsuma mandarins. Proc. Int. Soc. Citriculture,: 547- 551.

Patil, D. R., H. V. Ingle and N. G. Rathod (2002). Effect of growth regulators and mulching on fruit drop and dead wood of Nagpur Mandarin. Ann. Plant Physiol., 16(2): 200-201.

Protacio, C. M. (2000). A model for potassium nitrate induced floering in mango. Acta Horticulture, (509): 545-552.

Rabe, E. and P. J. J. van Rensburg (1996). Gibberellic acid sprays, girdling, flower thinning and potassium applications affect fruit splitting and yield in the 'Ellendale' tangor. J. Hort. Sci.,71(2): 195-203.

Rahemi, M. and M. Moghaddas (2003). Effects of (2,4-dichlorophenoxy)acetic acid isopropyl ester and naphthaleneacetic acid on fruit drop, size and quality of local tangerine. Iranian J. Agric. Sci., 34 (2): 439-445.

Reuther, W., P. F. Smith, J. R. Scudder and G. Hrncias (1957). Responses of Valencia orange trees to timing, rates and ratio of nitrogen fertilization. Proc. Amer. Soc. Hort. Sci., 70: 223-236.

Salazar-Garcia, S., M.H. Perez-Barraza and V. Vazquez-Valdivia (2000). Effect of ammonium nitrate sprays on flowering and harvest time of 'Manila', 'Ataulfo', and 'Tommy Atkins' mango in Nayarit, Mexico. Acta Hort., 509:573-580.

Saleem, B. A., A. U. Malik, M. A. Pervez and A. S. Khan (2008). Growth regulators application affects vegetative and reproductive behaviour of 'Blood Red' sweet orange. Pakistan J. Botany, 40 (5): 2115-2125.

Saleem, B. A., A. U. Malik, I. A. Rajwana and A. S. Khan (2011). Foliar application of LBU influences the leaf nitrogen level, vegetative and reproductive performance of 'Blood Red' sweet orange. Pakistan J. Botany, 43 (1): 503-514.

Shukla, A. K., R. R. Sharma and A. M. Goswami (2004). Effect of nitrogen and phosphorus on fruit drop and endogenous level of GA_3 in Kinnow mandarin under high density planting. Indian J. Hort., 61 (4): 299-301.

Snedecor, G. W. and W. G. Cochran (1980). Statistical Methods, 6th ed. lowa State Univ., Amess. lowa.

Tayeh, E. A. H., M. A. El-Fangary and M. Y. Hegab. 2003. Effect of some sources of nitrogen fertilizers on pre-bearing and bearing Valencia orange trees. Ann. Agric. Sci. Moshtohor. 41(4): 1655-1680.

Thirugnanavel, A., R. Amutha, W. B. Rani, K. Indira, P. Mareeswari, S. Muthulaksmi and S. Parthiban. 2007. Studies on regulation of flowering in acid lime (*Citrus aurantifolia*, Swingle.). Res. J. Agric. Biol. Sci., 3: 4, 239-241.

Xin, W. H. and Y. R. Lin. 2000. Effect of spraying GA3 on the fruit set of fingered citron. South China Fruits. 29: 1, 16-17.

تأثير عدد مرات إضافة النيتروجين ورش اليوريا، وGA_3 و NAA على التزهير ونسبة عقد وتساقط ثمار أشجار البرتقال بسره واشنجطون

محمد محمود إبراهيم – رزق عبد الحميد الأشقر –

ألفريد عدلي توفيق – كمال الدين محمد عبد الله

قسم البساتين – كلية الزراعة – جامعة الزقازيق – مصر

تمت دراسة تأثير GA_3 ، وNAA ، واليوريا وعدد مرات إضافة النيتروجين: ٣ جرعات (فبراير، مايو وأغسطس) و ٤ جرعات (أواخر الخريف ، فبراير، مايو وأغسطس) علي ميعاد تزهير، ونسبة عقد، وتساقط الثمار، والثمار المتبقة في أشجار البرتقال بسره واشنجطون عمر ١٥ سنة ناميه في تربة طينية في بستان موالح خاص بمركز منيا القمح ، محافظة الشرقية ، مصر خلال أعوام ٢٠٠٨ – ٢٠١٠.

أعطي رش الجبريللين ٣ مرات بتركيز ١٠ جزء في المليون (في بداية التزهير، والإزهار الكامل، وعند عقد الثمار) وإضافة النيتروجين ٤ مرات (أوائل ديسمبر، فبراير، مايو وأغسطس) والتفاعل بينهم أكبر زيادة في نسب عقد الثمار ، والثمار المتبقية إلا أنه أحدث نقصاً في النسبة الكلية للتساقط ، وأدي إضافة النيتروجين ٤ مرات إلي نقص نسبة تساقط يونيو وتساقط الثميرات الأولي، في حين أدي رش الجبريللين إلي زيادة تساقط يونيو، وتساقط الثميرات الأولي في الموسم الأول والثاني فقط ويتأثر تبكير التزهير في الربيع ببعض العوامل مثل التسميد النيتروجيني، ودرجة الحرارة ، والإجهاد المائي ، وأدي إضافة النيتروجين أربع دفعات وكذا التفاعل بين ٤ دفعات والرش باليوريا بتركيز ٢٪ ثلاث مرات إلي تبكير التزهير بحوالي أسبوع.