

Behaviour of Flowering, Dropping and Fruit Setting, of Washington Navel and Pineapple Oranges in Relation to Spraying GA_3 and Urea

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Abstract: Washington Navel and Pineapple orange trees received one spray on mid. Dec. early or mid Jan. with GA_3 at 100 or 150ppm, urea at 1.0 or 1.5 % as well as GA_3 at 100 or 150 + urea at 1.0 % the effect of GA_3 and urea treatments on the ratio between leafy inflorescences / total inflorescences, leafless inflorescences / total inflorescences, initial fruit setting %, flower drop %, primary fruitlet drop % June fruit drop, preharvest fruit drop % and fruit retention % were investigated. Most GA_3 and urea treatments were accompanied with increasing leafy inflorescences / total inflorescences, initial fruit setting % , primary fruitlet drop % , preharvest fruit drop % and fruit retention % , while were responsible for reducing leafless inflorescences / total inflorescences, flower drop % and June fruit drop. Washington Navel orange trees had higher leafless inflorescences, flower drop %, June drop, preharvest fruit drop % and fruit retention % and lower leafy inflorescences , initial fruit setting % and primary fruitlet drop % compared to Pineapple orange trees. Varying dates of spraying both GA_3 and urea had an obvious effect n all the investigated characters. The best treatment responsible for retaining more flowers and fruits as well as reducing fruit dropping was the application of GA_3 at 100 ppm in combined with urea at 1.0 % at the early of Jan. for both orange cv.

Key words: Orange, Washington navel, Pineapple and Gibberlin

INTRODUCTION

Controlling flowering and dropping of flowers and fruits in citrus is considered an important merit for citrus growers for gaining an economical yield. Application of GA_3 during flower induction greatly controlled of citrus flowering and reduced flower and fruit dropping^[1,8].

A remarkable promotion on flowering and fruit setting of citrus was observed as a result of spraying urea^[9,16].

This study was conducted on the hope that GA_3 and urea may reduce the number of flowers consequently decreased the great exhaustion of mineral and organic foods to enhance fruit setting.

MATERIALS AND METHODS

This investigations was conducted during 2002/2003 and 2003/2004 on 12 year old Washington Navel and Pineapple orange onto sour orange rootstock. The trees were grown in clay loam soil at 6 m apart and grown in a private citrus orchard at Aga district, Dakahlia Governorate.

The chosen trees were subjected to the normal horticultural practices that usually followed in the orchard.

This experiment included three factors: The first factor comprised from the following seven treatments:

- Control
- GA_3 at 100ppm
- GA_3 at 150 ppm
- Urea at 1.0 %
- Urea at 1.5 %
- Urea at 1.0 % + GA_3 at 100 ppm
- Urea at 1/0 % + GA_3 at 150 ppm.

The second factor included two orange cvs namely Washington navel and Pineapple.

The third factor consisted from three dates of spraying GA_3 and Urea namely Dec. 15th, Jan. 1st and Jan. 15th.

Therefore, the experiment included 42 treatments, each treatment replicated four times (168 trees as 84 trees for each orange cv). Completely randomized block design in split split plot arrangement was followed in which GA_3 and Urea treatments were randomly arranged in the main plots, orange cultivars were distributed in the subplots and spraying dates were distributed in the sub sub plots.

To determine fruit set, fruit drop and fruit retention percentages along growth season, the emerged flowers on 4 branches at the different tree directions were counted at

the end of March of each season (at the pallon stage). After fruit set, the setted fruitlets on the same branches were counted at the second week of April (10 and 13 April in the first and second seasons, respectively). Fruit set percentage and consequently the percentage of the dropped flowers (flower drop percentage) were calculated. The remaining fruits on the previous labelled branches were counted one month after the previous count. Fruitlet 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.

Moreover, the number of total, leafy and leafless inflorescences on each branch was counted. The ratio between each of leafy and leafless inflorescences to the number of the emerged inflorescences were calculated.

Statistical Analysis: The obtained data were statistically analysed according to split split plot design with 4 replicates and one tree for each replicate^[17]. The individual comparison between different treatments were carried out using L.S.D. at 5 % level.

RESULTS AND DISCUSSION

Effect on Leafy/ Total Inflorescences Ratio: As shown in Tables 1 and 2, the tested GA₃ and urea treatments significantly affected the ratio between leafy and total inflorescences in the two seasons of study. However, the untreated (control) trees induced the lowest leafy/ total

inflorescences ratio (39.11 and 43.02) in the first and second seasons, respectively. The highest corresponding ratio was recorded for GA₃ sprayed either at 100 or 150 ppm with or without urea without significant differences between these four treatments, especially in the first season. Trees sprayed with urea either at 1.0 or 1.5 % exhibited insignificantly different intermediate leafy/total inflorescences ratios in both seasons compared to the untreated (control) trees, GA₃ at 100 ppm increased leafy/total inflorescences ratio by 97.57 and 51.21 in the two seasons, respectively.

Data in Tables 1 and 2 clearly show also that leafy / total inflorescences ratio was of insignificantly varietal differences in the two seasons. Whereas spraying data significantly affected considered ratio in the second season only. Since trees sprayed at mid December (the first date) exhibited the highest leafy/ total inflorescences ratio (64.11) followed by those sprayed at early January (62.46), while those sprayed at the third date (mid. Jun.) induced the lowest ratio (59.37).

The interaction between the three tested factors (i.e. treatments, variety and spraying data) was significantly in the first season only and confirms the previous trends of each individual factors on the ratio between leafy and total inflorescences. The highest ratio (88.58 %) was exhibited by pineapple orange trees sprayed with GA₃ at 100+ urea at 1.0 % in mid January. Washington navel orange trees sprayed with GA) at 150 ppm with or without urea induced also higher leafy/ total Inflorescences ratios (87.96% & 86.49% respectively). The untreated trees of each variety revealed the lowermost ratio at the different spraying dates.

Table 1: Effect of GA₃, urea and spraying date on leafy/total inflorescences ratio of Washington navel and Pineapple orange trees (2002/2003 season)

Treatment	Cvs.	Washington navel			Pineapple				
		Date			Treatment average	Date			
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.		15 Dec.	1 Jan.	15 Jan.	Treatment average
(1)	0 (control)	40.87	40.87	40.87	40.87	37.34	37.34	37.34	37.34
(2)	100	77.65	71.01	77.63	75.43	74.68	76.77	85.85	79.10
(3)	150	86.49	60.01	67.70	71.40	78.58	77.42	80.00	78.67
(4)	0	64.78	62.97	67.06	64.94	62.81	62.10	67.21	64.04
(5)	0	59.37	76.12	61.51	65.67	59.71	71.97	66.89	66.20
(6)	100	60.78	69.18	83.69	71.22	75.21	82.05	88.58	81.96
(7)	150	87.96	58.41	73.13	73.17	82.10	78.77	75.90	78.92
Date average		68.27	62.65	67.37	66.10	67.22	69.49	71.68	69.46
Interaction between spraying date and treatments									
Date	Treatment								
	1	2	3	4	5	6	7	Date average	
15 Dec.	39.11	76.17	82.54	63.80	59.55	68.02	85.03	67.74	
1 Jan.	39.11	73.89	68.61	62.53	74.04	75.62	68.59	66.07	
15 Jan.	39.11	81.74	73.85	67.13	64.20	86.13	74.51	69.52	
Treat. average	39.11	77.27	75.03	64.49	65.93	76.59	76.04		
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	4.35	NS	NS	6.16	NS	7.52	10.65		

Table 2: Effect of GA₃, urea and spraying date on leafy/total inflorescences ratio of Washington navel and Pineapple orange trees (2003/2004 season)

Treatment	Cvs.	Washington navel					Pineapple			
		Date					Date			
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.	Treatment average	15 Dec.	1 Jan.	15 Jan.	Treatment average	
(1)	0	0 (control)	42.96	42.96	42.96	42.96	43.08	43.08	43.08	43.08
(2)	100	0	64.02	65.22	58.86	62.70	63.03	65.57	73.57	67.39
(3)	150	0	78.37	63.86	74.03	72.09	81.77	77.67	75.17	78.20
(4)	0	1	56.78	60.48	48.66	55.31	51.58	58.12	59.15	56.28
(5)	0	1.5	54.86	61.53	52.21	56.20	55.16	53.71	53.33	54.07
(6)	100	1	72.46	70.38	63.22	68.68	82.62	77.61	63.85	74.69
(7)	150	1	71.16	62.14	54.75	62.68	79.65	72.13	68.29	73.36
Date average			62.94	60.94	46.38	60.09	65.27	63.98	62.35	63.87
Interaction between spraying date and treatments										
Treatment		Date								
Date	1	2	3	4	5	6	7	Date average		
15 Dec.	43.02	63.52	80.07	54.18	55.01	77.54	75.41	64.11		
1 Jan.	43.02	65.40	70.76	59.30	57.62	73.99	67.14	62.46		
15 Jan.	43.02	66.22	74.60	53.91	52.77	63.53	61.52	59.37		
Treat. average		43.02	65.05	75.14	55.79	55.13	71.69	68.02		
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date			
	0.067	NS	0.04	NS	NS	NS	NS			

Table 3: Effect of GA₃, urea and spraying date on leafless /total inflorescences ratio of Washington navel and Pineapple orange trees (2002/2003 season)

Treatment	Cvs.	Washington navel					Pineapple			
		Date					Date			
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.	Treatment average	15 Dec.	1 Jan.	15 Jan.	Treatment average	
(1)	0	0 (control)	59.13	59.13	59.13	59.13	62.66	62.66	62.66	62.77
(2)	100	0	22.45	29.09	22.47	24.67	25.32	23.23	14.15	20.90
(3)	150	0	13.51	40.09	32.30	28.60	21.42	22.59	20.00	21.34
(4)	0	1	35.22	37.03	32.94	35.16	37.19	37.91	32.80	35.96
(5)	0	1.5	40.63	23.98	38.59	34.34	40.27	28.03	33.11	33.81
(6)	100	1	39.22	30.82	16.31	28.88	24.74	17.95	11.43	18.04
(7)	150	1	12.04	41.69	26.97	26.84	17.90	21.23	24.10	21.08
Date average			31.73	37.35	32.63	33.90	32.79	30.51	28.32	30.54
Interaction between spraying date and treatments										
Treatment		Date								
Date	1	2	3	4	5	6	7	Date average		
15 Dec.	60.89	23.83	17.46	36.20	40.45	31.98	14.97	23.26		
1 Jan.	60.89	26.11	31.29	37.47	25.96	24.39	31.41	33.93		
15 Jan.	60.89	18.26	26.15	32.87	35.80	13.87	25.49	30.48		
Treat. average		60.89	22.73	24.97	35.51	37.7	23.41	23.96		
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date			
	4.34	NS	NS	6.14	NS	7.54	10.65			

These results are in harmony with those obtained by Davenport^[18] and Lake Alfred^[19] who worked on GA₃ and Ali and Lovatt^[11] and Lovatt^[12] who worked on urea.

Effect on Leafless/ Total Inflorescences Ratio:

It is quite evident from Tables 3 and 4, that the ratio between leafless and total inflorescences was significantly affected by the tested GA₃ and urea treatments in both seasons.

So, the highest leafless/ total inflorescences ratio (60.89 and 56.98 %) was recorded for the unsprayed trees, while the lowest ratio was gained by trees treated with

GA₃ at 100 or 150 ppm with or without urea at 1.0 % (ranging from 22.73-24.97 % and 24.86- 34.96 %) in the first and second seasons, respectively. Urea sprayed trees either at 1.0 or 1.5 % induced intermediate leafless/ total inflorescences ratio without significant differences between them in both seasons. The ratio between leafless and total inflorescences was not significant varietal differences in the two seasons. Date of spraying significantly affected the considered ratio in the second season only. Anyhow, the lowest and highest leafless/ total inflorescences ratios were recorded from trees sprayed at mid Dec. and mid Jun., respectively. The ratio

Table 4: Effect of GA₃, urea and spraying date on leafless/total inflorescences ratio /total of Washington navel and Pineapple orange trees (2003/2004 season)

Treatment	Cvs.	Washington navel				Pineapple			
		Date				Date			
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.	Treatment average	15 Dec.	1 Jan.	15 Jan.	Treatment average
(1) 0	0 (control)	57.05	57.05	57.05	57.05	56.92	56.92	56.92	56.92
(2) 100	0	35.98	34.78	41.14	37.30	36.98	34.43	26.43	32.61
(3) 150	0	21.63	36.14	25.97	27.92	18.23	22.33	24.83	21.80
(4) 0	1	43.22	39.52	51.34	44.70	48.42	41.88	40.85	43.72
(5) 0	1.5	45.14	38.47	47.80	43.80	44.84	46.29	46.67	45.93
(6) 100	1	27.54	29.62	36.78	31.32	17.38	22.40	36.15	25.31
(7) 150	1	28.84	37.86	45.25	37.32	20.35	27.87	21.71	26.66
Date average		37.06	39.06	43.62	39.91	34.73	36.02	37.65	36.13

Interaction between spraying date and treatments									
Date	Treatment								
	1	2	3	4	5	6	7	Date average	
15 Dec.	56.98	36.48	19.93	45.82	44.99	22.46	24.59	35.89	
1 Jan.	56.98	34.61	29.24	40.70	42.38	26.01	32.86	37.54	
15 Jan.	56.98	33.78	25.40	46.10	47.23	36.47	38.48	40.64	
Treat. average		56.98	34.96	24.86	44.21	44.87	28.31	31.98	
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	6.70	NS	4.04	NS	NS	NS	NS		

Table 5: Effect of GA₃, urea and spraying date on fruit set (%) of Washington navel and Pineapple orange trees (2002/2003 season)

Treatment	Cvs.	Washington navel				Pineapple			
		Date				Date			
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.	Treatment average	15 Dec.	1 Jan.	15 Jan.	Treatment average
(1) 0	0 (control)	50.42	50.42	50.42	50.42	53.96	53.96	53.96	53.96
(2) 100	0	62.00	64.88	60.67	62.51	65.51	69.93	72.80	69.41
(3) 150	0	67.71	62.36	65.47	65.18	91.20	70.40	77.15	72.92
(4) 0	1	62.42	59.91	59.59	60.64	58.96	62.87	65.34	62.19
(5) 0	1.5	50.06	57.52	58.07	55.22	60.88	65.33	61.35	62.52
(6) 100	1	61.40	64.94	69.35	65.23	68.90	72.73	75.62	72.42
(7) 150	1	67.85	67.18	64.78	66.60	73.18	72.06	70.41	71.89
Date average		60.24	61.04	61.20	60.83	66.69	68.08	66.47	

Interaction between spraying date and treatments									
Date	Treatment								
	1	2	3	4	5	6	7	Date average	
15 Dec.	52.19	63.75	69.46	60.69	55.47	65.15	70.52	62.45	
1 Jan.	52.19	67.41	66.38	61.09	61.43	68.84	69.62	63.86	
15 Jan.	52.19	66.72	71.31	62.46	59.71	72.49	67.60	64.64	
Treat. average		52.19	65.96	69.05	61.41	58.87	68.82	69.24--	
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	2.27	0.76	1.68	NS	NS	3.94	NS		

of early Jun. sprayed trees was insignificantly different with those of trees sprayed at the first and third date of spraying.

The interaction between treatments and spraying date and that between the three factors was significant in the first season only and certain the previous trends recorded for each individual factor on the considered parameters.

The results of Harty and Sutton^[2], Jasan *et al.*^[5] and Youngeet *et al.*^[8] who worked on GA₃ and Albrigo^[13] and Rathore^[16] who worked on Urea supported the present results.

Effect on Fruit Set Percentage: It is quite evident from Tables 5 and 6 that the tested GA₃ and urea treatments significantly affected fruit set percentage of Washington navel and Pineapple orange trees in the two seasons. However, control (unsprayed) trees induced the lowest fruit set percentage (52.19 and 51.85 %) compared to those with GA₃ or urea, especially trees sprayed with GA₃ at 100 ppm + urea at 1.0 % (68.82 and 67.62%) and GA₃ at 150 ppm + urea at 1.0% (69.24 and 67.06%) without significant differences between them in both seasons, respectively. Spraying trees with GA₃ at 150 ppm gained significantly higher fruit set percentage

Table 6: Effect of GA₃, urea and spraying date on fruit set (%) of Washington navel and Pineapple orange trees (2003/2004 season)

		Washington navel			Pineapple					
Treatment	Cvs.	Date			Treatment average	Date			Treatment average	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.		15 Dec.	1 Jan.	15 Jan.		
(1)	0	0(control)	50.65	50.56	50.65	50.65	53.04	53.04	53.04	53.04
(2)	100	0	62.68	60.80	54.95	59.48	62.63	64.76	68.69	65.36
(3)	150	0	67.54	64.13	66.47	66.05	72.09	69.53	69.23	70.28
(4)	0	1	53.94	57.63	57.66	56.41	55.39	68.66	32.58	62.21
(5)	0	1.5	55.60	58.31	59.73	57.88	58.97	55.25	56.42	56.88
(6)	100	1	62.16	67.14	68.38	65.39	71.63	69.19	67.20	69.34
(7)	150	1	66.46	65.45	62.65	64.85	70.82	69.19	67.83	69.27
Date average	59.86		60.59	60.07	60.17	63.51	64.23	63.57	63.77	

Interaction between spraying date and treatments									
		Treatment							
Date	1	2	3	4	5	6	7	Date average	
15 Dec.	51.85	62.65	69.81	54.67	57.29	66.90	68.64	61.69	
1 Jan.	51.85	62.78	66.83	63.15	56.78	68.16	67.31	62.41	
15 Jan.	51.85	61.82	67.85	60.12	58.08	67.79	65.24	61.82	
Treat. average	51.85	62.42	68.16	59.31	57.38	67.62	67.06	--	
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	2.33	NS	NS	3.29	NS	4.03	5.71		

Table 7: Effect of GA₃, urea and spraying date on flower drop percentage of Washington navel and Pineapple orange trees (2002/2003 season).

		Washington navel			Pineapple					
Treatment	Cvs.	Date			Treatment average	Date			Treatment average	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.		15 Dec.	1 Jan.	15 Jan.		
(1)	0	0(control)	49.74	49.94	49.74	49.74	43.43	46.43	46.43	46.43
(2)	100	0	38.00	35.03	39.36	37.46	34.49	30.07	27.20	30.59
(3)	150	0	32.27	37.64	34.53	34.81	28.80	29.60	26.18	28.19
(4)	0	1	37.58	40.09	40.42	39.37	41.04	37.73	34.66	37.81
(5)	0	1.5	49.94	42.47	41.93	44.78	39.12	34.67	38.65	37.48
(6)	100	1	38.60	35.06	30.65	34.77	31.10	27.13	24.38	27.54
(7)	150	1	32.15	32.82	35.22	33.40	26.82	27.87	29.58	28.09
Date average			39.76	38.98	38.84	39.19	35.40	33.36	32.44	33.73

Interaction between spraying date and treatments									
		Treatment							
Date	1	2	3	4	5	6	7	Date average	
15 Dec.	48.09	36.25	30.54	39.31	44.53	34.85	29.49	37.58	
1 Jan.	48.09	32.55	33.62	38.91	38.57	31.10	30.35	36.17	
15 Jan.	48.09	33.28	30.35	37.54	40.29	27.51	32.40	35.64	
Treat. average	48.09	34.03	31.50	38.59	41.13	31.15	30.74		
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	2.08	0.72	1.59	2.94	NS	3.60	NS		

(69.05 and 68.16%) than those sprayed with GA₃ at 100 ppm (65.96 and 62.42 %) in the first and second seasons, respectively. Trees sprayed with urea exhibited intermediate fruit set percentages (61.41 and 59.31% for urea at 1.0% and 58.87 and 57.38 % for urea at 1.5 %) without significant differences between them in the two seasons, respectively.

Fruit set percentage of Pineapple trees (66.47 and 63.77) higher than that of Washington navel ones (60.83 and 60.17%); in both seasons, respectively, but the significance was clear in the first season only.

Spraying date significantly affected fruit set percentage of average cvs. in the first season only. Trees sprayed at the second and third (mid Jun.) dates exhibited the highest fruit set percentages (63.86 and 64.64 %) without significant difference between them, compared to that of first date (mid Dec.) sprayed trees which fruit set percentage (62.45 %).

The interaction between the three tested factors (treatments, variety and spraying date) was significant in the second season only and confirms the prementioned trends of each individual factor on fruit set percentage.

Table 8: Effect of GA₃, urea and spraying date on flower drop percentage of Washington navel and Pineapple orange trees (2003/2004 season).

		Washington navel				Pineapple				
Treatment	Cvs.	Date			Treatment average	Date			Treatment average	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.		15 Dec.	1 Jan.	15 Jan.		
(1)	0	0(control)	49.35	49.35	49.35	49.35	46.96	46.96	46.96	46.96
(2)	100	0	43.99	39.36	45.05	42.80	34.04	35.24	31.31	33.53
(3)	150	0	32.46	35.87	33.53	33.95	27.91	30.48	30.73	29.71
(4)	0	1	46.06	42.37	42.34	43.59	44.77	31.43	37.42	37.87
(5)	0	1.5	44.40	41.69	40.27	42.12	40.79	44.99	43.58	43.12
(6)	100	1	37.84	32.86	31.62	34.11	28.37	30.81	29.47	29.55
(7)	150	1	33.54	34.55	37.35	35.15	29.18	30.84	32.17	30.73
Date average		41.09	39.44	39.93	40.15	36.00	35.82	35.95	35.92	

Interaction between spraying date and treatments									
		Treatment							
Date	1	2	3	4	5	6	7	Date average	
15 Dec.	48.15	39.01	30.19	45.42	42.60	33.11	31.36	38.55	
1 Jan.	48.15	37.30	33.15	36.90	43.34	31.84	32.69	37.63	
15 Jan.	48.15	38.18	32.13	39.88	41.92	30.54	34.76	37.94	
Treat. average	48.15	38.17	31.83	40.73	42.62	31.83	32.94		
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	2.74	NS	NS	3.88	NS	NS	NS		

Table 9: Effect of GA₃, urea and spraying date on primary fruitlet drop percentage of Washington navel and Pineapple orange trees (2002/2003 season).

		Washington navel				Pineapple				
Treatment	Cvs.	Date			Treatment average	Date			Treatment average	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.		15 Dec.	1 Jan.	15 Jan.		
(1)	0	0(control)	27.92	27.92	27.92	27.92	34.93	34.93	34.93	34.93
(2)	100	0	36.85	39.88	35.48	36.74	44.66	47.99	51.17	47.94
(3)	150	0	40.70	27.09	37.50	38.43	48.08	47.84	52.10	49.33
(4)	0	1	35.87	32.19	28.75	32.27	38.69	42.22	44.05	41.65
(5)	0	1.5	23.33	31.58	32.06	28.99	40.18	45.83	40.76	42.26
(6)	100	1	35.52	38.07	41.17	38.25	45.86	49.60	51.56	49.00
(7)	150	1	40.44	41.87	39.93	40.75	49.74	48.11	48.38	48.74
Date average		34.37	35.51	34.40	34.76	43.16	45.22	46.14	44.84	

Interaction between spraying date and treatments									
		Treatment							
Date	1	2	3	4	5	6	7	Date average	
15 Dec.	31.42	40.75	44.37	37.28	31.76	40.69	45.09	38.70	
1 Jan.	31.42	43.94	42.46	37.21	38.71	43.83	44.99	40.36	
15 Jan.	31.42	42.33	44.80	36.40	36.41	46.36	44.16	40.27	
Treat. average		31.42	42.34	43.88	36.96	35.62	43.63	44.75	
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	2.11	0.76	1.47	2.99	NS	3.67	5.12		

The present findings were confirmed by the results of Chunrony *et al.*,^[3] and Farmahan^[4] who worked on GA₃ and El- Otmani *et al.*,^[14] and Malik *et al.*,^[15] who worked on urea.

Effect on Flower Drop Percentage: Data in Tables 7 and 8 show that the percentage of flower drop of the studied orange cvs. was significantly affected by the tested GA₃ and urea treatments in the two seasons. Anyhow, the highest flower drop percentage (48.09 & 48.15 %) was

recorded for the untreated (control) trees compared to those sprayed with GA₃ at 150 ppm without (31.50 & 31.83%) or with (30.74 & 31.74 %) urea at 1.0 % and GA₃ at 100 ppm + urea at 1.0 % 31.15 & 31.83 %) which gained the lowest flower drop percentage without significant differences between them in the first and second seasons, respectively.

Flower drop percentage of Pineapple orange trees (33.73 & 35.92 %) was lower than that of Washington navel orange ones (39.19 & 40.15 %) in both seasons,

Table 10: Effect of GA₃, urea and spraying date on primary fruitlet drop percentage of Washington navel and Pineapple orange trees (2003/2004 season)

		Washington navel				Pineapple				
Treatment	Cvs.	Date			Treatment average	Date			Treatment average	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.		15 Dec.	1 Jan.	15 Jan.		
(1)	0	0(control)	29.52	29.52	29.52	29.52	32.56	32.56	32.56	32.56
(2)	100	0	40.99	39.54	32.85	37.79	40.30	42.40	46.08	42.93
(3)	150	0	45.89	42.95	44.35	44.40	48.99	47.06	46.29	47.45
(4)	0	1	31.97	34.48	34.07	33.50	34.33	46.38	41.09	40.60
(5)	0	1.5	34.44	35.57	37.45	35.82	37.84	34.40	35.80	36.01
(6)	100	1	41.32	46.02	45.69	44.34	49.27	46.87	46.80	47.65
(7)	150	1	42.74	41.60	45.55	43.30	47.26	45.18	44.45	45.63
Date average			38.12	38.53	38.50	38.38	41.51	42.12	41.87	41.43

Interaction between spraying date and treatments									
Date	Treatment								Date average
	1	2	3	4	5	6	7		
15 Dec.	31.04	40.64	47.44	33.15	36.14	45.29	45.00		39.81
1 Jan.	31.04	40.97	45.01	40.43	34.98	46.45	43.39		40.32
15 Jan.	31.04	39.47	45.52	37.58	36.62	46.25	45.00		40.18
Treat. average		31.04	40.36	45.92	37.05	35.92	46.00		44.46
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	2.52	NS	NS	NS	NS	NS	6.14		

respectively, but the significance was clear in the first season only. Trees sprayed at the first date (mid Dec.) induced higher drop percentage than those sprayed at the last two dates (early and mid Jun.) which recorded insignificantly different lower flower drop percentages in the two seasons, but the significance was in the first season only.

The interactions between variety and spraying date and that between variety treatments and spraying date were insignificant in the two seasons, whereas the interaction between treatments and date of spraying was significant in the first season only. As GA₃ +urea treatments gained the lowest flower drop percentages in relation to that of untreated trees under the tested spraying dates. Also, trees sprayed at the first spraying date (mid Dec.) recorded higher flower drop percentages than those sprayed at the third date (mid Jan.) under most of the tested treatments.

These results are in agreement with those obtained by Zhang and Yan^[1] and Covatta *et al.*,^[6] who worked on GA₃ and Borarhtto *et al.*,^[20] and Rathore^[16] who worked on urea.

Effect on Primary Fruitlet Drop Percentage: As shown in Tables 9 and 10 the percentage of fruitlet drop was significantly affected with the tested GA₃ and urea treatments and followed an opposite trend In their effect on prementioned flower drop percentage in the two seasons, due mainly to citrus trees are able to modify their rate of fruits drop and adjust it to their fruit-bearing

potential. Thereby, the untreated trees gained the lowest percentage of fruitlet drop (31.42 & 31.04 %) compared to those sprayed with GA₃ at 100 ppm+ urea at 1.0 % (43.63&46.00%) or GA₃ at 150 ppm+ urea at 1.0 % (44.75 &44.46%) which exhibited the highest fruitlet drop percentages without significant differences between them in the first and second seasons, respectively.

Fruitlet drop percentages of Pineapple orange trees was higher than that of Washington navel orange ones in both seasons, but the significance was clear in the first season only.

Spraying date significantly affected fruitlet drop percentage in the first season only, although trees sprayed at early and mid Jun. revealed significantly different fruitlet drop percentages, compared with those sprayed at mid Dec. which gained lower percentage in the two seasons.

The interaction between treatments, variety and spraying date was significant and substantiate the foregoing trends of each individual factor on fruitlet drop in the two seasons.

In coincidence with the present results those obtained by Harty and Sutton^[2] and Chunrany *et al.*,^[3] who worked on GA₃ and Rabe^[10] and Lovatt^[12] who worked on urea.

Effect on June Drop Percentage: It is clear from Tables 11 and 12 that percentage of fruit drop in June (June fruit drop) was significantly affected by the tested GA₃ and urea treatments in both seasons. Anyhow, trees sprayed with urea at 1.5 % (14.64 & 15.67 %) and those

Table 11: Effect of GA₃, urea and spraying date on June drop percentage of Washington navel and Pineapple orange trees (2002/2003 season).

		Washington navel				Pineapple				
Treatment	Cvs.	Date			Treatment	Date			Treatment	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.	average	15 Dec.	1 Jan.	15 Jan.	average	
(1)	0	0(control)	16.28	16.28	16.28	16.26	14.10	14.10	14.10	14.10
(2)	100	0	18.81	18.65	16.33	17.93	14.62	15.33	15.01	14.99
(3)	150	0	14.28	13.96	14.75	14.33	15.30	15.33	14.21	14.95
(4)	0	1	16.99	18.13	19.49	18.20	15.06	14.84	15.05	14.98
(5)	0	1.5	16.50	15.15	16.97	17.20	14.83	14.42	14.07	14.44
(6)	100	1	14.72	13.91	13.51	14.05	15.16	14.77	14.76	14.90
(7)	150	1	12.74	13.29	13.51	13.18	15.18	14.33	15.38	14.96
Date average	16.18		15.93	15.83	15.88	14.89	14.73	14.65	14.76	
Interaction between spraying date and treatments										
		Treatment							Date average	
Date	1	2	3	4	5	6	7	Date average		
15 Dec.	15.20	16.72	14.79	16.02	17.16	14.94	13.96	15.54		
1 Jan.	15.20	16.98	14.65	16.48	14.76	14.34	13.81	15.18		
15 Jan.	15.20	15.67	14.48	17.25	15.52	14.14	14.46	15.74		
Treat. average		15.20	16.46	14.64	16.59	15.82	14.47	14.07		
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date			
	0.56	0.95	NS	0.79	NS	0.97	1.37			

Table 12: Effect of GA₃, urea and spraying date on June drop percentage of Washington navel and Pineapple orange trees (2003/2004 season).

		Washington navel				Pineapple				
Treatment	Cvs.	Date			Treatment	Date			Treatment	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.	average	15 Dec.	1 Jan.	15 Jan.	average	
(1)	0	0(control)	18.21	18.21	18.21	18.21	15.88	15.88	15.88	15.88
(2)	100	0	17.10	16.87	15.89	16.62	15.74	15.77	15.60	15.70
(3)	150	0	15.67	15.91	16.13	15.90	15.37	15.41	15.54	15.44
(4)	0	1	16.56	18.36	17.83	17.60	14.67	16.06	15.59	15.54
(5)	0	1.5	16.64	17.39	17.03	17.02	16.07	15.25	15.46	15.59
(6)	100	1	15.75	14.95	16.40	15.70	15.74	15.94	16.20	15.96
(7)	150	1	16.69	17.46	17.20	17.12	16.53	16.10	16.08	16.24
Date average			16.66	17.02	16.96	16.88	15.71	15.77	15.81	15.77
Interaction between spraying date and treatments										
		Treatment							Date average	
Date	1	2	3	4	5	6	7	Date average		
15 Dec.	17.05	16.42	15.52	15.62	16.35	15.75	16.61	16.19		
1 Jan.	17.05	16.32	15.66	17.21	16.32	15.44	16.78	16.40		
15 Jan.	17.05	15.74	15.83	16.89	16.25	16.30	16.64	16.39		
Treat. average		17.05	16.16	15.67	16.57	16.31	15.83	16.68		
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date			
	0.34	0.55	NS	0.48	NS	1.59	NS			

sprayed with GA₃ at 100 ppm + urea at 1.0 % (14.47 & 15.83%) induced the lowest June drop percentage without significant differences between them in the first and second seasons, respectively. Trees treated with GA₃ at 150 ppm + urea at 1.0 % gained also lowest June fruit drop percentage (14.07 %) in the first season only. The highest June fruit drop percentage was recorded for 100 ppm GA₃ treated trees (16.46 %) and those sprayed with urea at 1.5% (16.59 %) without significant difference between them in the first season and control trees (17.05 %) in the second one. The other treatments in each season indicated intermediate percentage of June fruit drop.

June fruit drop percentage of Washington navel orange trees (15.88 & 16.88%) was significantly higher than those Pineapple orange trees ones (14.76 and 15.77%) in the two seasons, respectively.

Spraying date affected June fruit drop percentage of the studied orange cv. insignificantly in both seasons.

As a general, the tested GA₃ and urea treatments significantly affected June drop percentage of Washington navel and Pineapple orange trees in two seasons of study. Trees sprayed with GA₃ at 150 ppm either singly or mixed with urea at 1.0 % and those

Table 13: Effect of GA₃, urea and spraying date on preharvest fruit drop percentage of Washington navel and Pineapple orange trees (2002/2003 season).

		Washington navel					Pineapple			
Treatment	Cvs.	Date			Treatment average	Date			Treatment average	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.		15 Dec.	1 Jan.	15 Jan.		
(1)	0 (control)	3.96	3.96	3.96	3.96	3.33	3.33	3.33	3.33	
(2)	100	3.99	4.07	7.93	5.33	3.82	3.52	4.49	3.95	
(3)	150	9.87	9.36	9.88	9.70	4.99	4.40	4.66	4.68	
(4)	0	6.48	6.19	4.63	5.77	3.72	3.28	3.20	3.40	
(5)	0	4.49	7.59	5.99	6.02	2.82	4.34	4.08	3.75	
(6)	100	8.52	9.77	11.53	9.94	4.96	5.28	5.40	5.21	
(7)	150	11.66	9.34	8.73	9.91	4.82	5.73	4.04	4.87	
Date average	7.00	7.18	7.52	7.23	4.07	4.27	4.17	4.19		

Interaction between spraying date and treatments									
		Treatment							
Date	1	2	3	4	5	6	7	Date average	
15 Dec.	3.64	3.90	7.43	5.10	3.65	6.74	8.24	5.53	
1 Jan.	3.64	3.80	6.88	4.74	5.96	7.53	7.54	5.73	
15 Jan.	3.64	6.21	7.27	3.92	5.04	8.47	6.39	5.85	
Treat. average	3.64	4.64	7.19	4.59	4.88	7.58	7.39		
LSD at 5 % for:	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	0.70	0.29	NS	0.99	NS	1.22	0.73		

Table 14: Effect of GA₃, urea and spraying date on preharvest fruit drop percentage of Washington navel and Pineapple orange trees (2003/2004 season)

		Washington navel					Pineapple			
Treatment	Cvs.	Date			Treatment average	Date			Treatment average	
GA ₃ (ppm)	Urea (%)	15 Dec.	1 Jan.	15 Jan.		15 Dec.	1 Jan.	15 Jan.		
(1)	0 (control)	2.30	2.30	2.30	2.30	3.38	3.38	3.38	3.38	
(2)	100	2.34	2.58	4.25	3.06	3.10	3.18	3.27	3.18	
(3)	150	3.86	3.84	3.52	3.74	3.54	3.24	3.65	3.48	
(4)	0	3.95	3.50	3.51	3.65	4.64	3.67	3.86	4.06	
(5)	0	3.18	3.40	3.43	3.34	3.35	3.47	3.39	3.40	
(6)	100	2.77	3.38	2.98	3.04	2.97	3.03	3.83	3.28	
(7)	150	3.11	3.10	2.77	2.99	3.97	4.01	4.03	3.90	
Date average	3.07	3.16	3.25	3.16	3.52	3.43	3.67	3.54		

Interaction between spraying date and treatments									
		Treatment							
Date	1	2	3	4	5	6	7	Date average	
15 Dec.	2.84	2.72	3.70	4.30	3.36	2.87	3.39	3.30	
1 Jan.	2.84	2.88	3.54	3.59	3.44	3.21	3.59	3.29	
15 Jan.	2.84	3.76	3.57	3.68	3.41	3.41	3.40	3.46	
Treat. average	2.84	3.12	3.61	3.85	3.37	3.16	3.45		
LSD at 5 % for :	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date		
	0.31	NS	NS	0.44	Ns	0.53	0.76		

treated with GA₃ at 100 ppm + urea at 1.0 % induced the lowest fruit drop percentage in both seasons.

These results are nearly in the same line with those obtained by Chen *et al.*,^[7] who worked on GA₃ and Jasan *et al.*,^[5] who worked on urea.

Effect on Preharvest Fruit Drop Percentage: Data in Tables 13 and 14 show that preharvest fruit drop percentage was significantly affected by the tested GA₃ and urea treatments in both seasons. However, untreated

trees gained the lowest preharvest fruit drop percentage (3.64 & 2.84 %), whereas the highest percentage was recorded from trees treated with GA₃ at 150 ppm either singly (4.19 & 3.61 %) or combined with urea at 1.0 % (7.39 & 3.45 %) in the first and second seasons, respectively.

The interaction between variety, treatments and spraying date was significant and confirms the prementioned trends of each individual factor on preharvest fruit drop percentage in both seasons.

Table 15: Effect of GA₃, urea and spraying date on fruit retention percentage of Washington navel and Pineapple orange trees (2002/2003 season).

		Washington navel				Pineapple				
Treatment	Cvs	Date				Treatment average	Date			Treatment average
		15 Dec.	1 Jan.	15 Jan.	15 Dec.		1 Jan.	15 Jan.		
GA ₃ (ppm)	Urea (%)									
(1)	0	0(control)	2.16	2.16	2.16	2.16	1.18	1.18	1.18	1.18
(2)	100	0	2.28	2.06	2.84	2.39	2.99	3.02	3.22	3.07
(3)	150	0	2.98	2.58	3.29	2.95	2.86	2.77	2.77	2.80
(4)	0	1	2.70	3.37	3.08	3.05	1.46	1.86	2.94	2.09
(5)	0	1.5	2.75	3.16	2.98	2.96	1.94	2.68	2.38	2.33
(6)	100	1	2.57	3.12	3.09	2.93	3.17	3.14	3.82	3.38
(7)	150	1	2.97	2.29	2.57	2.61	3.36	3.85	2.58	3.26
Date average	2.63		2.68	2.86	2.72	2.42	2.64	2.70	2.59	

Interaction between spraying date and treatments

Date	Treatment							Date average
	1	2	3	4	5	6	7	
15 Dec.	1.7	2.64	2.92	2.08	2.35	2.87	3.16	2.53
1 Jan.	1.67	2.54	2.68	2.61	2.92	3.13	3.07	2.66
15 Jan.	1.67	3.03	3.03	3.01	2.68	3.46	2.57	2.78
Treat. average	1.67	2.73	2.87	2.57	2.65	3.15	2.94	
LSD at 5 % for :	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date	
	0.38	NS	NS	0.54	NS	NS	NS	

Table 16: Effect of GA₃, urea and spraying date on fruit retention percentage of Washington navel and Pineapple orange trees (2003/2004 season).

		Washington navel				Pineapple				
Treatment	Cvs.	Date				Treatment average	Date			Treatment average
		15 Dec.	1 Jan.	15 Jan.	15 Dec.		1 Jan.	15 Jan.		
GA ₃ (ppm)	Urea (%)									
(1)	0	0(control)	1.29	1.29	1.29	1.29	1.14	1.14	1.14	1.14
(2)	100	0	2.21	1.79	1.93	1.98	3.41	3.32	3.68	3.47
(3)	150	0	2.10	1.58	2.68	2.12	4.09	3.77	3.71	3.86
(4)	0	1	1.43	1.62	2.14	1.73	1.55	2.24	1.70	1.83
(5)	0	1.5	1.33	1.91	1.98	1.74	1.91	1.85	1.73	1.83
(6)	100	1	2.29	2.64	3.25	2.72	3.59	3.27	3.64	3.50
(7)	150	1	3.82	3.22	3.25	3.43	3.29	3.82	3.07	3.39
Date average	2.07		2.01	2.36	2.14	2.71	2.77	2.67	2.72	

Interaction between spraying date and treatments

Date	Treatment							Date average
	1	2	3	4	5	6	7	
15 Dec.	1.22	2.81	3.10	1.49	1.62	2.94	3.55	2.39
1 Jan.	1.22	2.56	2.67	1.93	1.88	2.96	3.52	2.39
15 Jan.	1.22	2.81	3.20	1.92	1.86	3.45	3.16	2.51
Treat. Average	1.22	2.73	2.99	1.78	1.79	3.11	3.41	
LSD at 5 % for :	Treat.	Var.	Date	Var. X Treat.	Var. X Date	Treat. X Date	Var. X Treat. X Date	
	0.41	0.36	NS	0.59	NS	NS	NS	

However, preharvest fruit drop percentage of Washington navel orange trees ranged between 3.96 -11.66 % and 2.30-4.25 % , while that of Pineapple ones ranged between 2.92 – 5.73 % and 2.97 – 4.67 % in the first and second seasons, respectively.

Similar results were announced by Covatta *et al.*,^[6] who worked on GA₃ and Malik *et al.*,^[15] who worked on urea.

Effect on Fruit Retention Percentage: It is quite evident from Tables 15 and 16 that, percentage of fruit retention was significantly affected by the testes GA₃ and urea spraying in the both seasons. Anyhow, the lowest fruit retention percentage was recorded for the untreated trees (1.67 & 1.22 %), in comparison with those treated with GA₃ at 100 (3.15 & 3.11 %) or 150 (2.94 & 3.41 %) ppm + urea at 1.0 % which exhibited the highest fruit

percentage in the first and second seasons, respectively. Spraying trees with GA₃ or urea singly at the two dates of each, gained intermediate fruit retention percentages, without significant differences between them in the first season only.

Fruit retention percentage of Pineapple orange trees (2.72 %) was markedly higher than that of Washington navel orange ones (2.14 %) in the second season only. Trees sprayed at the third date of spraying (mid Jun.) had higher fruit retention than those sprayed at other two dates, but the difference was insignificant in the two seasons.

The interactions between variety and date of spraying, treatments and spraying date and between these three factors were insignificant throughout the two experimental seasons.

These results are in harmony with those obtained by Farmahan^[4] and Youngeetl *et al.*,^[8] who worked on GA₃ and Rathore^[16] who worked on urea.

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