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EFFECT OF NITROGEN AND GA_3 ON GROWTH, YIELD AND FRUIT QUALITY OF CHINESE MANDARIN TREES

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ABSTRACT: *This study was conducted to evaluate the effect of three rates of nitrogen fertilization as control (500), 750 and 1000 g N/tree/year and GA_3 at 10 and 20 ppm, alone or in combinations on vegetative growth, yield and fruit quality of Chinese mandarin trees. Results showed that, high nitrogen level (1000 g N/tree) with 10 or 20 ppm GA_3 enhanced vegetative growth parameters in terms of shoot length, leaves number/shoot and leaf area of Chinese mandarin trees in both seasons. Moreover, treatment of 1000 g N + 10 or 20 ppm GA_3 gave the best fruit set % and showed to be the superior one in reducing fruit drop and preharvest fruit drop percentages as compared to control treatment. Yield and fruit quality were significantly increased by all treatments of nitrogen and GA_3 compared to control treatment in both seasons. Therefore, it is recommended with the treatment of 1000 g N/tree plus spray with GA_3 at 10 or 20 ppm which gave the best growth, yield, fruit quality of Chinese mandarin trees under sandy soil conditions.*

Key words: *Citrus reticulata, fertilization, fruit set, preharvest drop, nitrogen, GA_3*

INTRODUCTION

Mandarin (*Citrus reticulata* Blanco) has a popular among citrus fruit trees grown in Egypt. Mandarin fruit is the cheap and rich source in vitamin C and A as well as it contains small amounts of vitamin B_6, carbohydrates and proteins. Usually, the fruits are eaten fresh; so internal fruit quality like fruit weight, peel colour, juice quantity and quality and easy peeling play an important role in fruit marketing. Chinese mandarin is increasing rapidly and cultivation spreads in many areas in Egypt especially in the newly reclaimed lands. Increasing yield and improving fruit quality, regarded from essential aims for growers. Therefore, nitrogen fertilization and exogenous applications of GA_3 aimed to ensure economical yield with a good quality from mandarin fruits under this conditions. Adequate nitrogen nutrition is essential for optimum vegetative growth, yield and fruit quality. Tachibana and Yahata (1996) revealed that, nitrogen fertilization at 200 and 300 kg/ha/year produced the best response on canopy volume and yield of Satsuma mandarin. Also, Sabbah *et al.,* (1997) reported that, yield and fruit properties of Valencia orange were responded positively to increasing the rates of nitrogen from 750 to 1000 N g/tree. In this concern, Helail *et al.,* (2012) concluded that, fertilizing Balady mandarin trees with different sources of nitrogen fertilizers enhanced tree fruiting parameters expressed as fruit set, fruit drop, yield and fruit quality. Similarly, growth regulators especially gibberellins perform an important role in growth, flowering and fruit set in many citrus species and varieties. In this respect, Nawaz *et al.,* (2008) revealed that GA_3 significantly affects tree yield and fruit quality of Kinnow mandarin. Also, Saleem *et al.,* (2007) noticed that fruit weight, fruit diameter, juice % and peel quality of Sweet orange fruits significantly influenced by GA_3 foliar application. The combination between nitrogen and GA_3 is important for regulation growth and yield. In this concern, Prasad and Singh (1980) studied the effect of nitrogen fertilization at 1000 g N/tree and foliar application of GA_3 at 150 ppm on Acid

lime trees, they resulted in the greatest increases in shoot length, leaves number/shoot, fruit set and yields. Also, Mostafa *et al.,* (2005) indicated that spray with KNO_3 at 2% and GA_3 at 20 ppm gave the best results with regard to yield and fruit quality of Balady mandarin trees. Moreover, Ibrahim (2011) showed that applying nitrogen at 1000 g/tree/year and sprayed with GA_3 at 10 ppm on Washington navel orange trees gave the maximum fruit set, fruit yield and reduced June and preharvest fruit drop.

Therefore, the present work was done to study the effect of nitrogen fertilization and foliar sprays with gibberellic acid on fruit set, dropping, yield and fruit quality of Chinese mandarin trees under sandy soil conditions.

MATERIALS AND METHODS

The present study was carried out during two successive seasons, 2013/2014 and 2014/2015 on eight years old of Chinese mandarin (*Citrus reticulata* Blanco) trees budded on sour orange (*Citrus aurantium* L.) rootstock. Trees were planted at 4 x 4 meters apart on sandy soil under drip irrigation system in a private orchard at El-Nubaria region, El-Beheira governorate, Egypt. The soil texture was sandy (7.4% clay, 5.8% silt and 86.8% sand), 2.54 dSm^{-1} an electrical conductivity and pH of 8.32. Fifty four trees were chosen as uniform as possible in growth, vigour and productivity, and subjected to the same cultural practices commonly adopted on the orchard. Trees were arranged in a randomized complete block design, each treatment replicated three time with two tree per replicate. Three nitrogen rates and two GA_3 concentrations, alone or in combinations making a nine treatments as follows:

•.500g N/tree/year (Control)
• 750g N tree/year
• 1000g N tree/year
• 10 ppm GA_3
• 20 ppm GA_3
• 750 g N tree/year + 10 ppm GA_3
• 750 g N tree/year + 20 ppm GA_3
• 1000 g N tree/year + 10 ppm GA_3
• 1000 g N tree/year + 20 ppm GA_3

The nitrogen rates were 500 as control, 750 and 1000 g N/tree/year, its equivalents 1.50, 2.25 and 3.00 kg ammonium nitrite (33.5% N) applied in doses by fertigation system from, early March to mid-October in both seasons. Gibberellic acid was used as sodium salt of gibberellic acid (Berlex), each tree was sprayed with prepared solution 10 l/tree at early morning at two dates, full bloom and after fruit set in both seasons. Four branches on each tree were selected and tagged in four directions for measuring and determination the following parameters:

1. Vegetative growth:

Vegetative parameters i.e. shoot length (cm) , leaves number/ shoot and twenty mature leaves were sampled from non fruiting shoot to determine leaf area (cm^2) by using the equation: Leaf area = ⅔ length × width, according to (Chou, 1966).

2. Fruit set and fruit drop (%):

Fruit set percentage was calculated according the equation: Fruit set % = (No. of fruits ÷ Total No. of flowers) x 100. Also, the percentage of fruit and preharvest drop were calculated according the equations: Fruit drop % = (number of dropping fruits ÷ No. of fruits in July) x 100, Pre-harvest drop % = (No. of dropping fruits ÷ No. of fruits at December) x 100.

3. Yield:

Yield was determined at December in both seasons as number of fruits/tree and weighed kg/tree for each treatment.

4. Fruit quality:

To determine fruit quality, 20 fruits were taken at random from each tree at harvest time of both seasons and prepared for determination of physical and chemical fruit characteristics.

4.1. Physical characters:

Fruit length (cm), fruit diameter (cm) and fruit weight (g), fruit juice %, fruit peel % and fruit pulp % were measured and calculated.

4.2. Chemical characters:

Total soluble solids was determined by handly refractometer, total acidity was determined as citric acid according to (A.O.A.C., 1995), and TSS/acid ratio was calculated. Ascorbic acid as mg/100 ml/juice was determined by using 2, 6 dichlorophenol indophenol according to Jacobs (1951).

Statistical analysis:

The obtained data were subjected to analysis of variance according to Snedecor and Cochran (1990). Duncan's multiple range test (Duncan, 1955) at 5% level was used to compare the mean values.

RESULTS AND DISCUSSION

1. Vegetative growth:

Data in Table (1) showed that, nitrogen fertilization and gibberellic acid (GA_3) foliar spray, alone or in combined significantly increased shoot length, leaves number per shoot and leaf area of Chinese mandarin trees compared to control treatment. Nitrogen and GA_3 as individual application increased all vegetative growth parameters compared with control. It is also clear that nitrogen treatments proved better compared to GA_3 concentrations and control. The highest shoot length, leaves number per shoot and leaf area were obtained from trees treated with 1000 g N/tree/year + 20 ppm GA_3 followed by 1000 gm N/tree/year + 10 ppm GA_3, while the lowest values of growth parameters belonged to control treatment (500 g N/tree/year). These findings are in line with those obtained by Wassel *et al*., (2007) who found that adding nitrogen at rates of 400, 600, 800 and 1000 g/tree/year on Balady mandarin trees increased shoot length and leaves number/shoot. In this respect, El-Sayed and Ennab (2013) concluded that raising nitrogen rates from 600 to 1200 g/tree have high positive effect and significantly improved shoot length, leaves number/shoot and leaf area of Valencia orange trees. Similarly, Saleem *et al.,* (2008) reported that application of GA_3 at 30 mg/l on sweet orange cv. Blood Red trees markedly increased shoot length, number of leaves/shoot and leaf age. Also, Monselise and Halevy (1962) reported that increasing concentrations of GA_3 progressively increased shoot and internode length, did not influence number of leaves, and decreased leaf area of sweet lime. Our results about combined effect between nitrogen and GA_3 found to be in agreement with those of Yousuf (1984) on local orange. In this respect, Ibrahim (2011) reported that adding nitrogen at 1000 g/tree/year and spraying with GA_3 at 10 ppm significantly enhanced the most vegetative growth parameters of Washington navel orange trees.

Generally, the data in Table (1) indicated that, nitrogen fertilization and gibberellic acid foliar application enhanced most vegetative growth parameters of Chinese mandarin trees in both seasons. The treatment of 1000 gm N/tree/year with GA_3 at 20 or 10 ppm was more effective than other treatments. The obtained increase in vegetative growth as a result of nitrogen and GA_3 application may be due to the role of nitrogen in plant tissues (Boyle *et al.,* 1994). Gibberellins are convoluted in cell division and cell elongation (Zhang and Whiting., 2011). Also, gibberellic acid is also reported to promote growth by increasing plasticity of the cell wall followed by the hydrolysis of starch into sugars which reduces the cell water potential, resulting in the entry of water into the cell and causing elongation (Richard, 2006)

Table (1): Effect of nitrogen and GA_3 concentration on shoot length, leaves number per shoot and leaf area of Chinese mandarin trees in 2013/2014 and 2014/2015 seasons.

Treatments	2013/2014 season			2014/2015 season		
	Shoot length cm	Leaves number per shoot	Leaf area cm^2	Shoot length cm	Leaves number per shoot	Leaf area cm^2
Cont. (500g N/tree)	32.81 e	14.75 e	15.42 f	34.61 f	16.54 f	15.79 h
750g N/tree	33.95 de	17.42 c	17.89 e	36.58 e	19.47 d	18.60 g
1000g N/tree	35.53 c	19.25 b	20.54 b	38.53 bc	21.44 ab	21.14 c
10 ppm GA_3	33.45 de	16.83 d	18.51 d	36.50 e	18.60 e	18.34 g
20 ppm GA_3	34.32 d	16.95 d	18.92 cd	36.76 de	18.85 e	19.16 f
750g N+10 ppm GA_3	35.70 c	17.92 c	18.72 cd	37.65 cd	19.82 cd	19.77 e
750g N+20 ppm GA_3	36.22 bc	19.42 b	19.10 c	39.50 ab	20.10 c	20.72 d
1000g N+10 ppm GA_3	37.28 ab	20.41 a	20.75 ab	39.78 a	21.14 b	22.36 b
1000g N+20 ppm GA_3	37.55 a	20.62 a	21.08 a	40.33 a	21.75 a	22.66 a

Means followed by different letter are significantly different within columns by Duncan's multiple range test, $P \leq 0.05$

2. Fruit set and fruit drop (%):

Data in Table (2) showed that, fruit set, fruit drop and preharvest fruit drop percentages were significantly affected by nitrogen and GA_3 application alone or combined with the other in both seasons. Nitrogen and GA_3 application as a single treatments increased fruit set percentage of Chinese mandarin trees as compared to control treatment. Moreover, nitrogen was more effective in increasing fruit set percentage than gibberellic acid in both seasons. Similar results were obtained by Ibrahim *et al.,* (2011) on Washington navel orange. In this respect, Saleem *et al.,* (2005) revealed that nitrogen fertigation at 3 kg N/tree ammonium sulphate was responsible for maximizing fruit set % of two mandarin cultivars. Similarly, Khan *et al.,* (2014) reported that foliar 20 ppm GA_3 significantly improved fruit set % of sweet orange trees. In addition, treatment of 1000 g N + 20 ppm GA_3 exhibited the high fruit set percentage followed by 1000 g N + 10 ppm GA_3 and 1000 g N in the first season, and 750 g N + 20 ppm GA_3 in the second season. On the other hand, control treatment (500 g N) gave the lowest values of fruit set percentage in both seasons. These results are in agreement with those obtained by Abd El-Rahman *et al.,* (2012) and Baghdady *et al.,* (2014) on Washington navel orange and Valencia orange. In this respect, Chao and Lovatt (2006) revealed that foliar spray with 10 ppm GA_3 + 1% urea increased fruit set % of Clementine mandarin trees.

As for fruit drop and preharvest fruit drop, data in Table (2) indicate that fruit drop and preharvest fruit drop % of Chinese mandarin trees were significantly decreased by using all tested treatments, the superior treatment was 1000 g N + 20 ppm GA_3 followed by using the treatments of 1000 g N + 10 ppm GA_3 and 750 g N + 20 ppm GA_3 as compared with control and other treatments in both seasons. On the other hand, the highest fruit drop and preharvest fruit drop were observed on control trees followed by 750 g N/tree in both seasons, respectively. Similar results were obtained by Yousuf (1984) and Ibrahim *et al.,* (2011) they report that GA_3 and nitrogen alone or combined together significantly decreased the percentages of June drop and preharvest drop on local orange and Washington navel orange.

Table (2): Effect of nitrogen and GA_3 concentration on fruit set and fruit drop of Chinese mandarin trees in 2013/2014 and 2014/2015 seasons.

Treatments	2013/2014 season			2014/2015 season		
	Fruit set %	Fruit drop %	Pre-harvest drop %	Fruit set %	Fruit drop %	Pre-harvest drop %
Cont. (500g N/tree)	24.60 d	19.74 a	10.40 a	27.49 d	16.00 a	9.51 a
750g N/tree	26.83 a-d	15.38 b	8.46 b	28.62 c	14.20 b	7.36 b
1000g N/tree	28.89 ab	11.60 c	7.45 c	29.56 b	10.66 d	6.69 c
10 ppm GA_3	25.81 cd	11.49 c	7.21 c	28.49 c	10.93 c	6.62 c
20 ppm GA_3	26.26 bcd	10.62 d	7.13 c	29.90 b	10.21 e	6.55 cd
750g N+10 ppm GA_3	27.30 a-d	10.33 e	7.06 c	29.77 b	10.10 e	6.45 cd
750g N+20 ppm GA_3	27.76 abc	10.15 e	7.11 c	29.95 b	09.27 f	6.33 de
1000g N+10 ppm GA_3	29.25 ab	10.12 e	6.86 c	30.23 ab	09.17 f	6.30 de
1000g N+20 ppm GA_3	29.51 a	09.27 f	6.79 c	30.96 a	08.68 g	6.27 e

Means followed by different letter are significantly different within columns by Duncan's multiple range test, $P \leq 0.05$

Generally, data in Table (2) revealed that, fruit set, fruit drop and preharvest drop of Chinese mandarin trees were positively affected by GA_3 concentrations with rates of nitrogen in both seasons. In this respect, treatment of 1000 g N + 20 ppm GA_3 gave the best fruit set % and showed to be the superior one in reducing fruit drop and preharvest fruit drop percentages as compared with control and other treatments in both seasons. The balance between nitrogen and GA_3 gave best nutritional status of the plant. Thus, improved fruit set % and reduces fruit drop and preharvest drop. These results agreed with those of Mohsen *et al.,* (1989) on Valencia orange.

3. Yield:

Results presented in Table (3) shows the effect of nitrogen, GA_3 and their combination on yield as number of fruits and weight (kg) per tree of Chinese mandarin trees in both seasons. Nitrogen and GA_3 application alone or combined with the other significantly increased yield as compared to control treatment in both seasons. In this respect, 1000 g N/tree + foliar spray with GA_3 at 20 ppm recorded the highest fruit yield per tree followed by 1000 g N + 10 ppm GA_3 and 750 g N + 20 ppm GA_3 compared with the other treatments in both seasons. Control treatment recorded the lowest yield as number of fruits or weight per tree in both seasons. The obtained results are in agreement with those reported by Mostafa *et al.,* (2005) and Abd El-Rahman *et al.,* (2012) they concluded that foliar spraying KNO_3 and GA_3 increased the yield of Balady mandarin and Washington navel orange. Similar result was noticed by Prasad and Singh (1980) they reported that, number of fruits per tree and yield of Acid lime showed greatest increase as nitrogen added at 1000 g N/tree and sprayed with GA_3.

Generally, data in Table (3) showed that Chinese mandarin trees fertilized with nitrogen at 1000 g N/tree and sprayed with 20 or 10 ppm GA_3 raised fruit yield significantly compared with control in both seasons. The increment in the yield may be

due to increasing fruit numbers/ tree, also could be explained as a result of increasing fruit set % and reducing fruit drop % (Table 2). Such conclusion was conformed with Mohsen *et al.,* (1989) who showed that 2 kg N/tree + 20 ppm GA_3 gave the best fruit set % and yield of Valencia orange trees. Moreover, our data in Table (4) showed that, nitrogen and GA_3 application increased fruit weight and other physical parameters which higher than control treatment, this led to increasing yield and its components.

Table (3): Effect of nitrogen and GA_3 concentration on yield of Chinese mandarin trees in 2013/2014 and 2014/2015 seasons.

Treatments	2013/2014 season		2014/2015 season	
	Fruit number/tree	Kg/tree	Fruit number/tree	Kg/tree
Cont. (500g N/tree)	238.43 g	35.97 f	248.20 h	37.77 e
750g N/tree	275.54 e	39.81d	264.75 g	39.81 d
1000g N/tree	284.78 d	40.79 c	276.74 e	40.18 d
10 ppm GA_3	271.52 f	38.46 e	274.03 f	40.78 c
20 ppm GA_3	277.53 e	40.64 c	282.26 d	41.79 b
750g N+10 ppm GA_3	287.20 cd	40.65 c	282.21 d	41.83 b
750g N+20 ppm GA_3	289.54 c	42.11 b	289.03 c	41.83 b
1000g N+10 ppm GA_3	293.43 b	42.65 a	295.50 b	44.48 a
1000g N+20 ppm GA_3	297.33 a	42.89 a	297.31 a	44.79 a

Means followed by different letter are significantly different within columns by Duncan's multiple range test, $P \leq 0.05$

Table (4): Effect of nitrogen and GA_3 concentration on physical fruit quality of Chinese mandarin trees in 2013/2014 and 2014/2015 seasons.

Treatments	2013/2014 season			2014/2015 season		
	Fruit length cm	Fruit diameter cm	Fruit weight g	Fruit length cm	Fruit diameter cm	Fruit weight g
Cont. (500g N/tree)	5.37 d	5.96 g	141.18 e	5.75 e	6.40 h	149.12 g
750g N/tree	5.68 bc	6.45 f	158.15 cd	6.17 cd	7.17 g	163.15 e
1000g N/tree	5.71 b	6.82 d	161.01 bc	6.22 bc	7.53 e	165.85 d
10 ppm GA_3	5.64 c	6.73 e	155.68 d	6.12 d	7.37 f	158.33 f
20 ppm GA_3	5.67 bc	6.78 de	158.56 cd	6.18 cd	7.49 e	165.47 d
750g N+10 ppm GA_3	5.70 b	7.32 c	158.43 cd	6.24 ab	7.94 d	163.32 e
750g N+20 ppm GA_3	5.71 b	7.52 b	159.30 cd	6.25 ab	8.03 c	167.96 b
1000g N+10 ppm GA_3	5.77 a	7.55 b	163.12 ab	6.30 ab	8.20 b	166.86 c
1000g N+20 ppm GA_3	5.80 a	7.85 a	164.19 a	6.35 a	8.29 a	172.10 a

Means followed by different letter are significantly different within columns by Duncan's multiple range test, $P \leq 0.05$

4. Fruit quality:

4.1. Physical characters:

Data in Table (4) showed that, fruit length, fruit diameter and fruit weight were significantly improved by all treatments compared to the control in both seasons. This improving was much more pronounced on the second season. The highest values of fruit length, fruit diameter and fruit weight obtained from trees fertilized with 1000 g N/tree + 20 ppm GA_3 followed by 1000 g N/tree + 10 ppm GA_3 and 750 g N/tree + 20 ppm GA_3 as compared with control trees and other treatments in both seasons. On the other hand, control treatment (500 g N/tree) gave the least values of fruit length, fruit diameter and fruit weight in both seasons. Moreover, treatments of 750g N/tree, 1000g N/tree, 10 ppm GA_3, 20 ppm GA_3 and 750g N+10 ppm GA_3 gave intermediate values in this respect. Similar results were obtained by Ahmed *et al.,* (1988), and Mostafa *et al.,* (2005). In this respect, Abo El- Enien (2012) on Navel orange found that spraying GA_3 improved fruit length and diameter. This can be attributed to GA_3 which stimulate cell elongation and membrane permeability to water uptake (Chaudhary *et al.* 2006) .Gibberellins are involved in cell division and cell elongation. They are known to influence fruit size (Zhang and Whiting 2011).

Also, data in Table (5) indicated that nitrogen application and GA_3 foliar spray had a significant effect on fruit juice %, fruit peel % and fruit pulp % in both seasons. Regarding fruit juice percentage, the results showed that highest juice percent was observed in treatment of 1000 g N/tree + 20 ppm GA_3 followed by 1000 g N/tree + 10 ppm GA_3 and 750 g N/tree + 20 ppm GA_3 as compared with control fruits in both seasons. while the lowest fruit juice percentage was found in control and 750g N/tree, respectively. Similar results were obtained by Davies *et al.,* (1997) on Hamlin orange.

Table (5): Effect of nitrogen and GA_3 concentration on fruit juice %, peel % and pulp % of Chinese mandarin trees in 2013/2014 and 2014/2015 seasons.

Treatments	2013/2014 season			2014/2015 season		
	Fruit juice %	Fruit peel %	Fruit pulp %	Fruit juice %	Fruit peel %	Fruit pulp %
Cont. (500g N/tree)	45.11 f	29.28 bc	25.61 b	44.87 g	26.75 b	26.76 b
750g N/tree	46.82 e	29.58 ab	22.60 d	46.48 f	26.60 bc	26.77 b
1000g N/tree	49.22 cd	29.99 a	20.79 e	49.63 c	27.37 a	23.77 f
10 ppm GA_3	48.63 d	27.85 d	23.52 c	47.80 e	25.86 c	26.34 c
20 ppm GA_3	49.55 bc	23.64 h	26.81 a	48.71 d	22.66 f	28.41 a
750g N+10 ppm GA_3	49.97 ab	28.82 c	21.21 e	49.45 c	24.93 d	25.62 d
750g N+20 ppm GA_3	49.92 ab	25.84 f	24.24 c	50.50 b	22.88 ef	26.84 b
1000g N+10 ppm GA_3	50.83 ab	26.70 e	22.47 d	50.76 b	25.83 c	23.41 g
1000g N+20 ppm GA_3	51.05 a	25.10 g	23.85 c	52.20 a	23.66 e	24.14 e

Means followed by different letter are significantly different within columns by Duncan's multiple range test, $P \leq 0.05$

With regard to fruit peel %, it is clear from data in Table (5) that, nitrogen as individual applications gave the highest values of fruit peel %, and found in decreasing order; 1000g N/tree, 750g N/tree and control (500g N/tree) respectively. On the other hand, the lowest fruit peel % was recorded in fruit harvested from trees treated with 20 ppm GA_3 followed by 750g N+20 ppm GA_3 and 1000g N+20 ppm GA_3 respectively. These results are in harmony with those reported by Fidelibus *et al.,* (2002) on Valencia orange. Also, maximum fruit pulp % recorded in 20 ppm GA_3 treated trees followed by control treatment and 750g N+20 ppm GA_3, while minimum fruit pulp percentage was obtained by trees fertilized by 1000g N/tree in the first season and 1000g N+10 ppm GA_3 in the second season. The other treatments gave intermediate values in this respect. Similar results were obtained by Saleem *et al.,* (2007) on Blood Red sweet orange.

It is obvious from data in Tables (4 and 5) that, nitrogen fertilization and spraying with GA_3 had significant effects in improving physical fruit quality in terms of fruit length, diameter, weight, fruit juice, peel and pulp percentages compared to control in both seasons. The treatments of 1000 g N/tree + 20 ppm GA_3 and 1000 g N/tree + 10 ppm GA_3 showed to be the superior in improving physical fruit quality of Chinese mandarin fruits as compared with control and other treatments in both seasons. Similar results were reported by Bons *et al.,* (2015).

4.2. Chemical characters:

The results in Table (6) revealed that all treatments significantly effected on chemical fruit quality in both seasons. Trees treated with 750 g N/tree + 10 ppm GA_3, 750 g N/tree + 20 ppm GA_3 and 750 g N/tree gave fruits with higher SSC, while control and GA_3 sprayed at 10 or 20 ppm gave the lowest SSC in both seasons. Acidity was higher in fruits harvested from trees fertilized with nitrogen rates as alone, while the lowest fruit acidity was recorded in trees treated with 1000g N+20 ppm GA_3. SSC/acid ratio and vitamin C were significantly increased by all treatments compared to control in both seasons, especially in combination treatments.

Table (6): Effect of nitrogen and GA_3 concentration on chemical fruit quality of Chinese mandarin trees in 2013/2014 and 2014/2015 seasons.

Treatments	2013/2014 season				2014/2015 season			
	SSC %	Acidity %	SSC/acid ratio	Vit.C mg/100 ml juice	SSC %	Acidity %	SSC/acid ratio	Vit.C mg/100 ml juice
Cont. (500g N/tree)	9.95 de	0.99 a	10.01 e	30.59 e	10.32 cd	0.99 a	10.39 d	30.05 g
750g N/tree	10.48 a	0.99 a	10.51 d	30.63 d	10.52 ab	0.97 a	10.77 d	31.35 e
1000g N/tree	10.39 b	0.95 b	10.86 d	31.82 c	10.44 bc	0.98 a	10.66 d	31.88 cd
10 ppm GA_3	9.93 e	0.88 c	11.24 c	30.94 d	10.16 d	0.91 b	11.16 c	30.88 f
20 ppm GA_3	9.98 d	0.83 d	12.02 b	31.58 c	10.23 d	0.88 c	11.53 c	31.30 e
750g N+10 ppm GA_3	10.51 a	0.88 c	11.94 b	31.76 c	10.58 a	0.91 b	11.54 c	31.70 d
750g N+20 ppm GA_3	10.48 a	0.79 e	13.21 a	32.53 b	10.54 ab	0.87 c	12.06 b	32.39 b
1000g N+10 ppm GA_3	10.40 b	0.86 f	12.05 b	32.77 ab	10.42 bc	0.90 b	11.49 c	32.08 bc
1000g N+20 ppm GA_3	10.35 c	0.76 g	13.56 a	32.95 a	10.40 bc	0.82 d	12.64 a	32.85 a

Means followed by different letter are significantly different within columns by Duncan's multiple range test, $P \leq 0.05$

Generally, the treatments containing nitrogen and GA_3 are able to consistently improve chemical fruit quality in terms of SSC, acidity, SSC/acid ratio and vitamin C compared to control. When either nitrogen or GA_3 was used alone, results were not consistent especially on SSC%. Similar results were obtained by Davies *et al.,* (1997), Nawaz *et al.,* (2008) and Saleem *et al.,* (2008). The increase in chemical characters in fruits with nitrogen or GA_3 may be due to the effect of them in improving trees growth which include leaf area, total chlorophyll of the leaves, absorption of water, nutrients and increasing in the food synthesized and translocated to fruits as recorded by Al- Hmadawi *et al*. (2011).

CONCIUSION

In light of this study, it is clear that, nitrogen fertilization and GA_3 foliar applications enhanced most vegetative growth parameters, gave the best fruit set % and showed to be superior in reducing fruit drop and preharvest fruit drop percentages as well as improving yield and fruit quality, especially treatment of 1000 g N/tree/year + 10 or 20 ppm GA_3. So, it is recommended with the treatment of 1000 g N/tree/year plus spray with GA_3 at 10 or 20 ppm which gave the best growth, yield and fruit quality of Chinese mandarin trees under sandy soil conditions..

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تأثير النيتروجين و حامض الجبريليك على نمو و محصول و جودة ثمار اليوسفى الصينى

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أجريت هذة الدراسة لمعرفة تاثير مستويات مختلفة من النيتروجين و حامض الجبرلين على النمو الخضرى و المحصول و جودة ثماراشجار اليوسفى الصينى. تم إضافة النيتروجين فى ثلاث معدلات هى 500 (كنترول) و 750 و 1000 جرام نيتروجين /شجرة / سنة و تم رش الجبرلين بتركيزين هما 10 و 20 جزء فى المليون؛ تم عمل عدة توليفات بين النيتروجين و الجبرلين وبمجموع تسع معاملات وزعت فى تصميم قطاعات كاملة العشوائية مع ثلاثة مكررات.

أظهرت النتائج ان المعدل العالى من النيتروجين مع رش الجبرلين بتركيز 10 او 20 جزء فى المليون ادى الى تحسين قياسات النمو الخضرى و المتمثلة فى طول الفرع و عدد الاوراق على الفرع و مساحة الورقة لاشجار اليوسفى الصينى. ايضا المعاملة 1000 جرام نيتروجين / شجرة مع رش الجبرلين بتركيز 10 او 20 جزء فى المليون ادت الى تحسن النسبة المؤية لعقد الثمار و قللت من تساقط الثمار و كذلك تساقط ماقبل الجمع مقارنة مع معاملة الكنترول فى كلا الموسمين. زاد المحصول وتحسنت صفات الجودة للثمار و ذلك نتيجة المعاملة بالنيتروجين و الرش بالجبرلين و ذلك عند المقارنة بمعاملة الكنترول. لذلك ينصح باستخدام المعاملة 1000 جرام نيتروجين لكل شجرة مع رش الجبرلين بتركيز 10 او 20 جزء فى المليون و التى اعطت افضل نمو خضرى و محصول و جودة الثمار فى اشجار اليوسفى الصينى.