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EFFECT OF DIFFERENT LEVELS OF IRRIGATION WATER AND NITROGEN FERTILIZER ON VEGETATIVE GROWTH, YIELD AND FRUIT QUALITY OF VALENCIA ORANGE TREES

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ABSTRACT: *This study was carried out during 2010/2011 and 2011/2012 seasons under Gharbiya governorate conditions on Valencia orange trees 16 years old, 5 x 5 meters apart and grown onto Sour orange rootstock in clay soil. The experiment included 9 combinations treatments of nitrogen at three rates, i.e., 600, 900 and 1200 gm/tree/year and irrigation at three levels, i.e., 8000, 4000 and 2800 m^3/faddan/year to study the effect of irrigation levels and nitrogen rates on growth, yield and fruit quality. The obtained results showed that; canopy volume, spring shoot length, leaves number and leaf area were significantly increased with increasing irrigation levels from 2800 to 8000 m^3 water /faddan / year and nitrogen rates from 600 to 1200 gm N / tree. Moreover, initial fruit set and final fruit set of Valencia orange trees were positively affected by irrigation, nitrogen fertilization and their combinations, also it decreased June fruit drop and perharvest drop. Yield as kg/tree or fruit numbers were significantly increased by raising the amount of nitrogen or water applied. In addition, weight, volume, juice volume, length, and diameter of the fruits were significantly increased by increasing irrigation levels from 2800 to 8000 m^3 water / faddan / year and nitrogen rates from 600 to 1200 gm N / tree, whereas peel thickness was significantly decreased. Concerning juice fruit quality, data showed that increasing irrigation and nitrogen levels caused significant decreasing on percentages of TSS and acidity, on the other hand vitamin C was increased; meanwhile TSS/ acid ratio did not affected by most treatments. Clear through the discussion of these results finally, using treatment 4000 cubic meters per faddan per year with the addition of nitrogen fertilizer at 1200 grams per tree per year is recommended for their positive impact on the trees and saving 50% of irrigation water without damage on vegetative growth, yield and fruit quality.*

Key wards: *Valencia orange –Sour orange – Rootstocks.*

INTRODUCTION

In Egypt there is scarcity in water irrigation resources, thereby the basic irrigation system must be adapted and controlling irrigation methods and amount of irrigation water especially in old soil in Nile Delta. Therefore, this can be achieved by using the water saved through improving surface irrigation systems in the Delta. Water and nitrogen supply have pronounced effects on crop yield and fruit quality of citrus (Koo and Smajstrla 1984; Swietlik 1992; Alva *et al.*, 2006; and Junior *et al.*, 2011). Valencia orange (*Citrus sinensis* L) is sensitive to water and nutrition specially nitrogen, deficits during the flowering period are directly related to reduced fruit set, it will increase fruit drop as will as reduce fruit growth (Youssef *et al.*, 1985; Zayan *et al.*, 1989; Wassel *et al.*, 2007b; and Gasque *et al.*, 2010). The objectives of this study were to: 1) compare the effects of various irrigation levels on growth, yield and fruit quality of Valencia orange trees; 2) determine tree responses to various nitrogen application rates under irrigation; 3) determine the optimum irrigation-nitrogen fertilization practices for Valencia orange trees.

MATERIALS AND METHODS

This study was carried out during 2010/ 2011 and 2011/2012 seasons on 16 years old Valencia orange (*Citrus sinensis,* Osbeck) budded on Sour orange (*Citrus aurantium* L.) rootstock, planted at 5 x 5 meter apart in a private farm at Kafr El-Zayat, Gharbiya governorate. The soil of the experimental orchard classified as clay, the data in Table (1) show some physical and chemical properties of this soil.

Table (1): some physical and chemical properties of the experimental soil:

Physical properties				Chemical properties					pH
Clay	silt	Fine sand	Coarse sand	o.m.%	Ec. ds /m	Total N %	P ppm	K ppm	
60.56	21.14	16.85	1.36	1.39	1.48	0.18	16.36	604.50	8.00

The fertilization program applied by the farmer for each tree was 3 kg ammonium sulphate (21% N) + 1 kg potassium sulphate (48% K_2o) + 2 kg calcium super phosphate (16% P_2o_5). The trees were flood irrigated 24 times/year. Treatments involved 3 irrigation levels and 3 rates of nitrogen fertilizer making a total of 9 combination treatments. All treatments replicated 3 times in 3 trees plots. The experimental trees were arranged in a split plot of a randomized complete block design according to Snedecor and Cochran(1967),and the least significant differences (L.S.D at 5%) was used to compare the main values. The amount of nitrogen were 3 kg/tree/year, 4.5 kg/tree/year and 6 kg/tree/year as ammonium sulphate (21%N) was applied to each tree/year, its equivalents were 600, 900 and 1200 gm N/tree/year respectively. The nitrogen fertilizer was added to trees in three equal doses at March, May and July in both seasons. Irrigation treatments included three levels, i.e., 8000, 4000 and 2800 m^3/faddan/year added 24 irrigations/year in both seasons. The experimental plots were irrigated through the main mesqa which contents plastic tubes (5 inches diameter) to conduct the water into the different plots. The irrigation requirements were calculated according to the following equation:

$$W = [(\theta_{Fc} - \theta wp) \div 100] \; B \times D \times S$$

according to (FAO,2005)

Where:

W = irrigation requirement (m^3)

θ_{Fc} = moisture content at field capacity (%)

θwp = moisture content directly before the next irrigation (%)

B = bulk density (g/cm^3)

D = depth of the soil (cm)

S = plot area (cm^2)

The corresponding delivered irrigation water through digged plastic tube (5 inches diameter) at the bottom of mesqa with a constant effective head (h) at the required time could be written as follows:

$$W = A \sqrt{2gh} \times T$$

according to (FAO,2005)

Where:

A = cross sectional area of the plastic tube (cm^2)

G = acceleration gravity (m/sec)

T = water delivery time (sec)

As the time of irrigation increased the delivered water was accordingly increased.

The following data was recorded:

1. Vegetative growth:

Spring shoot length (cm), number of leaves per shoot, leaf area (cm^2) were measured and tree canopy volume (m^3) was calculated according to the formula: 0.5238 x tree height x diameter square (Turrell, 1946).

2. Initial fruit set, final fruit set, June drop and preharvest drop:

- initial fruit set percentage by counting the flowers at five days intervals starting at the second week of March until final fruit set. (first of April), then the number of fruitless was counted and the initial fruit set percentage was calculated according the equation:

Initial fruit set % = (No. of fruitless ÷ Total No. of flowers) x 100.

- Final fruit set % was calculated by dividing the number of fruits before harvesting by the total number of flower.

Final fruit set % = (No. of fruits ÷ Total No. of flowers) x 100.

- The percentage of June drop was calculated by recording the number of dropping fruits and the equation:

June drop % = (number of dropping fruits ÷ No. of fruits in April) x 100.

- Preharvest drop percentage was calculated by recording fruits from mid November to mid January (harvest time).

The percentage of preharvest drop was calculated by the equation:

Preharvest drop % = (No. of dropping fruits ÷ No. of fruits at mid November) x 100.

3. **Yield:** at harvest time (commercial harvesting time at the first of April in both seasons); the yield of each tree was determined as number and weight (kg) of fruits/tree.

4. **Fruit quality:** 10 fruits were taken at random from the fruit yield of each tree for the determinations of physical and chemical characteristics such: fruit length and diameter (cm), fruit weight (gm), fruit volume (cm^3), juice volume/fruit (%), peel thickness (mm), total soluble solids by hand refractometer, total acidity as citric acid according to (A. O. A. C 1985), ascorbic acid as mg/100 ml/juice by using 2, 6 dichlorophenol indophenol according to Jacobs 1951) and TSS/acid ratio was estimated.

RESULTS AND DISCUSSION

1. Vegetative growth:

Data in Table (2) show the effect of irrigation levels, nitrogen rates and their interaction on canopy volume, spring shoot length, number of leaves per shoot and leaf area of Valencia orange trees. As for the effect of irrigation levels, it is clear that canopy volume, spring shoot length, leaves number per shoot and leaf area were significantly increased by increasing irrigation level from 2800 to 8000 m^3 water / faddan / year in both seasons. Similar results were obtained by Boman (2003) on Valencia orange, and Junior *et al.* (2011) on Tahiti lime trees. In this respect, Wassel *et al.* (2007a) concluded that increasing irrigation levels from 16 to 30 m^3 water / tree / year had a positive effect on shoot length, leaves number per shoot and leaf area of Balady mandarin trees. As for the effect of nitrogen rates, it is clear that nitrogen treatments indicated significant differences among them in vegetative growth parameters in both seasons. The highest values in both seasons were always recorded for 1200 gm N / tree treatment (Table 2). In this respect, Reuther and Smith (1951) noted on Valencia orange trees that nitrogen fertilizer increased tree growth. Also, Reese and Koo (1974) compared Hamlin, Pineapple and Valencia oranges treated with 4 levels of nitrogen resulted that canopy growth significantly increased with increasing nitrogen levels. Such conclusions agree with those presented by Youssef *et al.* (1985) on local orange in Riyadh, Saudi Arabia, reported that 3Kg $(NH_4)_2So_4$ trees induced greater number of shoots formed in the relevant flushes than other treatments (1 and 2 Kg$(NH_4)_2$ So_4).

Also, the interaction between irrigation levels and nitrogen rates had a significant effect on growth characters of Valencia orange trees, except of canopy volume in both seasons. The highest values belonged to treatment of (8000 m^3 water / faddan / year x 1200 gm N / tree) followed by those received (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N / tree) respectively, while, the least values belonged to the lowest levels of irrigation and N fertilizer (2800 m^3 water /faddan / year x 600 gm N / tree). The results are in agreement with those of Wassel *et al.* (2007a) who showed that the combinations between quantities of water and nitrogen levels and frequencies had significant affect on spring shoot length, leaves number per shoot and leaf area of Balady mandarin trees.. Generally, the data in Table (2) indicate that vegetative growth parameters were gradually increased with increasing irrigation levels from 2800 to 8000 m^3 water /faddan / year and nitrogen rates from 600 to 1200 gm N / tree in both seasons. Moreover, four combinations between irrigation levels and nitrogen rates gave the best vegetative growth without significant differences among them, these were (8000 m^3 water / faddan / year x 1200 gm N / tree), (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N / tree) respectively. On the other hand, the combination (4000 m^3 water / faddan / year x 1200 gm N / tree) would be preferred in light of the fact that it saves 50% of irrigation water compared with other one .

Table (2): Effect of different levels of irrigation and nitrogen rates on vegetative growth of Valencia orange trees.

Treatment: Irrigation Water m^3/ fadan/year	Treatment: Nitrogen gm/fadan	Canopy volume m^3	Spring shoot length cm	Leaves number per shoot	Leaf area cm^2
			2010-2011		
2800	600	25.20	28.02	13.56	13.233
	900	26.48	33.56	16.33	14.322
	1200	27.84	37.89	18.56	14.956
4000	600	27.48	44.99	19.33	18.611
	900	28.38	48.59	22.22	20.156
	1200	29.53	52.18	25.89	23.422
8000	600	29.74	53.59	27.67	26.544
	900	29.87	55.48	27.22	29.122
	1200	30.80	61.17	30.33	31.356
Mean of irrigation levels					
2800		26.51	33.16	16.15	14.170
4000		28.46	48.59	22.48	20.730
8000		30.14	56.74	28.41	29.007
Mean of Nitrogen rates					
600		27.47	42.20	20.19	19.463
900		28.24	45.87	21.48	21.200
1200		29.39	50.41	24.93	23.244
		5%	5%	5%	5%
L.S.D.	Irrigation	0.91	0.70	0.85	0.25
	Nitrogen	1.00	0.74	.0.88	.0.28
	(I x N)	NS	1.28	1.52	0.48
			2011/2012		
2800	600	26.17	28.41	13.88	14.580
	900	27.32	34.08	17.00	15.140
	1200	28.42	39.06	17.66	16.730
4000	600	28.80	46.02	20.55	19.140
	900	29.76	50.00	22.66	21.280
	1200	30.40	52.71	28.33	24.280
8000	600	30.40	55.59	29.11	27.790
	900	30.90	58.04	30.88	30.510
	1200	31.83	61.40	33.88	33.730
Mean of Irrigation levels					
2800		27.30	33.85	16.18	15.490
4000		29.65	49.58	23.85	21.570
8000		31.04	58.34	31.29	30.680
Mean of Nitrogen rates					
600		28.46	43.34	21.18	20.500
900		29.33	47.37	23.51	22.310
1200		30.22	51.06	26.63	24.910
		5%	5%	5%	5%
L.S.D.	Irrigation	1.23	0.91	0.52	0.45
	Nitrogen	1.33	0.98	0.48	0.48
	(I x N)	NS	1.69	0.83	0.86

NS = non significant

2- Initial fruit set, final fruit set, June drop and preharvest drop:

Data in Table (3) reveal that increasing irrigation levels caused significant increasing on percentages of initial fruit set and final fruit set in both seasons. The results are in line with those obtained by El-Wazzan *et al.* (2001) on Valencia orange, and Wassel *et al.* (2007b) on Balady mandarin, they concluded that increasing irrigation levels led to an increase in initial fruit set and final fruit set. In this respect, Stover *et al.* (2002) revealed that deficit of available irrigation water led to a lower fruit set in sweet orange trees. Also, initial fruit set and final fruit set were significantly increased by increasing nitrogen rates from 600 to 1200 gm / tree in both seasons. The present result are confirmed by El-Nabawy *et al.* (1975) on Washington navel orange, Youssef *et al.* (1985) on local orange, they report fruit set was significantly higher in nitrogen fertilized trees than in the control trees. Concerning the interaction between irrigation levels and nitrogen rates, it is clear that the interaction effect on initial fruit set and final fruit set was significant on both seasons (Table 3). Generally, the highest values of initial fruit set and final fruit set were found on trees treated with (8000 m^3 water / faddan / year x 1200 gm N / tree) followed by (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N / tree) respectively, while, the least values belonged to the lowest levels of irrigation and N fertilizer (2800 m^3 water /faddan / year x 600 gm N / tree). The data obtained in Table (3) show the percentages of June drop and preharvest fruit drop were affected by irrigation levels, nitrogen rates and their interaction in both seasons. The percentages of June drop and preharvest fruit drop were significantly decreased with increasing both irrigation and nitrogen fertilizer in both seasons. The combinations between irrigation levels and nitrogen rates were effective in reducing June drop and preharvest drop of Valencia orange trees. The lowest values of both parameters came from trees treated with (8000 m^3 water / faddan / year x 1200 gm N / tree) followed by (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N / tree) respectively, while, the highest values belonged to the lowest levels of irrigation and N fertilizer (2800 m^3 water /faddan / year x 600 gm N / tree). Similar results were obtained by Kanber *et al.* (1999), and Gasque *et al.* (2010) they reported increased quantities of water applied via irrigation led to a lower June drop and preharvest drop in citrus trees. In this respect, El-Nabawy *et al.* (1975), Youssef *et al.* (1985) and Zayan *et al.* (1989) they reported that increasing nitrogen level up to 1200 gm / tree significantly decreased the percentages of June drop and preharvest drop in different orange varieties. Generally, data in Table (3) revealed that initial fruit set, final fruit set, June fruit drop and preharvest drop of Valencia orange trees were positively affected by irrigation, nitrogen fertilizer and their combinations in both seasons. In this respect, irrigation regime and nitrogen gave the best fruit set and also reduced June drop and preharvest drop. Beside, the best combined treatments which gave high values of initial fruit set and final fruit set and also reduced June drop and preharvest drop was: (8000 m^3 water / faddan / year x 1200 gm N / tree), followed by (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N I tree) respectively, in both seasons.

3. Yield:

Data in table (4) clear that yield as weight kg / tree and number of fruit / tree was significantly increased by increasing irrigation levels to 8000 m^3 water / faddan / year followed by 4000 m^3 water / faddan / year in both seasons. Similar results were obtained by Sanchez Blanco *et al.* (1989) on Verna lemon, Gasque *et al.* (2010) on Navelina orange, and Junior *et al.* (2011) on Tahiti lime. The data also clarify significant differences due to nitrogen rates used in the trees fertilized with different levels. On the other words, raising nitrogen rate increased fruit yield as weight kg / tree or number of fruits per tree in both seasons. Similar results were reported by Sahata and Arora (1981) on Hamlin orange, As for the combinations between irrigation levels and nitrogen rates, it is clear that yield as weight kg / tree or number per tree was gradually increased by increasing the irrigation and nitrogen levels in both seasons. The differences were also significant among all combinations in both seasons. In this respect, the highest yield produced from trees treated with (8000 m^3 water / faddan / year x 1200 gm N / tree) followed by (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N / tree) respectively, while, the lowest (2800 m^3 water /faddan / year x 600 gm N / tree). Similar results were obtained by Koo *et al* (1973) on Bearss lemon, Koo (1979) on Valencia orange, Swietlik (1992) on Ray Ruby grapefruit, Alva *et al.* (2006) on Hamlin orange and Wassel *et al.* (2007a,b) on Balady mandarin.

Table (3). Effect of different irrigation levels and nitrogen rates on initial fruit set, final fruit set, June drop and Preharvest drop of Valencia orange trees.

Treatment		2010/2011				2011/2012			
Irrigation water m^3/faddan / year	Nitrogen gm / tree	Initial fruit set %	Final fruit set %	June drop %	Preharvest drop %	Initial fruit set %	Final fruit set %	June drop %	Preharvest drop %
2800	600	11.14	0.82	15.49	1.69	10.92	0.28	13.67	1.51
	900	12.01	1.20	15.02	0.96	11.15	0.61	13.44	1.41
	1200	12.10	1.31	14.92	0.64	11.24	1.01	12.98	1.33
4000	600	12.62	1.54	10.86	0.61	12.63	1.25	12.52	1.03
	900	13.67	1.83	10.16	0.60	13.04	1.28	12.31	0.94
	1200	13.95	2.04	9.86	0.52	13.44	1.35	10.93	0.67
8000	600	14.24	2.11	9.79	0.42	14.36	1.42	10.18	0.61
	900	15.17	2.10	9.62	0.28	15.24	2.34	9.27	0.57
	1200	15.53	2.23	8.07	0.10	15.51	2.54	8.45	0.19
Mean of Irrigation levels									
2800		11.75	1.11	15.14	1.10	11.10	0.63	13.37	1.42
4000		13.41	1.80	9.96	0.58	13.04	1.29	11.92	0.88
8000		14.98	2.15	9.16	0.26	15.04	2.10	9.30	0.46
Mean of Nitrogen rates									
600		12.67	1.49	12.05	0.91	12.64	0.98	12.13	1.05
900		13.62	1.71	11.60	0.61	13.14	1.41	11.67	0.97
1200		13.86	1.86	10.61	0.42	13.40	1.63	10.79	0.73
L.S.D.		5%	5%	5%	5%	5%	5%	5%	5%
	Irrigation	0.07	0.02	0.43	0..02	0.11	0.01	0..23	0..02
	Nitrogen	0.06	0.05	0.53	0..03	0.13	0.02	0..26	0..03
	(I x N)	0.10	0.03	NS	0.04	0..23	0.04	0.45	0..06

NS= non significant

Table (4): Effect of different irrigation levels and nitrogen rates on yield of Valencia orange trees.

Treatment		2010/2011		2011/2012	
Irrigation water m^3 / fadan/year	Nitrogen gm/tree	Kg	number	Kg	number
2800	600	36.80	301	41.86	313
	900	42.02	326	44.53	332
	1200	45.38	343	49.46	350
4000	600	53.91	341	54.72	359
	900	57.02	357	60.70	372
	1200	67.91	372	70.18	400
8000	600	80.28	423	78.20	418
	900	83.79	435	83.66	428
	1200	85.84	441	91.29	459
Mean of Irrigation levels					
2800		41.40	323	45.28	331
4000		59.62	356	61.87	377
8000		83.30	433	84.38	435
Mean of Nitrogen rates					
600		57.00	355	58.26	363
900		60.94	372	62.96	377
1200		66.38	385	70.31	403
L.S.D.		5%	5%	5%	5%
	Irrigation	1.15	2.00	1.12	1.50
	Nitrogen	1.19	2.09	1.10	1.52
	(I x N)	2.07	3.62	1.90	2.63

It is obvious from data in Table (4) that four combinations between irrigation levels and nitrogen rates gave high yield in both seasons, these were (8000 m^3 water / faddan / year x 1200 gm N / tree), (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N / tree) respectively. The best treatment was (4000 m^3 water / faddan / year x 1200 gm N / tree) This treatment is preferred in light of the fact that it saves 50% of irrigation water compared with other treatments.

4. Fruit quality:

4.1. Physical characters:

Data in Table (5) show the effect of irrigation levels, nitrogen rates and their interaction on physical fruit quality in terms of weight, volume, juice volume, length, and diameter and rind thickness of Valencia orange trees.

As for the effect of irrigation levels, it is clear that weight, volume, juice volume, length, and diameter of the fruits were significantly increased by increasing irrigation levels from 2800 to 8000 m^3 water / faddan / year in both seasons. Similar results were obtained by Chartzoulakis *et al.* (1999) on Bonanza orange, In this respect, Wassel *et al.* (2007b) concluded that increasing irrigation levels from 16 to 30 m^3 water / tree / year was accompanied with improving fruit weight of Balady mandarin trees. Similar results were reported by Sanchez-Blanco *et al.* (1989) they observed that the effect of irrigation on Verna lemon fruit quality such weight, length, diameter, peel thickness and juice % was improved. Also, it was clear from Table (5),that peel thickness was significantly decreased with increasing irrigation water in both seasons. Similar results were reported by Castel and Buj (1990), Chartzoulakis *et al.* (1999), and Junior *et al.* (2011).

As for the effect of nitrogen rates, it is clear that nitrogen treatments indicated significant differences among them in physical fruit quality parameters in both seasons. The highest values in both seasons were always recorded for 1200 gm N / tree treatment (Table 5). In this respect, Alva *et al.* (2006) noted on Hamlin orange trees that increasing nitrogen level increased fruit weight and peel thickness. Also, Sabbah *et al.*(1997) reported that Valencia orange trees received 0, 250, 500, 750 and 1000 g N/tree improved volume, length, diameter and juice volume of the fruits, and also increasing nitrogen rates increased peel thickness and fruit weight. Such conclusions agree with those presented by Youssef *et al.* (1985), that fruit diameter, volume, weight and peel thickness were increased with increasing nitrogen rates.

However, the interaction between irrigation levels and nitrogen rates had significant affect on fruit quality of Valencia orange trees in both seasons. The highest values belonged to treatment of (8000 m^3 water / faddan / year x 1200 gm N / tree) followed by (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N / tree) treatment respectively, while, the least values belonged to the lowest levels of irrigation and N fertilizer (2800 m^3 water /faddan / year x 600 gm N / tree). This result was true for most fruit quality parameters, except peel thickness. These results are in agreement with those of Wassel *et al.* (2007b) who showed that combinations between quantities of water and nitrogen levels and frequencies had significant affect on physical fruit quality of Balady mandarin trees.

4.2. Chemical characters:

Data in Table (6) reveal that increasing irrigation levels caused significant decreasing on percentages of TSS and acidity in both seasons. On the other hand, vitamin C was increased with increasing irrigation water, Meanwhile TSS/ acid ratio did not affected by irrigation treatment. These results are in line with those obtained by Kanber *et al.* (1999), Gasque *et al.* (2010) and Junior *et al.* (2011). In this respect, Sanchez-Blanco *et al.* (1989), Castel and Buj (1990) concluded that there was an increase in TSS and acidity as the amount of water applied decreased.

As for the effect of nitrogen rates on fruit juice quality, it is clear from Table (6) that 600 and 900 gm N / tree /year did not affected on TSS value, meanwhile 1200 g N / tree caused significant decrease in TSS in both seasons. Acidity was significantly decreased with increasing nitrogen rates from 600 to 1200 gm / tree, whereas vitamin C was significantly increased by all nitrogen rates in both seasons. TSS/acid ratio was unaffected by nitrogen rates. The present results are confirmed by Sahota and Arora (1981) on Hamlin sweet orange. In this respect, Sabbah *et al.* (1997) found that increasing nitrogen rates decreased acidity of Valencia orange juice. Also, Youssef *et al.* (1985) and Futch and Alva (1994) found that TSS/acid ratio and vitamin C were not affected with nitrogen fertilization. However, Reese and Koo (1974) working on Hamlin, Pineapple and Valencia orange trees, found that increasing nitrogen rates increased soluble solids and acidity, also Young and Koo (1967) reported that TSS and total acidity in Persian lime juice were increased by high nitrogen application.

Concerning the interaction between irrigation levels and nitrogen rates, it is clear that the interaction effect on juice fruit quality was not significant on most cases (Table 6). Generally, the highest values of juice fruit quality were found on trees treated with (2800 m^3 water / faddan / year x 600, 900 and 1200 gm N / tree) followed by (4000 m^3 water / faddan / year x 600, 900 and 1200 gm N / tree) treatments respectively. These findings were somewhat in agreement with those obtained by Koo *et al* (1973), Koo (1979), on different orange varieties.

Table (5): Effect of different irrigation levels and nitrogen rates on physical characters of Valencia orange fruits.

Treatment: Irrigation water m^3/faddan / year	Treatment: Nitrogen gm / tree	Fruit weight gm	Fruit volume cm^3	Fruit Length cm	Fruit diameter cm	Fruit peel thickness mm	Fruit juice volume %
2010/2011							
2800	600	131.80	175 .56	7.40	5.91	4.98	52.50
	900	140.30	185 .44	7.40	5.94	4.98	54.30
	1200	151.20	208 .22	7.60	5.96	5.08	54.60
4000	600	168.60	234 .56	8.70	6.27	4.87	56.80
	900	178.10	234 .67	8.70	6.31	4.88	58.00
	1200	183.70	277 .22	8.80	6.36	4.87	58.31
8000	600	180.00	305.44	9.10	7.11	4.79	61.40
	900	202.20	308.22	9.19	7.21	4.84	61.50
	1200	205.80	30..56	9.19	7.21	4.86	62.60
Mean of Irrigation levels							
2800		141.10	189. 74	7.46	5.93	5.01	53.80
4000		176.80	248. 81	8.73	6.31	4.87	57.70
8000		196.00	307.74	9.16	7.18	4.83	61.83
Mean of Nitrogen rates							
600		160.10	238. 52	8.40	6.43	4.88	56.90
900		173.60	242. 78	8.43	6.48	4.90	57.93
1200		180.20	265. 00	8.53	6.51	4.93	58.50
L.S.D		5%	5%	5%	5%	5%	5%
	Irrigation	10.2	2.11	0.01	0.09	0.07	0.50
	Nitrogen	11.3	2.31	0.02	NS	NS	0.45
	(I XN)	19.5	4.00	0.05	0.15	0.12	0.86
2011/2012							
2800	600	135.33	180.33	6.15	6.00	4.83	55.10
	900	139.89	181.78	6.20	6.16	4.92	57.00
	1200	151.67	202.22	6.29	6.26	4.96	57.31
4000	600	161.56	258.11	7.90	6.92	4.76	59.60
	900	179.78	268.56	7.93	6.99	4.74	60.80
	1200	188.44	285.44	7.98	7.01	4.83	61.10
8000	600	199.44	300.22	8.23	7.32	4.66	64.30
	900	204.44	305.67	8.27	7.36	4.70	64.40
	1200	204.11	305.78	8.30	7.41	4.71	65.60
Mean of Irrigation levels						4.90	56.74
2800		142.30	188.11	6..21	6.14	4.77	60.50
4000		176.59	270.70	7..93	6.97	4.69	64.77
8000		202.67	303.89	8.26	7.36		
Mean of nitrogen rates							
600		165.44	246.22	7.42	6.74	4.75	59.67
900		174.70	252.00	7.46	6.83	4.78	60.73
1200		181.41	264.48	7.52	6.89	4.83	61.34
	Irrigation	5%	5%	5%	5%	5%	5%
L.S.D.	Nitrogen	2.00	2.61	0.01	0.15	0.03	1.45
	(I x N)	2.04	2.65	0.02	0.17	0.04	1.40
		3.53	4.92	0.03	0.26	0.05	2.43

NS = non significant

Table (6). Effect of different irrigation levels and nitrogen rates on chemical characters of Valencia orange fruits.

Treatment		2010/2011				2011/2012			
Irrigation water m3/ faddan / year	Nitrogen gm / tree	TSS %	Acidity %	TSS/ acid ratio	Vit. C gm/100 ml	TSS %	Acidity %	TSS/ acid ratio	Vit. C gm/100 ml
2800	600	13.97	1.352	10.33	30.30	13.95	1.282	10.88	32.80
	900	13.94	1.242	11.22	31.00	13.91	1.180	11.78	33.60
	1200	12.84	1.231	10.43	34.00	12.80	1.161	11.02	36.90
4000	600	12.31	1.180	10.43	35.00	12.60	1.122	11.22	38.00
	900	11.84	1.181	10.02	36.00	12.39	1.120	11.06	39.10
	1200	11.66	1.160	10.05	39.00	11.54	1.100	10.49	42.40
8000	600	11.26	1.150	9.79	41.30	11.54	1.090	10.58	44.90
	900	11.24	1.110	10.12	44.60	11.22	1.061	10.57	48.49
	1200	11.12	1.110	10.01	49.30	11.10	1.050	10.57	53.70
Mean of Irrigation level									
2800		13.57	1.275	10.66	31.77	13.55	1.207	11.22	34.43
4000		11.93	1.173	10.16	36.67	12.17	1.114	10.92	39.83
8000		11.20	1.123	9.97	45.07	11.28	1.067	10.57	49.03
Mean of Nitrogen rates									
600		12.51	1.227	10.18	35.53	12.69	1.164	10.89	38.57
900		12.34	1.177	10.45	37.20	12.50	1.120	11.13	40.40
1200		11.86	1.167	10.16	40.77	11.81	1103	10.69	44.33
L.S.D.		5%	5%	5%	5%	5%	5%	5%	5%
	Irrigation	0..25	0..02	0.44	1.4	0..33	0.02	0..35	1..3
	Nitrogen	0..28	0..03	NS	1.5	0..36	0.01	0..36	1..2
	(I x N)	0..48	NS	NS	NS	0..58	0.04	NS	2. 1

ns = non significant

Conclusions

In light of this study the best treatments of vegetative growth, fruit set, less percentage of June and preharvest fruit drop, higher yield with good quality were obtained from Valencia orange trees that received (8000 m^3 water / faddan / year x 1200 gm N / tree), (8000 m^3 water / faddan / year x 900 gm N / tree), (8000 m^3 water / faddan / year x 600 gm N / tree) and (4000 m^3 water / faddan / year x 1200 gm N / tree) respectively. The treatment of (4000 m^3 water / faddan / year x 1200 gm N / tree) is promising in light of the fact that it saves 50% of irrigation water compared with other treatments.

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تأثير مستويات مختلفة من ماء الرى و التسميد النيتروجينى على النمو الخضرى و المحصول و جودة الثمار في أشجار البرتقال الفالنشيا

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قسم الموالح – محطة بحوث البساتين بسخا – كفر الشيخ

الملخص العربي

اجريت هذه الدراسةِ خلال موسمى ٢٠١٠/٢٠١١ و٢٠١١/٢٠١٢ تحت ظروف محافظةِ الغربية، على أشجارِ برتقال فالينشيا عمرها ١٦ سنةً، ومسافات الزراعة ٥ x ٥ متر مطعومة على اصل النارنج ونامية في تربةِ طينيةِ تم معاملة الأشجار بمجموعة من التوليفات بين النتروجينِ في ثلاث معدلات هى ٦٠٠ و ٩٠٠ و ١٢٠٠ جرام/ شجرة / سَنَة و الرَيّ في ثلاثة مستويات، وهم ٨٠٠٠ و ٤٠٠٠ و٢٨٠٠ متر مكعب/فدان/ سنة و ذلك لدراسَة تأثيرِ مستويات الرَيِّ ومعدلات النتروجينِ المختلفة على النمو الخضري والمحصولَ و جودة الثمار بغرض ترشيد استخدام السماد ومياه الري و قد بينت النتائج ان:

١- ادت زيادة مستويات الرى من ٢٨٠٠ الى ٨٠٠٠ متر مكعب/فدان/سنة و النيتروجين من ٦٠٠ الى ١٢٠٠ جرام/شجرة/سنة الى احداث زيادة معنوية حجم الشجرة و طول نموات الربيع و مساحة الورقة في الموسمين.

٢- تحسن في عقد الثمار المبدئي و النهائي لأشجار البرتقال الفالينشيا و أيضا قلت النسبة المئوية للثمار المتساقطة فى يونيو و تساقط ماقبل الجمع و ذلك بزيادة الرى والتسميد النيتروجين في موسمي الدراسة,

٣- زاد معنويا محصول الثمار و المتمثل فى وزن الثمار الكلى للشجرة و عدد الثمار لكل شجرة مع زيادة كمية الرى و النيتروجين خلال موسمي الدراسة.

٤- قياسات الجودة الطبيعية و المتمثلة فى وزن الثمرة و حجم الثمرة و حجم العصير و طول و قطر الثمرة زادت معنويا بزيادة مستوي الرى من ٢٨٠٠ الى ٨٠٠٠ متر مكعب/فدان/سنة وزيادة النيتروجين من ٦٠٠ الى ١٢٠٠ جرام/شجرة/سنة بينما ادت هذة المعاملات الى قلة سمك القشرة . فيما يتعلق بجودة عصير الثمار وجد ان زيادة كمية ماء الرى ومعدلات النيتروجين سببت نقص معنوى للمواد الصلبة الكلية TSS و الحموضة الكلية في حين زاد محتوى عصير الثمارمن فيتامين C اما نسبة المواد الصلبة الكلية الى الحموضة TSS/acid ratio فلم تتاثر بالمعاملات .

النتائج المتحصل عليها في هذه الدراسة توصى باستخدام المعاملة ٤٠٠٠ متر مكعب للفدان فى السنة مع اضافة السماد النيتروجينى بمعدل ١٢٠٠ جرام للشجرة فى السنة وذلك لتاثيرها الايجابى على الاشجار و توفيرها ٥٠ % من مياه الرى بدون اثر سلبى على النمو الخضرى و المحصول و جودة الثمار.