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EFFECT OF NITROGEN, POTASSIUM AND MAGNESIUM FERTILIZATION ON YIELD AND FRUIT QUALITY OF MANDARIN

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ABSTRACT

The present study was carried out in Salheya area, Sharkiya Governorate Egypt, during season 2011 -2012 to study the effect of N, K and Mg fertilization of mandarin (15 years old) budded on sour orange and grown on a sandy soil. The study was done on orchards considered to be low yielding (<30kg/tree). The experiments were fertilized with N at rates of 333, 500 and 666 g N / tree/year as ammonium sulphate, K at rates of 166, 250 and 333 g K /tree/year as potassium sulphate and Mg at rates of 0, 20 and 40 g Mg/tree/year as soil application. It was clear that increasing N, K and Mg levels increased the yield of the trees, fruit quality, vitamin C content, fruit weight and peel thickness, while decreased both total acidity, and total sugars contents .Also, increasing the rates of N, K and Mg caused increases in leave contents with previous elements. In general, the differences between the two higher levels of each of the fertilizers used were not significant. Thus, the most effective and economical treatment was500 g N/ tree/year as ammonium sulphate, 333g K/tree/year as potassium sulphate and 20 g Mg/tree/year as magnesium sulphate.

Key words: Citrus, mandarin, nitrogen, potassium, magnesium fertilization.

INTRODUCTION

Citrus is considered one of the most important fruit crops all over the world. in Egypt ,citrus is the second or the third one after grapevines and apples. The total aria of citrus in Egypt reached 462,772 fad., (194364 ha) out of them 369,022 fad., (155051 ha) are fruitful producing 3, 522, 953 tons with average of 9.55 tons/fad., (22.72 tons/ha). (Mohamed, 2011). Taking into consideration the high population growth rate and the improvement in standard of living in Egypt during the last few years, increasing agricultural products and water resources to fulfill these demands developing agricultural techniques especially for management of sandy soils, have to be used.

Citrus trees require large quantities of water and mineral nutrients (specially nitrogen) in varying amounts to maintain high production of good quality fruit.

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Nitrogen has the dominate influence (than P and K) on growth and productivity not only because of its high requirement by plants but because it is a constituent of proteins, nucleic acid, vitamins, hormones and many other important substance.

Citrus represents a considerable portion of the lands cultivated by fruits. Sharkia Governorate is one of the main areas where citrus is concentrated mainly in the newly reclaimed soils. Most of this areas cultivated by orange.

Fertilization is one of the most important practices affecting citrus yield and quality. Nitrogen and potassium are the main nutrients needed for citrus trees. Also, the balance between N and K is very important Monga *et al.* (2002). Working on sweet orange Cv. Jaffa found that fruit yield was increased with increasing N rate. The highest yield was observed in trees supplied with N at 900 g /tree/year. in combination with K and P.

The aim of this research is to study the effect of N, K and Mg on mandarin yield and its quality and increasing fertilizer efficiency.

MATERIALS AND METHODS

A field experiment was initiated on a sandy soil during the season 2011 - 2012 at Salheya area, Sharkiya Governorate, Egypt. This experiment was carried out to study the effect of N, K and Mg fertilization on balady mandarin yield and its quality under surface irrigation system. 15- years old trees budded on sour root - stock, specked at 4x4 meters *i.e.,* about 240 tree/fad." (570 trees/ha) were used.

A composite soil sample was prepared by collecting samples before starting the experiment and was analyzed. Table 1-a shows chemical and physical characteristics of the studied soil. Irrigation water was available from underground water well.

This experiment was carried out during season 2011 – 2012. All plots were fertilized with superphosphate at a rate of 300 Kg /fad., (714 $kg.ha^{-1}$) and 3000 Kg/fad. (7140 $kg.ha^{-1}$) compost mixed with chicken manure at a ratio of 5: 1. Foliar spray application of the micronutrients Fe, Mn and Zn as Fe-EDTA, Mn-EDTA and Zn- EDTA. concentrations of 300, 200 and 100 mg/l of Fe, Mn and Zn, respectively were foliar sprayed 3 times on March, June and September. The volume of each spray was 400 l/faddan (952 l/ha^{-1}).

Treatments

1. Nitrogen fertilization at three rates *i.e.,* 333, 500 and 666 g N/tree/year as ammonium sulphate "20% N".
2. Potassium at three rates *i.e.* 166,250 and 333" g K/tree/year as potassium sulphate"48.5% K.
3. Magnesium at three rates *i.e.* 0, 20 and 40 g Mg /tree/year as magnesium sulphate "16% Mg". fertilization treatments were applied through 4 doses on March , May , July and September as soil application by unequal four doses as shown in Table 1-b.

Therefore, the total number of treatments of the experiment was 3 N rates x 3 K rates x 3 Mg rates = 27. The experimental design was randomized complete block with three replicates. The total number of plots was 81.

During the usual picking period through January, the number and weight of picked fruits per tree were recorded.

Fruit Quality

Fruit samples were taken (10 fruits per tree) for assessing the following quality parameter, pulp weight, peel thickness and peel weight.

Fruit Juice Chemical Properties

The chemical constituents of fruit juice were determined at time of harvest. The extracted juice was used for the following determinations.

1. Total sugars using a hand refractometer according to Lane and Eynon (1960).
2. Total acidity by titration against 0.1 N sodium hydroxide using phenolphthalein according AOAC (1990).
3. Ascorbic acid "vitamin C" by titration against 2.6 –dichlorophenol indophenol die "mg /100 ml juice according to AOAC. (1990).

Soil Analysis

Soil analysis was performed as follows:

1. Particle size distribution was carried out by International Pipette method as described by Piper (1950).
2. Organic matter content was determined by Wolkely and Block method according to Jackson (1967).
3. Soil reaction (pH) was determined in (1:2.5) soil water suspension by pH meter.
4. Electrical conductivity "EC" of the soil extract was determined in 1: 2.5 soil water extract according to Jackson (1967).
5. Available N, P and K wer extracted by 1% K_2SO_4 Solution, 0.5 M Solution bicarbonate and 1.0 N ammonium acetate, respectively according to Juckson 1967.

RESULTS AND DISCUSSION

Mandarin Yield (kg/tree)

Data presented in Table 2 show that the total mandarin yield ranged between 29.00 and 73.33 kg/tree. he greatest mandarin yield was obtained under the application of 666, 250 and 20g /tree/year of N, K and Mg, respectively. On the

Table 1-a. Physical and chemical properties of the investigated soil

Soil property	Values
Soil particle distribution	
Sand (%)	88.6
Silt (%)	7.3
Clay (%)	4.1
Textural class	Sand
pH	8.6
EC (dSm^{-1})	0.30
Available N (mg kg^{-1}soil)	22
Available P (mg kg^{-1}soil)	12
Available K (mg kg^{-1}soil)	185

Table 1-b. Time and rates of nutrients through growing season

Time of addition	N rate g /tree			K rate g /tree			Mg rate g /tree		
	N_1	N_2	N_3	K_1	K_2	K_3	Mg_0	Mg_1	Mg_2
Marsh	66	100	133	41	62	83	0	5	10
May	100	150	200	42	64	83	0	5	10
July	100	150	200	42	62	83	0	5	10
August	66	100	133	41	62	84	0	5	10
Total	332	500	666	166	250	333	0	20	40

Table 2. Mandarin yield (kg /tree), fruit weight (g) and fruit number/tree as influenced by the application of N, K and Mg fertilizers

N Rate (g N/tree) (A)	K Rate (gK/ tree) (B)	Mg application rate g/tree/year (C)											
		0	20	40	Mean	0	20	40	Mean	0	20	40	Mean
		Yield (kg/tree)				Fruit weight (g.)				Fruit Number/tree			
	166	31.67	29.00	30.00	30.22	110.97	112.83	111.97	111.92	285	257	268	270
333	**250**	34.67	39.67	32.67	35.67	110.53	114.63	122.93	116.03	314	346	266	308
	333	48.67	58.33	59.67	55.56	123.87	123.30	116.20	121.12	393	473	513	460
Mean		38.33	42.33	40.78	40.48	115.12	116.92	117.03	116.36	329	360	348	346
	166	37.33	38.33	38.33	38.00	108.63	113.67	116.03	112.78	344	337	330	337
500	**250**	39.00	41.67	53.33	44.67	114.63	113.00	127.83	118.49	340	369	417	375
	333	58.33	65.00	70.00	64.44	138.27	143.97	138.27	140.17	422	451	506	460
Mean		44.89	48.33	53.89	49.04	120.51	123.54	127.38	123.81	373	388	421	394
	166	40.00	43.33	40.00	41.11	127.97	120.00	126.57	124.84	312	361	316	330
666	**250**	67.67	73.33	64.00	68.33	125.63	116.40	119.97	120.67	539	630	533	568
	333	54.67	59.33	58.33	57.44	121.23	110.97	121.47	117.89	450	535	480	489
Mean		54.11	58.67	54.11	55.63	124.94	115.79	122.67	121.13	434	513	445	464
						Mean of K							
166		36.33	36.89	36.11	36.44	115.86	115.50	118.19	116.52	314	318	305	312
250		47.11	51.56	50.00	49.56	116.93	114.68	123.58	118.40	398	448	405	417
333		53.89	60.89	62.67	59.15	127.79	126.08	125.31	126.39	422	486	500	469
G. Mean		45.78	49.78	49.59	48.38	120.19	118.75	122.36	120.43	378	420	405	401
LSD 0.05	A 4.76		B 4.76		C NS	A 4.49		B 4.49	C NS	A 0.081		B 0.081	C NS
	AB 8.25		AC NS		BC NS	AB 7.78		AC NS	BC NS	AB 7.78		AC NS	BC NS
	ABC NS					ABC NS				ABC NS			

NS = Not significant

other hand, the lowest yield was obtained by the treatment 333,166 and 20 g /tree /year of N, K and Mg, respectively.

The data of yield presented in Table 2 show that nitrogen application at the rates 333, 500 and 666 g N/tree/year caused significant increases in mandarin yield. Regarding the relative effect, the data show that increasing N fertilization from 333 to 500 and 666g N/tree/year increased the mean of mandarin yield by 21.14 and 37.42%, respectively over the rate of 333g N/tree/year. In addition, the application of 666 g N/ tree/year increased the mean of mandarin yield by 13.43 % over the rate of 500g N/tree/year. The nitrogen consumptive use was 0.50, 0.40 and 0.35 kg fruit/kg applied N for the treatments 333, 500 and 666 g N/tree/year, respectively. This means that the consumptive use of N decreased by increasing the rate of N application.

The obtained results are in harmony with those reported by Ahmed *et al.* (1988); Sabbah *et al.* (1997); Monga *et al.* (2002); Tayeh *et al.* (2003); Vedamani *et al.* (2006); Quinones *et al.* (2009) and Mohamed (2011) who found that yield of citrus trees was increased with increasing nitrogen fertilizer rate.

Concerning potassium fertilization, the data cleared that increasing K fertilization from 166 to 250 and 333 g K/tree/year caused increases in mandarin yield by 36% and19.35% respectively. While increasing rates of applid N from 166 to 333g K/tree/year caused increases by an average 62.32%.

Regarding the effect of Mg fertilization data presented in Table 2 indicated that increasing of magnesium rate from 0 to 20g Mg/tree/year caused increases in mandarin yield by 8.42% while increasing Mg rate from 20 to 40g Mg/ tree/ ear decreased mandarin yield by an average 8.42%.

Studying the interaction effect of N and K on mandarin yield, the data indicated that in general K application under each N rate increased the yield. The relative yields for K rates are 18.03 and 55.76% when using the first rate of N (333g N/tree/year). Under the second rate (500g N/tree/year), the relative yields were 17.5 and 44.25. The corresponding value of the third N rate (666g N/tree/year) were 66.21 and 39.72%. For the interaction between N and Mg, the data revealed that under the application of 333g N/tree/year with rates of Mg, the application of 20 and 40g Mg/tree/year increased the mandarin yield by 10.4% and 6.3% over the control. Under the application of 500g N/tree/year, these increases were 7.6% and 20% while under the application of 666g N/tree/year with 20g Mg/tree/year caused increase of about 8.4% while increasing rate of the applied Mg to applying 40g Mg /tree/year decreased mandarin yield by 8.4%.

Fruit Weight

Data in Table 2 show the means of fruit weight of mandarin as influenced by different levels of N, k and Mg .The general means of fruit weight ranged between 110.97 and 143.97 g/fruit. The greatest value of fruit weight was obtained by application of 500, 333 and 20g/tree/year of N, K and Mg, respectively. On the other hand, the lowest value was obtained by the treatment 333g N and 166 g k/tree/year without using Mg.

Studying the effect of nitrogen fertilization., the data showed that increasing nitrogen application rate from 333 to 500 g N/tree/year caused significant increases in the mean fruit weight by 6.4% while the application of 666 g N/ tree/year decreased the mean fruit weight as compared with that achieved upon application of N at rate of 500 g N/tree/year by 2.21%, however increasing N fertilization rate from 333 to 666 increased fruit weight by 4.10%

Concerning potassium fertilization, the data cleared that increasing K fertilization from 166 to 250 g K/tree/year caused increases in fruit weight averaged 1.61% while increasing K rate from 250 to 333 g K/tree/year caused insignificant increases averaged 6.74% but at the same time increasing K rate from 166 to 333 g K/tree/year increased average fruit weight by 8.47%.

Regarding effect of Mg fertilization, data presented in Table 2 indicate that increasing application rate of magnesium from 0 to 20 g Mg/tree/year caused slight decreases in fruit weight averaged 7.32%. While increasing Mg fertilization rate from 20 to 40g Mg/tree/year caused increases in fruit weight by an average 5.94%.

Studying the interactive effect of N and K on fruit weight, the data indicated that under application of 333g N/tree/year, increasing rate of potassium from 166 to 250 and 333g K/tree/year increased the fruit weight by 3.67% and 4.38% respectively. Under the second rate of applied N (500g N/tree/year), the corresponding increases were 5.06% and 18.29%, respectively. While under application of the third N rate (666g N /tree/year), increasing K rate from 166 to 250 and 333 g K/tree/year decreased fruit weight by 3.45% and 2.35%, respectively.

Under the application of 333g N/tree/year, application of 20 and 40g Mg /tree/year increased fruit weight by 1.56% and 0.9% over the no Mg application. Under the application of 500 g N /tree/year, the corresponding increases were 2.51% and 3.10% respectively while under the application of 666g N/tree/year, application of Mg at rate of 20g Mg/tree/year caused decreases averaged 7.90% but upon increasing rate N application of Mg to 40 g Mg/tree/year fruit weight increased with an average of 5.94%.

These results are in agreement with those obtained by Nokrashy *et al.* (1977) and Monga *et al.* (2002 and 2004), who reported that fruit weight was increased with the application of different fertilizer doses.

Fruit Number

Table 2 show the means of mandarin fruit number as influenced by different levels of N, K and Mg as soil application. There means varied between 257 and 630 fruits/tree The greatest value of mandarin fruit number was obtained under application of 666, 250 and 20 g/tree/year of N, K and Mg, respectively. The lowest value was obtained under application of 333, 166 and 20g/tree/year of N, K and Mg, respectively.

With regard to the effect of N fertilization, the data showed that increasing N fertilization from 333 to 500 and 666 g N/tree/year increased fruit number by13.99% and 17.72%, respectively.

Concerning potassium fertilization, the data cleared that increasing K fertilizers rate from 166 to 250 and 333g K/tree/year caused increases in fruit number by 33.65% and 12.4 % while increasing rate of the applied K from 166 to 333 g K/tree/year increased fruit number by average of 50.32%.

Regarding Effect of Mg fertilization, data presented in Table 2 indicated that increasing rate of application of magnesium from 0 to 20 g Mg/tree/year increased fruit number by an average 18.20% while increasing Mg fertilization rate from 20 to 40 g Mg /tree/year decreased fruit number by an average 15.28%. However changes occurred in fruit number due to fertilization with Mg were insignificant.

The interaction between N and K was of significant effect on fruit number. Under N application rate of 333g N/tree/year increasing rate of potassium from 166 to 250 and 333g K/tree/year increased the fruit number by average of 13.53% and 49.13%, respectively. Under the second N rate (500 g N /tree/year) the corresponding increases were 11.67% and 22.84%, respectively. The increases under the third N rate (666g N/tree/year) due to increasing rate of K from 166 to 250 g K/tree/year increased fruit number by 72.12%, but under application of 666g N /tree/year with increasing rate of applied K to 333g k/tree/year fruit number decreased by an average of 15.76%.

However under the application of 333g N/tree/year, no significant effect occurred due to interaction between N and Mg. Application of 20g Mg /tree/year increased fruit number by an average of 9.39% over the control, while increasing Mg from 20 to 40g Mg/tree/year decreased fruit number by an average 3.25%. Under the application of 500 g N /tree/year the increases occurred in fruit number / tree due to increasing rate of the applied Mg from 0 to 20 and 40 g Mg / tree / year averaged 4.23% and 8.41%, respectively, while under the application of 666 g N/tree/year, application of Mg at rate of 20g Mg caused increases in fruit number/tree averaged 18.29% over the control, Increasing application rate of N to 666g N /tree/year with 40 g Mg/tree/year decreased fruit number by an average 15.25%.

These findins are in accordance with those recorded by Atawia and Desouky, (1997); El-Sese, (2005); Chao and Lovatt (2006); Vedamani *et al.* (2006) Saleem *et al.* (2008), Shinde *et al.* (2008) and Mohamed (2011).

Physical Properties of Mandarin Fruits

Data presented in Table 3 reveal some physical properties (peel thickness, peel weight and pulp weight,) as influenced by application of N, K and Mg.

Peel Thickness

Table 3 show that the means of peel thickness of mandarin ranged between 2.17 and 3.37 mm. The greatest value of peel thickness was obtained under application of 500, 333 and 40g /tree/year of N, K and Mg, respectively. The lowest value was obtained by application of 333, 166 and 40g /tree/year of N, K and Mg, respectively.

Nitrogen fertilization exerted significant effect on peel thickness. Increasing N fertilization rate from 333 to 500g N/tree/year increased fruit peel thickness by an average of 18.85%. In addition the application of 666 g N/ tree/year increased fruit peel thickness by an average 7.58% over the rate of 500 g N/ tree/ year, while increasing N fertilization from 333 to 666 g N/tree/year increased fruit peel thickness by an average 27.86%.

Potassium fertilization was of insignificant effect on peel thickness increasing. However, increasing K fertilization rate from 166 to 250 and 333 g K/tree/year caused increases in fruit peel thickness by averages 2.99% and 13.85%, respectively. Also increasing K rate from 166 to 333g K/tree/year increased peel thickness by an average 10.54%.

Mg fertilization was of no significant effect on peel thickness However application of magnesium at rates of 20 and 40 g Mg/tree/year slightly increased peel thickness by 1.95% and 1.27% respectively.

The interaction between N and K, had significant effect on peel thicknes. However, under 333g N/tree/year, increasing rate of potassium from 166 to 250 or 333g K/tree/year increased the fruit peel thickness by averases of 5.19 % and 5.76%. Under the second rate of N (500g N /tree/year) the corresponding increases were 2.60 and 21.56%, respectively. The corresponding average values under the third N rate (666 g N /tree/year) were 1.32 and 8.94%, respectively.

Pulp Weight

The nitrogen treatments were of significant effect on pulp weight (Table 3), increasing N fertilization rate from 333 to 500 g N/tree/year increased fruit pulp weight by 7.12%. Furthermore the application of 666 g N/tree/year decreased fruit pulp weight by an average of 1.82%, while increasing N fertilization rate from 333 to 666 g N/tree/year increased fruit pulp weight by an average 5.20%.

The fertilization with potassium was also of significant effect on pulp weight. The data cleared that increasing K fertilization rate from 166 to 250 g K/tree/year caused increases in fruit pulp weight by an average 1.84% while the increase in K rate from 250 to 333 g K/tree/year increased pulp weight by an average of 6.56%, Increasing K rate from 166 to 333 g N/tree/year increased pulp weight by an average of 8.14%.

Mg fertilization data presented in Table 3 did not affect significantly pulp weight, however increasing Mg rate from 0 to 20 and 40 g Mg/tree/year increased pulp weight by averages of 1.18% and 1.58% respectively. Non of the interactions between N and Mg or K and Mg could significantly affect pulp weight. On the other hand interaction between N and K significantly affected pulp weight. In this concern the interaction between N at a rate of 500 g N /tree/year and K at a rate of 333 g Mg /tree/year was the most pronounced effect on pulp weight.

Means of pulp weight ranged between 88.20 and 117.30 g. The greatest value of pulp weight was obtained under applying 500, 333 and 20g /tree/year of N, K and Mg, respectively. The lowest value was obtained under application of 333, 166 and 20g /tree/year of N, K and Mg, respectively.

Peel Weight (g)

Table 3 show that the means of peel weight ranged between 21.40 and 26.67 g. The greatest value of peel weight was obtained under application treatment of 500, 333 and 20 g /tree/year of N, K and Mg, respectively. Whereas the lowest value was obtained under application of 500 and 166 g /tree/year of N, K without Mg application.

Table 3. Peel thickness (mm), peel weight and pulp weight (g) as influenced by application N, k and Mg fertilizers

N Rate (g N/tree/year) (A)	K Rate (gK/tree) (B)	Mg application rate g/tree/year (C)											
		0	20	40	Mean	0	20	40	Mean	0	20	40	Mean
		Peel thickness (mm)				Peel weight (g)				Pulp weight (g)			
333	166	2.37	2.40	2.17	2.31	21.80	22.77	22.40	22.32	89.17	88.20	89.57	88.98
	250	2.50	2.30	2.50	2.43	21.80	22.77	23.37	22.64	88.73	91.87	99.53	93.38
	333	2.40	2.63	2.67	2.57	23.20	23.13	21.60	22.64	100.70	100.83	94.27	98.60
Mean		2.42	2.44	2.44	2.44	22.27	22.89	22.46	22.54	92.87	93.63	94.46	93.65
500	166	2.83	2.63	2.60	2.69	21.40	22.30	22.20	21.97	87.23	91.93	93.83	91.00
	250	2.70	2.73	2.83	2.76	22.10	22.07	23.73	22.63	92.60	90.93	104.10	95.88
	333	3.17	3.27	3.37	3.27	25.33	26.67	26.27	26.09	112.93	117.30	112.00	114.08
Mean		2.90	2.88	2.93	2.90	22.94	23.68	24.07	23.56	97.59	100.06	103.31	100.32
666	166	2.90	3.07	3.10	3.02	24.40	23.80	23.23	23.81	104.13	96.77	102.80	103.43
	250	2.97	3.13	3.07	3.06	22.93	23.30	23.10	23.11	99.07	97.97	98.00	98.34
	333	3.33	3.20	3.33	3.29	23.37	23.23	21.73	22.78	89.23	98.30	93.83	93.79
Mean		3.07	3.13	3.17	3.12	23.57	23.44	22.69	23.23	97.48	97.68	98.21	98.52
						Mean of K							
166		2.70	2.70	2.62	2.67	22.53	22.96	22.61	22.70	93.51	92.30	95.40	94.47
250		2.72	2.72	2.80	2.75	22.28	22.71	23.40	22.80	93.47	93.59	100.54	95.87
333		2.97	3.03	3.12	3.04	23.97	24.34	23.20	23.84	100.96	105.48	100.03	102.16
G. Mean		2.80	2.82	2.85	2.82	23.57	23.44	22.69	23.23	97.48	97.68	98.21	98.52
LSD 0.05	A 0.094	B 0.094		C NS		A 0.058	B 0.058	C NS		A 0.081	B 0.081	C NS	
	AB NS	AC NS		BC NS		AB NS	AC NS	BC NS		AB 0.14	AC NS	BC NS	
	ABC NS					ABC NS				ABC NS			

Increasing N fertilization rate from 333 to 500 g N/tree/year increased fruit peel weight by an average of 4.52% over the rate of 333 g N/tree/year. The application of 666 g N/tree/year decreased fruit peel weight by an average of 1.40%. While increasing N rate from 333 to 666 g N/tree/year increased fruit peel weight by an average of 3.06%.

Potassium fertilization had significant effect on peel weight. Increasing K fertilization rate from 166 to 250 g K/tree/year caused increases in fruit peel weight averaged 0.44% and increasing from 250to 333 g K /tree/year increased peel weight by an average 4.56% while increasing K rate from 166 to 333 g K/tree/year increased peel weight by an average 5.02%.

Concerning Mg fertilization the data show that increasing Mg rate from 0 to 20 and 40 g mg/tree/year decreased peel weight by an average 0.55% and 3.30%, respectively.

No significant interaction effect could be observed between either N and K, N and Mg, K and Mg or among N, K and Mg. Application of 333 g N/tree/year and increasing rate of potassium from 166 to 250 g K/tree/year increased the fruit peel weight by an average of 1.43%. but increasing K rate from 250 to 333 g K /tree/year did not affect peel weight. Under the second rate of N (500 g N/tree/year) the increases averaged 3.00% and 15.28% respectively. The third N rate (666 g N/tree/ year), increasing K rate from 166 to 250 and 333 g K/tree/year caused decreases averaged 3.02% and 1.44% respectively.

However under the application of 333 g N/tree/year, increasing application rate from 20 to 40 g Mg /tree/year increased peel weight by an average 2.78% while increasing Mg rate from 20 to 40 g Mg/tree/year had no effect .Under the application of 500 g N/tree/year, there were increases by average 3.22% and 1.64% due to application of Mg at 20 respectively, while under the application of 666 g N/tree/year both rates of 20 and 40 g Mg /tree/year did not affect peel weight .

These results are in harmony with those found by Harminder *et al.* (1990).

Chemical Properties of Mandarin Fruit

Total sugars

Table 4 show the means of total sugars of mandarin as influenced by different levels of N, K and Mg as soil application .The total sugar ranged between 6.20 and 8.50%. The greatest value of total sugars was obtained under application of 333, 333 and 20 g /tree/year of N, K and Mg respectively. While the lowest value was obtained under application of 666, 166 and 40g/tree/year of N, K and Mg, respectively.

Application of N fertilizer was of significant effect on total sugar content of mandarin fruit. The data show that increasing nitrogen application rat from 333 to 500 and from 500 to 666 g N/tree/year /year decreased the total sugars by averages of 6.61% and 6.14% while increasing N fertilization rate from 333 to 666 g N /tree/year decreased the total sugars by 13.15%.

Also potassium fertilization, affected significantly total sugar content. Increasing K fertilization rate from 166 to 250 and 333g K/tree /year caused increases in total sugars by 8.85% and 8.82% respectively.

Application of magnesium at 20 g Mg/tree/ year increased total sugars by an average 3.24%. while increasing Mg fertilization rate from 20 to 40 g Mg /tree/year decreased total sugars by an average 3.85%.

The interaction effect between N and K was significant on total sugars. Data indicate that application rates of potassium 166 to 250 g K / tree/year increased the total sugars by 8.87% and 8.66% respectively. Under the rate 500 g N /tree/year increasing K rate from 166 to 250 and then from 250 to 333 g K/tree/year caused increases in total sugars averaged 10.21% and 8.99%, respectively. The corresponding increases in total sugar under the third N rate *i.e.,* 666g N /tree /year. averaged 7.59% and 8.82%, respectively.

Interaction between N and Mg was of significant effect on total suger content. While interaction between K and Mg was of significant effect in this concern. Likewise, non significant effect occurred due to the interaction among N, K and Mg.

Table 4. Total sugars (%), Total acidity (%) and V. C content (mg / L) as influenced by application of N, k and Mg fertilizers

N Rate (g N/tree/year) (A)	K Rate (gK/tree) (B)	Mg application rate g/tree/year (C)											
		0	20	40	Mean	0	20	40	Mean	0	20	40	Mean
		Total sugars (%)				Total acidity (%)				V.C content (mg/L)			
333	166	7.33	7.07	6.90	7.10	1.77	1.72	1.67	1.72	43.40	42.87	42.53	42.93
	250	7.63	7.73	7.83	7.73	1.57	1.62	1.61	1.60	43.47	42.83	42.43	42.91
	333	8.30	8.50	8.40	8.40	1.52	1.53	1.52	1.52	42.27	42.47	42.83	42.52
Mean		7.75	7.77	7.71	7.74	1.62	1.62	1.60	1.61	43.04	42.72	42.60	42.79
500	166	6.87	6.50	6.30	6.56	1.78	1.81	1.82	1.80	43.43	42.80	42.63	42.96
	250	7.23	7.13	7.33	7.23	1.84	1.80	1.81	1.82	42.33	43.43	42.93	42.90
	333	7.77	7.97	7.90	7.88	1.76	1.77	1.77	1.77	43.43	43.73	42.37	43.18
Mean		7.29	7.20	7.18	7.22	1.79	1.79	1.80	1.80	43.07	43.32	42.64	43.01
666	166	6.37	6.40	6.20	6.32	1.86	1.88	1.87	1.87	42.10	41.43	42.30	41.94
	250	6.70	7.17	6.53	6.80	1.85	1.84	1.85	1.85	42.80	42.53	43.00	42.78
	333	7.27	7.43	7.50	7.40	1.81	1.80	1.80	1.80	43.07	43.03	43.40	43.17
Mean		6.78	7.00	6.74	6.84	1.84	1.84	1.84	1.84	42.66	42.33	42.90	42.63
Mean of K													
166		6.85	6.66	6.47	6.66	1.80	1.80	1.78	1.80	42.98	42.37	42.49	42.61
250		7.19	7.34	7.23	7.25	1.75	1.75	1.75	1.75	42.87	42.93	42.79	42.86
333		7.78	7.97	7.93	7.89	1.70	1.70	1.70	1.70	42.92	43.08	42.87	42.96
G. Mean		7.27	7.32	7.21	7.27	1.75	1.75	1.74	1.75	42.92	42.79	42.71	42.81
LSD 0.05	A 1.28	B 1.28		C 1.28		A 0.058	B 0.058	C NS		A 2.23	B 2.23	C 2.23	
	AB 3.84	AC NS		BC 3.84		AB NS	AC NS	BC NS		AB 6.69	AC 6.69	BC 6.69	
	ABC NS					ABC NS				ABC 20.07			

Total acidity

Data in Table 4 revel the values of total acidity of mandarin as influenced by different levels of N, K and Mg as soil application values ranged between 1.53 and 1.88% The greatest value of total acidity was obtained due to the application of 666, 166 and 20 g /tree/year of N, K and Mg, respectively, while the lowest value was obtained due to the application of 333, 333 and 20 g/tree/year of N, K and Mg, respectively.

Nitrogen application caused significant increases in total acidity. Increasing N fertilization rate from 333 to 500 g N/tree/year increased the total acidity by an average of 11.80%. Increasing N application rate from 500 to 666 g N/ tree /year increased the total acidity by an average of 2.22% while increasing N fertilization rate from 333 to 666 g N /tree/year increased total acidity by an average 14.28%.

Concerning potassium fertilization, the data cleared that increasing K fertilization rate from 166 to 250 g K/tree/year caused decreases in total acidity averaged 2.85% while increasing K rate from 250 to 333g K/tree/year decreased total acidity by an average 2.94%.

Data in Table 4 indicate that application of magnesium did not effect significantly total acidity.

The interaction between N and K was of insignificant effect on total acidity. Likewise neither the interaction between K and Mg not that between N and Mg was of significant effect on total acidity.

V. C content (Ascorbic acid mg/100 mL juice)

Table 4 show that the mean values of ascorbic acid of mandarin as influenced by the different levels of N, K and Mg as soil application ranged between 41.43 and 43.73 mg/ 100mL juice. The greatest value of ascorbic acid was obtained due to application of 500, 333 and 20g /tree/year of N, K and Mg, respectively; while the lowest value was obtained due to application of 666, 166 and 20g /tree/year of N, k and Mg, respectively.

Increasing N fertilization rate from 333 to 500 g N/tree/year increased the mean ascorbic acid by 0.51% while increasing N rate from 500 to 666 g N/tree/year decreased the mean ascorbic acid by 0.89%. Increasing N fertilization rate from 333 to 666 g N/tree/year decreased ascorbic acid by 0.37%.

Potassium fertilization was of significant effect on ascorbic acid content. Increasing K fertilization rate from 166 to 250 g K/tree/year caused increases in ascorbic acid averaged 0.58% while increasing it from 250 to 333g K/tree /year increased ascorbic acid by an averaged, of 0.23% whereas increasing K rate from 166 to 333g K/tree/year increased ascorbic acid by an average of 0.82% .

Data present in Table 4 indicated that application of magnesium by rates 0, 20 and 40g Mg/ tree/ year had no effect in ascorbic acid content.

Studying the interaction effect of N and K on ascorbic acid, the data indicate that application rates of potassium 166, 250 and 333g k/tree/year caused insignificant increase. Under the second rate (500 g N /tree/year) increasing K rate from 166 to 250 g K/tree/year decreased ascorbic acid by0.13% while incising K rates from 250 to 333g /tree/year increased ascorbic acid by 0.65%. The corresponding value of the third N rate (666 g N/tree/year). increasing K fertilization from 166 to 250 and 333g K/tree/ year increased ascorbic acid by 2.00% and 0.91% respectively.

Under the application of 333g N/tree/year with rates of Mg, the data show that application of 20 and 40 g Mg /tree/year decreased ascorbic acid by 0.28%. Under the application of 500 g N /tree/year, with increasing Mg from 20 to 40 g /tree/year cased decreases in ascorbic acid by 1.59%. While under the application of 666 g N/tree/year with increasing Mg from 20 to 40 g/tree /year increasing ascorbic acid by 1.34%.

These findings came in line with those of Nokrashy *et al.* (1977) on navel orange, Inoue and Isobe (1981) on Satsuma mandarin, Nath and Mohan (1995) on assam lemon, Monga *et al.* (2002) on sweet orange, Monga *et al.* (2004) on Kinnow mandarin, Vedamani *et al.* (2006) on acid lime and Quinones *et al.* (2009) on clementine cv. Nules mandarins. Most of their results revealed that ascorbic acid contain in fruit juice increased as rate of N application increased.

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تأثيــر التســميد النيتروجيــني والبـوتاســي والماغنســيومي علـى محصـول وجودة ثمار اليوسفى

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أقيمت تجربة حقلية بمنطقة الصالحية محافظة الشرقية – مصر لدراسة تأثير النيتروجين والبوتاسيوم والماغنسيوم على إنتاج وجودة ثمار اليوسفى النامية على ارض رملية و المروي سطحيا، تم إضافة الأسمدة على أربع دفعات (مارس – مايو – يوليو – سبتمبر) وذلك لتقليل الفقد بالغسيل، وكانت المعدلات ٣٣٣ ، ٥٠٠ ، ٦٦٦جم N /شجرة/ السنة باستخدام سماد سلفات الامنيوم و١٦٦، ٢٥٠ ، ٣٣٣جم K /شجرة/ السنة باستخدام سماد سلفات البوتاسيوم ، صفر، ٢٠ ، ٤٠جم Mg /شجرة/ السنة باستخدام سلفات المغنسيوم، تشير النتائج المتحصل عليها أن زيادة التسميد النيتروجينى والبوتاسى ادى إلى زيادة الإنتاج بشكل واضح وفروق معنوية كما نلاحظ أن التوازن بين التسميد النيتروجينى والبوتاسى يؤدى إلى زيادة الإنتاج وتحسين جودة الثمار كما نلاحظ أن زيادة التسميد النيروجينى مع نقص التسميد البوتاسى أثر سلبا على الخواص الطبيعية والكيمائية للثمار، لذلك فان نتائج هذه الدراسة تجعلنا نوصى بالاتي: وضع السماد البوتاسى قبل السماد النيتروجينى، عدم الإسراف فى الرى عقب التسميد مباشرة، زيادة معدل التسميد البوتاسى خلال مرحلة نضج الثمار وكان أعلى محصول وأفضل صفات جودة عند المعاملة ٥٠٠ + ٣٣٣ + ٥٠جم/ الشجرة/السنة من كل من Mg, K, N.

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