451
Arab Univ.
J. Agric. Sci.,
Ain Shams Univ.,
Cairo, 16(2), 451-457, 2008

EFFECT OF SOME ORGANIC AND BIOFERTILIZER TREATMENTS ON MINIMIZING MINERAL NITROGEN FERTILIZATION OF WASHINGTON NAVEL ORANGE TREES

[36]

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Keywords: Washington Navel orange, Organic fertilizer, Biofertilizer, Yield, Fruit quality, Nitrate and nitrite content

ABSTRACT

The present investigation was conducted during two successive seasons to study the effect of replacing mineral nitrogen fertilization by organic nitrogen source with or without biofertilizer addition on Washington Navel orange trees, under sandy soil conditions. Percentages of 100, 50, and 25% of mineral nitrogen were replaced by 50, 75 and 100% of organic nitrogen with or with out *Saccharomyces cerevisae* (yeast) as a source of biofertilizer. Treatment of 50% mineral N + 50% organic N and treatment of 100% organic N as well as the control (100% mineral nitrogen) recorded the higher values of N in the leaves especially in the second season. Treatments included organic fertilization raised N% in the second season. Phosphorus percentage in the leaves did not differ by treatments in both seasons. All treatments enhanced K content in the leaves especially in the second season. On the other hand, adding biofertilizer treatments improved N, P and K content in the leaves especially in the presence of mineral N. As for yield per tree, all treatments increased number of fruits and yield weight/tree than the control especially in the second season. The effect of treatments on fruit quality was clearly shown in the first season, since most of the treatments improved fruit quality parameters especially treatment of 50% mineral N + 50% organic N fertilizers. On the other side, treatments containing organic or bio-fertilizer reduced nitrogen, nitrate and nitrite values in fruit juice comparing with the control (100% mineral N fertilizer).

(Received May 15, 2008)
(Accepted May 26, 2008)

INTRODUCTION

Citrus is the first fruit crop in Egypt. Washington Navel orange cultivar has a great importance either for the local market or export needs. Economically, it ranks the top among orange cvs., since it occupies 124271 feddan (one feddan = 4200 m^2) with fruiting area reached 110050 feddan, producing 1050462 tons according to Ministry of Agriculture and Land Reclamation statistics, 2004. This means that the yield is still low and attained about 9.55 tons per feddan. Increasing productivity and improving fruit quality are the main targets of many specialists. There is a general agreement that several factors affect productivity and fruit quality of orange trees. One of the important factors plays a vital role, in this concern, is nitrogen fertilization which considered as agent of accumulative harmful residues like nitrate and nitrite in fruit juice, **Montasser *et al* (2003)**.

Thus, a great attention is focused on minimizing the intensive amounts of mineral nitrogen fertilization especially under sandy soils conditions which are naturally poor either in nutrient elements or organic matter through using alternative organic N fertilization as well as using biofertilizer which had illustrated greater nutrient use efficiencies of crops and in particular fruit crops when such inoculates were added to either organic matter or soil, **Sangakkora and Weerakera, 1999 (as quoted by Saleh *et al* 2006)**.

Accordingly, the present investigation was planned and conducted to evaluate the effect of combined application of mineral N and Farmyard manure (FYM) as organic N fertilizer with or without addition of *Saccharomyces cerevisae* (yeast) as a source of biofertilizer on leaf mineral content, yield and fruit quality as well as nitrate and nitrite

content in fruit juice of Washington Navel orange trees grown under sandy soil conditions.

MATERIALS AND METHODS

The present investigation was conducted during two successive seasons 2004 and 2005 in a private citrus orchard located at El-Sadat district, Menofiya Governorate, Egypt on 15 years old Washington Navel orange trees. The trees were budded on Volkamer lemon (*C. volkameriana*) rootstock and planted at 5X5 meters apart under drip irrigation system. The texture of the soil is sandy as the result of soil analysis **(Table 1).** Also, farmyard manure analysis according to **Wilde *et al* (1985)** are given in **Table (2).** The selected trees were nearly uniform in vigor as possible.

Table 1. Analytical properties of the soil at the experimental location

a- Mechanical analysis

Sand (%)	Silt (%)	Clay (%)	Texture
90	5	5	Sandy

b- Chemical analysis

pH (1:2.5)	EC dsm^{-1} (1:1)	$CaCO_3$ (%)	N ppm	Soluble cations (meq/l)				Soluble anions (meq/l)			
				K	Na	Ca	Mg	Cl	SO_4	HCO_3	CO_3
8.2	1.5	5.5	traces	0.57	9.18	2.65	2.40	5.3	5.65	3.85	---

Table 2. Some physical and chemical characteristics of the used Farmyard manure

Parameter	Values
Cubic meter weight (kg)	650
Moisture %	35
Organic matter	23.6
Organic carbon	21.4
pH (1:10)	8.7
EC (mmohs/cm)	5.7
C/N ratio	24.0
Total N %	0.89
Total P %	0.32
Total K %	0.92
Total Ca %	1.82
Total Mg %	0.96
Total Fe ppm	1500
Total Mn ppm	420
Total Zn ppm	53

The experiment included seven treatments as follows:

1- 100% MNF (control).
2- 50% MNF + 50% ONF
3- 50% MNF + 50% ONF + BF
4- 25% MNF + 75% ONF
5- 25% MNF + 75% ONF + BF
6- 100% ONF
7- 100% ONF+ BF

Where

MNF = Mineral N fertilization.
ONF = Organic N fertilization.
BF = Biofertilization with Yeast *(Saccharomyces cerevisae)*.

The control trees received the common amount of nitrogen fertilizer (1000 gm N/tree/year) as ammonium sulphate (20.5% N). Organic N fertilizer was added as Farmyard manure (FYM) (0.89% N) at rate of 56 kg/tree. Yeast *(Saccharomyces cerevisae)* (BF) isolated and identified by **Gomaa (1995)** were grown to the late exponential phase in a sterilized medium prepared in Microbiology De-

partment, National Research Centre. The resultant cultures contained 6.2 X 105cell/ml for biofertilizer (BF) which added at rate of two liters per tree. Organic and biofertilizer were side dressed in a band of 100 cm wide on both sides of the tree at one meter apart from the tree trunk in the direction of tree row and mixed with the surface of 20 cm of soil in late January of each season while mineral N fertilization was added at three equal doses on March, May and August. Each treatment was replicated three times on one tree plots and the randomized complete block design was arranged.

The chosen trees received the normal fertilization program including the addition of 100 Kg per feddan calcium super phosphate (15.5% P_2O_5) in late January and 600 gm potassium sulphate (48-52% K_2O) /tree/year in March and August. The other horticultural practices were the same for all trees under investigation.

To determine leaf mineral content, about forty leaves were taken in late August in each season from tagged non-fruiting and non-flushing spring growth cycle according to **Jones and Embleton (1960)**. Leaf samples were washed with tap water, then with distilled water and dried at 105^{o}C till a constant weight, finally ground and digested. The digested solution was used to determine N, P and K content as percentage on dry weight basis according to **Cottenie *et al* (1982)**.

At the harvesting time (late December of each season), yield per tree was determined as number and weight of fruits (kg)/tree.

For fruit quality determinations, samples of ten fruits were taken from each replicate to determine the physical and chemical properties as the methods described in **A.O.A.C. (1985)**.

A sample of 10 ml of fruit juice was taken from each replicate to determine nitrogen, phosphorus, potassium, nitrate and nitrite content in fruit juice. N, P and K% were determined using the same methods described in leaf mineral content, while NO_3^- and NO_2^- content were determined according to the methods outlined by **Sen and Donaldson (1978)**.

The data were subjected to analysis of variance and Duncan's multiple range test was used to differentiate means, **Duncan (1955)**.

RESULTS AND DISCUSSION

Leaf mineral content

Data in **Table (3)** show that leaf mineral content was significantly affected by different treatments in both seasons.

As for nitrogen content in the leaves in the first season, it is clear that 100% mineral nitrogen fertilization treatment gave the highest value of N% compared with the other treatments. In other word, reducing mineral nitrogen amount decreased nitrogen content in the leaves. While in the second season, organic fertilization treatments raised N% in the leaves compared with the first season. However, treatments 3, 6 increased N value and did not differ statistically than the control (100% mineral N) which gave the higher N content.

Regarding P content in the leaves, no significant differences were detected between treatments in both seasons.

Concerning K% in the leaves, the control and treatment 5 gave the higher values of K% compared with other treatments in the first season, while in the second one, all treatments enhanced K content in the leaves and no differences were detected between them except treatments 4 and 5 which gave the lower values.

On the other hand, it is observed that adding biofertilizer treatments raised N, P and K content in the leaves especially with the treatments included mineral N.

The obtained results are in harmony with the findings by **Abd El-Migeed *et al* (2007)** on orange, **Saleh *et al* (2006)** on grapevine and **Fayed (2005)** on apple since the chemical fertilizer gave the highest leaf N and K contents compared with organic fertilization with or without biofertilizers.

Yield

As for yield, **Table (4)** showed that in both studied seasons, all treatments increased number of fruits/tree than the control. However, in the first season, treatment 3 gave the highest number of fruits followed by treatment 2 and 5. In the second season, treatment 4 gave the highest value, while 100% mineral N fertilization (control) gave the lowest one.

Regarding yield weight (kg) in the first season, treatment 3 gave the highest yield compared with other treatments including the control. While in the second season, the obtained results seemed to took the same trend of No. of fruits/tree. Average yield of the two seasons indicated that, treatment 3 gave the highest yield followed in a decreasing order by treatment 4, 5 and 2 without significant differences between them.

Concerning average fruit weight, in the first season all treatments gave the same statistical results and no differences were detected between

Table 3. Leaf mineral content of Washington Navel orange trees as affected by mineral and organic nitrogen fertilization with some biofertilizers during 2004 and 2005 seasons

No.	Treatments	N%		P%		K%	
		2004	2005	2004	2005	2004	2005
1	100% MNF (control).	1.47a	1.50a	0.140	0.137	0.97a	0.96a
2	50% MNF + 50%ONF	1.30b	1.33bc	0.120	0.120	0.44cd	0.94a
3	50% MNF + 50% ONF + BF	1.33b	1.50a	0.130	0.153	0.66bc	0.70abc
4	25% MNF + 75% ONF	1.23c	1.30bc	0.126	0.107	0.71b	0.43c
5	25% MNF + 75% ONF + BF	1.30b	1.20c	0.120	0.150	0.90ab	0.53bc
6	100% ONF	1.20c	1.40ab	0.140	0.110	0.45cd	0.90a
7	100% ONF+ BF	1.20c	1.30bc	0.130	0.167	0.36d	0.78ab

Means having the same letters within a column are not significantly different at 5% level.

Table 4. Number of fruits/tree, yield weight/tree and average fruit weight of Washington Navel orange trees as affected by mineral and organic nitrogen fertilization with some biofertilizers during 2004 and 2005 seasons

No.	Treatments	No. fruits/tree		Yield (kg/tree)		Average yield of the two seasons	Average fruit weight (gm)	
		2004	2005	2004	2005		2004	2005
1	100% MNF (control).	147.0cd	140.0c	46.5bc	38.8c	42.6c	273.0a	278.0
2	50% MNF + 50%ONF	295.0ab	226.0ab	61.3b	58.8ab	60.0ab	206.0b	260.0
3	50% MNF + 50% ONF + BF	327.0a	210.0ab	88.2a	53.3abc	70.7a	263.0ab	260.0
4	25% MNF + 75% ONF	220.0bcd	235.0a	63.5b	65.7a	64.4a	320.0a	283.0
5	25% MNF + 75% ONF + BF	228.0abc	216.0ab	64.5b	58.0ab	61.2ab	273.0a	256.0
6	100% ONF	143.0d	193.0abc	38.8c	50.1abc	44.4c	270.0a	268.0
7	100% ONF+ BF	175.0cd	171.0bc	51.4bc	45.1bc	48.2bc	300.0a	268.0

Means having the same letters within a column are not significantly different at 5% level

them except treatment 2 which gave the lowest fruit weight, while in the second season, no significant differences were observed between treatments. On the other hand, the increment in yield weight was due to the increasing in number of fruits/tree. The obtained results are in line with **Fayed (2005)** and **Hassan and Abou Raya (2003)** on apple.

From the above results, it is observed that the increment of yield weight may be due to the improvement of fruit set, consequently increased final fruit numbers per tree. The positive effect of most organic treatments on yield as number of fruits/tree or weight (kg/tree) could be attributed to the beneficial effect of the tested materials (organic manure) on improving fruit set.

Fruit quality

Table (5) shows the effect of the studied treatments on fruit quality. In this concern, peel thickness was increased by all treatments than the control in the first season. On the contrary, all treatments reduced such parameter than the control in the second season.

Juice weight was increased by all treatments except treatment 2 which gave the lowest value. This was true in the first season, while in the second one, no significant differences were observed between the treatments.

Total soluble solids (TSS) in the fruit juice reached the maximum value with treatment 2 followed in a decreasing order by treatment 7 and 3,

Table 5. Some physical and chemical properties of Washington Navel orange trees as affected by mineral and organic nitrogen fertilization with some biofertilizers during 2004 and 2005 seasons

No.	Treatments	Peel thickness (cm)		Juice weight (gm)		TSS (%)		Titratable acidity (%)		Ascorbic acid mg/100ml	
		2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
1	100% MNF (control).	0.40b	0.60a	100.0ab	111.0	12.3cd	12.1	0.77ab	0.68	45.6ab	44.6
2	50% MNF + 50%ONF	0.57a	0.50ab	77.0b	107.0	13.7a	12.6	0.75ab	0.73	44.0ab	47.0
3	50% MNF + 50% ONF + BF	0.50ab	0.40b	112.0a	101.0	13.0abc	12.4	0.89a	0.68	52.3a	44.0
4	25% MNF + 75% ONF	0.50ab	0.47ab	102.0ab	96.0	11.9d	13.4	0.69b	0.71	46.0ab	44.0
5	25% MNF + 75% ONF + BF	0.50ab	0.47ab	97.0ab	113.0	12.5bcd	13.3	0.69b	0.81	50.6ab	43.6
6	100% ONF	0.47ab	0.57ab	109.0a	109.0	12.8bc	12.8	0.63b	0.77	40.6b	48.6
7	100% ONF+ BF	0.57a	0.43ab	105.0ab	111.0	13.2ab	12.3	0.70b	0.68	48.0ab	49.3

Means having the same letters within a column are not significantly different at 5% level.

Table 6. Nitrogen, nitrite and nitrate contents (ppm) in fruit juice of Washington Navel orange trees as affected by mineral and organic nitrogen fertilization with some biofertilizers during 2004 and 2005 seasons

No.	Treatments	N (ppm)		NO_2 (ppm)		NO_3 (ppm)	
		2004	2005	2004	2005	2004	2005
1	100% MNF (control).	1624a	1297a	2.56a	2.50a	47.2a	46.5a
2	50% MNF + 50%ONF	1094b	573e	2.10b	1.86bc	20.7c	33.4b
3	50% MNF + 50% ONF + BF	803bc	587be	1.85b	2.10b	27.5b	29.3bc
4	25% MNF + 75% ONF	870b	751cd	2.03b	1.56c	28.4b	26.3c
5	25% MNF + 75% ONF + BF	719bc	904bc	1.80b	1.73bc	29.3b	25.1c
6	100% ONF	898b	920bc	1.83b	1.86bc	31.7b	29.9bc
7	100% ONF+ BF	441c	931b	1.90b	1.83bc	27.5b	27.9c

Means having the same letters within a column are not significantly different at 5% level.

while, it reached the lowest value with treatment 4. This was true in the first season only, while in the second one, no significant differences were detected between the studied treatments.

Titratable acidity percentage in the first season, recorded the highest value with treatment 3 followed in a decreasing order by treatment 1 and 2. In the second season, no significant differences between all treatments were observed.

As for ascorbic acid (vitamin C) content in the fruit juice, treatment 3 gave the highest value and no differences were detected between it and the other treatments, except treatment 6 which gave the lowest value in the first season. In the second season, no significant differences were observed between all the studied treatments.

The obtained results are in line with the findings by **Moustafa (2002)** on Washington Navel orange, **Akl *et al* (1997)** on grapevine and **Salama (2002)** on Balady mandarin.

Nitrogen, nitrate and nitrite content in the fruit juice are shown in Table 6, since all treatments containing organic or bio-fertilizer reduced nitrogen, nitrate and nitrite values in fruit juice comparing with the control (100% mineral N fertilizer).

As shown in **Table (6)**, results revealed that nitrate and nitrite contents in fruit juice were significantly decreased by different treatments in the two

studied seasons comparing with 100% mineral N (control). This means that replacing nitrogen fertilization through using organic form (FYM) instead of mineral N form had a beneficial effect on reducing nitrate and nitrite contents in fruit juice. In this respect, mineral nitrogen fertilization easily forms nitrate, whereas organic fertilizers slowly form nitrate, **Ibraheem (1994)**.

The beneficial effect of organic and biofertilizer on reducing nitrate and nitrite contents in fruit juice is supported by those obtained on grapevine by **Farag (2006) and Rizk-Alla (2006)**.

From the abovementioned results, it could be concluded that using 50% mineral N + 50% organic N + biofertilizer is the promising treatment to improve both fruit yield and quality of Washington Navel orange trees.

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