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

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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).

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 m²) 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**

| Parameter  | Values |
|------------|--------|
| Sand (%)   | 90     |
| Silt (%)   | 5      |
| Clay (%)   | 5      |
| Texture    | Sandy  |

**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-
Effect of biofertilizers on Navel orange trees

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 words, 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

Leaf mineral content

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

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

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   | 13.3   | 12.5bcd | 0.69b   | 0.81    | 50.6ab  | 43.6    |
| 6   | 100% ONF                                  | 0.47ab  | 0.57ab  | 109.0a  | 109.0   | 12.8bc | 12.8    | 0.63ab  | 0.77    | 40.6ab  | 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) | NO₂ (ppm) | NO₃ (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-Alia (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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