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USING OF SOME BIO AND ORGANIC FERTILIZERS TO REDUCE THE RATE OF MINERAL N FERTILIZATION AND IMPROVING ORANGE TREE PRODUCTION

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ABSTRACT: In a field experiment during the two successive seasons of 2004 and 2005, mature fruiting Washington navel orange trees were subjected to flood irrigation system and received ten different combinations of mineral nitrogen (MN), organic nitrogen (ON) and biofertilizers (Bio). Control trees received 1kg MN without bio or organic fertilizers. Other combinations were: 1.0, 0.75, 0.50 kg mineral N with or without organic or biofertilizers [Biogein or Effective Microorganisms (EM)].

The obtained results revealed that the combination of 1 kg MN with organic or biofertilizers increased total yield, fruit set, fruit retention, number of fruit/tree, fruit weight, pulp fresh weight and leaf N (%). Moreover, these combinations decreased flower drop (%), primary fruitlet drop (%) and June drop, preharvest drop and peel fresh weight. As a conclusion, the best results with regard to the yield and fruit quality were obtained by fertilizing the trees with 1 kg mineral N/tree with biofertilizers (Biogein or EM) or organic fertilizer. On the other side, treatment of 0.75 kg mineral N/tree with Biogein (minimizing rate mineral N fertilization was nearly as efficient as the control and no significant differences between them on fruit set percentages, fruit retention, number of fruits / tree, fruit weight, total yield/tree and leaf N percentage.

Key words: Citrus, navel orange, mineral nitrogen, organic fertilizers, biofertilizers, fruit set, June drop, yield and fruit quality.

INTRODUCTION

Navel oranges is one of the most important group for fresh fruit and have the prominent distinctive feature of a small , secondary fruit embedded in the apex of the main fruit (Spiegel-Roy and Goldschmidt, 1996).

Organic matter affects citrus growth and production, either growth and production, either directly by supplying nutrients and facilitating the availability of most elements or indirectly by modifying soil physical properties that can improve the rooting environment and stimulate plant growth (Mengel and Kirkby, 1987; Darwish *et al.*, 1995). According to Nijjar (1985) organic nitrogen fertilizers have the following advantages: (1) supplying the trees with some essential macro and micro-nutrients; (2) improving fertility of sandy soil; (3) reducing the various wastes; (4) controlling and partially checking the application of chemical fertilizers; (5) depressing the pollution occurring in our environment; (6) facilitating the availability and uptake of most nutrients to the trees; (7) encouraging the chance for exporting fruits to the markets of American, European and Arab countries.

Biofertilization based on altering the rhizosphere flora by seed or soil inoculation with certain organisms capable of inducing beneficial effects on compatible host (El-Haddad *et al.*, 1993). Bio-fertilizers are biological preparations containing life or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic microorganisms which accelerate certain microbial processes to augment the extent of the availability of nutrients in a form can be easily assimilated by plants (Subba - Rao, 1993). Nitrogen fixing bacteria such as *Azotobacter*, *Azospirillum* and Bacillus are considered of the most important beneficial microorganisms. *Rhizobacterien*, Biogein and Nitrobein could be used as sources for fixing nitrogen in the soil. Several processes other than nitrogen fixation could account for these positive effects, including production of growth regulators, protection from root pathogens and modification of nutrient uptake by the plant (Techan, 1988). The use of bacteria in combination with organic fertilizers results in encouraging yield, particularly in new reclaimed soils through overcoming drought, salt and some pathogens stresses as well as decreasing the applied fertilizers and increase the availability of

most macro- and micro-elements. The studies in this field showed that inoculation with N bio-fertilizers could save half the normal field rate of N chemical fertilizers and at the same time promote plant production (Ishac, 1989).

Studies in this respect, revealed that 1300 g N/tree was optimum for Navel Orange in South Africa (De Villiers, 1969), 900 g N/tree was the optimum for navel orange trees in Australia (Mungomery *et al.*, 1978), 1000 g N/tree was the optimum for Navel orange trees in Spain (Legaz *et al.*, 1981). Increasing the N rate /tree over the optimum dose encourages excessive vegetative growth (Alva *et al.*, 2003; Schumann *et al.*, 2003)

The main target of this study is to evaluate the response of using some types of organic and biofertilizers which leads to reduce the recommended doses of chemical fertilizers, and to study their effects on growth, yield and fruit quality of navel orange trees.

MATERIALS AND METHODS

The present investigation has bean carried out in the two successive seasons of 2004 and 2005 on 35- years- old Washington navel orange (*Citrus sinensis* L. Osbeck) budded on sour orange rootstock grown at 5 x 5 m apart in a private citrus orchard at Belbeis district, Sharkia Governorate.

The orchard soil was silty loam at a depth of 30 cm, then sandy loam up to the depth of 90 cm (Table 1). The trees were under flood irrigation system (18 irrigation times/season).

Forty-eight trees, nearly uniform in size and vigour were sellected for the present work to receive different twelve fertilization treatments. Each treatment was adopted on four trees replicated four times.

All experimental trees received uniform irrigation, pest and weed control practices. Each experimental tree received 1.2kg calcium super-phosphate (15.5% P_2O_5) (200kg /fed.) broadcasted on soil surface under tree canopy and mixed with soil by hoeing in the first week of December. In addition, each tree received 1.2 kg potassium sulphate (48.5 % K_2O) in the second week of Feb., added under tree canopy as described above.

Table 1. The main physical and chemical characteristics of orchard soil

Parameters	Values at depth (cm)		
Physical properties:	30	60	90
Sand %	46.8	56.2	41.8
Silt %	33.2	28.2	48.2
Clay %	20.0	15.6	10.0
Texture	Silty loam	Sandy loam	Sandy loam
Chemical constituents:			
pH	7.72	7.96	8.08
EC	0.208	0.136	0.140
$CaCO_3$ (%)	2.47	2.47	2.47
Ca^{++} (Meq/100 g soil)	0.125	0.050	0.350
Mg^{++} (Meq/100 g soil)	0.045	0.050	0.350
Na^{+} (Meq/100 g soil)	0.930	0.570	0.570
K^{+} (Meq/100 g soil)	0.980	0.690	0.760
CO_3^{-} (Meq/100 g soil)	--	--	--
HCO_3^{-} (Meq/100 g soil)	0.475	0.125	0.100
SO_4^{--} (Meq/100 g soil)	1.450	1.210	1.250
Cl^{-} (Meq/100 g soil)	0.150	0.030	0.050
N (ppm)	25	15	15
P (ppm)	1.250	1.250	1.250
K (ppm)	428	378	361
Fe (ppm)	0.195	0.400	0.400
Mn (ppm)	0.680	0.640	0.610
Zn (ppm)	0.285	0.240	0.245
Cu (ppm)	0.058	0.056	0.045

Soil analysis were performed according to Piper (1950).

The Tested Fertilization Treatments

The experiment comprised ten different treatments regarding the doses of mineral N fertilization, organic manures (cattle manure, 1.1% N) and two types of biofertilizers; i.e., Biogein and EM (Effective microorganisms). The treatments were as follows:

1. Control (mineral N fertilization alone at 1 kg N/ tree/year (4.85 kg ammonium sulphate/fed.).
2. Mineral N fertilization at 1 kg N/tree/year + organic fertilizer (22.75 kg).
3. Mineral N fertilization at 1 kg N/ tree/year+ 100 g biogein biofertilizer/ tree/ year.
4. Mineral N fertilization at 1 kg N/ tree/year+ 0.25 l EM biofertilizer/ tree/ year.
5. Mineral N fertilization at 0.75 kg N/ tree/year+ 100 g biogein biofertilizer/ tree/ year.
6. Mineral N fertilization at 0.75 kg N/ tree/year+ 0.25 l EM biofertilizer/ tree/ year.
7. Mineral N fertilization at 0.50 kg N/ tree/year+ 100 g biogein biofertilizer/ tree/ year.
8. Mineral N fertilization at 0.50 kg N/tree/year + 0.25 l EM biofertilizer/tree/ year.
9. Mineral N fertilization at 0.50 kg N/ tree/year+ 0.25 kg N/ tree in the form of organic fertilizer (22.75kg cattle manure/ tree/year) + 100g biogein biofertilizer/tree/ year.
10. Mineral N fertilization at 0.50 kg N/ tree/year+ 0.25 kg N/ tree in the form of organic fertilizer (22.75kg cattle manure/ tree/year) + 0.25l EM biofertilizer/ tree/ year.

The same experimental trees and stock of cattle manure were used in the two seasons to minimize the possible differences in comparison. Cattle manure was added at the same time (first week of Dec.) with phosphorus fertilization, using the same method. Ammonium sulphate (20.6 %) was used as a source of mineral N fertilization. The amount of mineral N fertilizers assigned for each treatment was divided into four equal doses added in Feb. April, June and August. Each dose was broadcasted on the soil under tree canopy before irrigation. The Biogein contains Azotobacter as a nitrogen fixing bacteria were applied at 100 g/tree/year in the third week of Feb. in shallow trenches (30 cm length x 20 cm width x 10 cm depth) according to recommendation of the productive

unit of this biofertilizer. The second form of biofertilization was EM. EM (Effective microorganisms) is a liquid biofertilizer contains many species of beneficial microbes. EM includes photosynthetic bacteria, lactic acid bacteria, yeast, Ray Fungi and Actinomyces. The source of biofertilizers was the General Organization for Agricultural Equalization Found (GOAEF), Ministry of Agriculture, Egypt. Each tree received 6 ml / week in the same way as shown above for Biogein. Irrigation was conducted after the addition of organic manure, chemical and biofertilizers in both seasons.

The trees response to the applied fertilization treatments was evaluated through looking for floral, fruiting parameters and leaf mineral contents as follows:

Floral and Remaining Fruits

To determine fruit set, fruit drop and fruit retention percentages along growth season, flowers of each four branches at the different tree directions were counted at full bloom stage (by the end of March in each season). After fruit set, the set fruitlets on the same branches were counted by the end of April in each season. The fruit set percentage, and consequently the percentage of the dropped flowers were calculated according to the following equations

Fruit set percentage =

Number of set fruitlets/Total number of flowers x 100

Flower drop percentage =

(Total flowers - Number of set fruitlets) / Total number of flowers x 100

The remaining fruitlets on the previous labelled branches were counted again one month after the previous count. Fruitlet drop percentage (primary fruit drop) was then calculated.

Percentage of remaining fruits =

Number of remaining fruits/ Total number of flowers x 100

The remaining fruits were counted again at the end of June and December of each season to estimate June and preharvest fruit drop percentages as well as fruit retention percentage, respectively.

Total Yield and Its Components

At the harvest date of Washington navel orange fruits (end of December in both seasons) the remained fruits on each tree were picked and weighed. The total yield per tree (kg/tree) and the number of fruits/ tree were

recorded. The cropping efficiency was also calculated by dividing the fruit yield (kg/tree) by the tree canopy volume (Whitney *et al.*, 1995).

Fruit Quality

At time of harvesting (end of Dec. in both seasons) 10 fruits were randomly collected from each replicate to determine the following fruit characteristics: Average fruit weight (g), average pulp and peel weights (g) and pulp/ fruit ratio, was calculated.

Ascorbic acid (Vitamin C) content was determined by titration against 2 % oxalic acid solution as substrate in presence of 2, 6-dichlorophenol-indophenol dye as indicator. Ascorbic acid was calculated as (mg / 100 ml juice) (Lucoss, 1944). Total soluble solids percentage (TSS %) was determined in fruit juice using a hand refractometer. Titratable acidity in fruit juice was determined as citric acid by titration against 0.1 N sodium hydroxide solution in presence of phenolphethaline dye (A.O.A.C., 1990). TSS/ acid ratio was also calculated.

Leaf Mineral Nutrients Contents

Nitrogen (N%) was determined as described by Naguib (1969), phosphorus (P %) determined according to Brown and Lilleland (1964), Potassium (K) was described followed the method of (Barrows and Simpson (1962).

Statistical Analysis

The obtained data were statistically analysed according to the complete randomized block design with 4 replicates and one tree for each replicate (Snedecor and Cochran, 1980). The individual comparisons between mean values were carried out using new LSD at 5 % level.

RESULTS

Floral Aspects

Fruit set percentage

As shown in Table 2, the fruit set, generally, ranged from 12.32 to 28.84 in the first season and from 8.09 to 32.40 in the second season. The highest fruit set percentages (28.84 and 32.40 %) in the first and second seasons, respectively, were recorded from treatment 1 kg mineral N (MN) + 100g Biogein/tree without organic fertilizer in the two seasons. Results show that fertilization treatments had significant effect on fruit set in both seasons. The lowermost fruit set (12.37 and 12.32 in the first season and 10.04 and 8.09 in the second season)

resulted from 0.5 kg mineral N (MN) +100 g Biogein or 0.25l EM/ tree without organic fertilizer in the both seasons. Generally, the highest values came from complete mineral fertilizer either with organic or biofertilizers (Biogein and EM). However, the combination between 0.75 kg mineral N fertilizer with biofertilizer and without organic fertilizer recorded values nearly as efficient as the complete mineral rate without organic or biofertilizer and with insignificant differences between them. In addition, the treatment (0.5kg mineral N+ 22.75 kg organic N + Biogein) recorded values (15.11%) nearly as the complete mineral rate without significant differences in the first season only. The other treatments had significant decrease on fruit set as compared with the complete rate mineral N in the two seasons.

Fruit retention percentage

From Table 2, it is clear that differences between the tested treatments in fruit retention were significant in the two seasons. The results show that, applying 1kg mineral N without organic fertilizer + Biogein or EM recorded maximum values of fruit retention (2.80 and 2.17) in the first season and (2.51 and 2.09 %) in the second season, respectively the differences were significant between using Biogein and EM with 1kg mineral N and without organic N. The least values of fruit retention (1.13 and 1.15 %) in the first season and (1.14 and 1.16 %) in the second season came from the treatments (0.5 kg) mineral N without organic N + Biogein or EM fertilizers, respectively and without significant differences between them. The other treatments recorded values of fruit retention between them.

Cropping efficiency

Data in Table 2 clearly show that the tested fertilization treatments significantly affected cropping efficiency of Washington Navel orange trees in the two seasons.

Treatments of 1 kg mineral N + organic or EM only and 0.75 kg mineral N + Biogein only increased cropping efficiency as compared with the treatment of 1 kg mineral N+ Biogein only in the two seasons. Application of 0.75 kg MN +EM only and 0.50 kg mineral N with organic N only or with biofertilizer only decreased cropping efficiency as compared with other treatments. The highest values (2.26 and 2.73) in the first and second seasons, respectively, came from the treatment of 1kg

Table 2. Effect of some fertilization treatments on fruit set, fruit retention and cropping efficiency of Washington navel orange trees (2004 and 2005 seasons)

	Treatments			First season			Second season		
	Mineral N (MN)kg/tree	Cattle manure (kg/tree)	Biofertilizers (Bio)	Fruit set (%)	Fruit retention (%)	Cropping efficiency	Fruit set (%)	Fruit retention (%)	Cropping efficiency
1.	1.00	0.0	0.0	16.41	1.64	1.61	19.41	1.66	2.73
2.	1.00	22.75	0.0	21.41	1.99	2.26	24.83	1.97	2.02
3.	1.00	0.0	Biogein (100g)	28.84	2.80	1.25	32.40	2.51	1.66
4.	1.00	0.0	EM* (0.25 L)	26.65	2.17	1.81	29.23	2.09	2.06
5.	0.75	0.0	Biogein (100g)	16.32	1.57	1.32	19.41	1.52	2.12
6.	0.75	0.0	EM (0.25 L)	15.71	1.43	0.79	15.57	1.42	1.23
7.	0.50	0.0	Biogein (100g)	12.37	1.13	0.61	10.04	1.14	1.37
8.	0.50	0.0	EM (0.25 L)	12.32	1.15	0.70	8.09	1.16	1.27
9.	0.50	22.75	Biogein (100g)	15.11	1.28	1.12	14.69	1.29	1..37
10.	0.50	22.75	EM (0.25 L)	13.96	1.29	0.77	10.80	1.42	1.07
New LSD at 0.05 level				2.57	0.15	0.05	2.49	0.16	0.06

*EM: effective microorganisms

mineral N + organic N in the first season and from treatment of 1 kg mineral N only in the second season as compared with other treatments. The least value (0.61) in the first season was from treatment 0.50 kg MN+ Biogein without organic N and from 0.50 kg MN+EM with organic N in the second season.

Flower drop percentage

Concerning flower drop (%), it is obvious from data in Table 3 that the tested treatments had significant effect on flower drop percentage in both seasons. The uppermost values of flower drop (86.13%, 87.88 % and 87.68 % in the first season and 89.93%, 90.67 % and 91.60 %) in the second one came from the treatments 1 kg mineral N with organic N and biofertilizer and 0.5 kg mineral N without organic N+ biofertilizer, respectively Also, treatments of mineral N (0.75 kg) without organic N + biofertilizer and mineral N (0.50 kg) with organic N (22.75 kg) + biofertilizer, recorded values nearly from previous values. The lowest values of flower drop (%) (78.60, 77.31 and 72.51 % in the first season and 72.76, 76.54 and 70.69 % in the second one were gained by applying 1 kg mineral N either with 22.75 organic N without biofertilizer, or with Biogein and EM without organic fertilizer in the both seasons.

Primary fruitlet drop percentage

It is quite evident from Table 3 that the tested treatments significantly affected primary fruitlet drop (%) of Washington navel orange trees during the two seasons. The values varied between (78.59 and 89.19 % in the first season and 59.70 and 77.01) in the second season. The treatment that recorded significantly lower primary fruitlet drop percentage (78.59 and 59.70 %) in the first and second seasons, respectively, it was 1kg mineral N/ tree + EM 0.25 L/tree). The treatments of 1 kg MN/tree with organic N (22.75 kg/tree) or with Biogein (100 g/tree) decreased the primary fruitlet drop percentage and without significant differences between them, and also, with significant differences between them and 1 kg mineral N/tree without organic N or biofertilizer.

June fruit drop percentage

From Table 3, it is obvious that treatments 0.5 kg MN+0.0 organic N + Biogein or EM induced the uppermost increments in June fruit

Table 3. Effect of some fertilization treatmenst on flower drop, primary fruitlet drop, June fruit drop and preharvest fruit drop of Washington navel orange trees (2004 and 2005 seasons)

Treatments			First season				Second season			
Mineral N (MN) kg/tree	Cattle manure (kg/tree)	Biofertilizers (Bio)	Flower drop (%)	Primary fruitlet drop (%)	June fruit drop (%)	Preharvest fruit drop (%)	Flower drop (%)	Primary fruitlet drop (%)	June fruit drop (%)	Preharvest fruit drop (%)
1. 1.00	0.0	0.0	86.13	86.73	22.32	13.93	89.93	72.76	24.76	14.03
2. 1.00	22.75	0.0	78.60	80.28	8.22	11.43	72.76	61.00	10.73	12.53
3. 1.00	0.0	Biogein (100g)	77.31	80.62	8.52	9.61	76.54	62.33	11.95	9.87
4. 1.00	0.0	EM* (0.25 L)	72.51	78.59	6.87	10.48	70.69	59.70	8.73	10.28
5. 0.75	0.0	Biogein (100g)	86.04	85.80	18.18	15.40	90.38	75.61	25.78	16.20
6. 0.75	0.0	EM (0.25 L)	84.30	83.66	6.67	18.99	84.54	71.91	20.42	14.79
7. 0.50	0.0	Biogein (100g)	87.88	88.51	23.12	27.79	90.67	76.10	27.73	28.59
8. 0.50	0.0	EM (0.25 L)	87.68	89.19	28.51	29.99	91.60	77.01	28.82	30.79
9. 0.50	22.75	Biogein (100g)	84.90	89.07	14.32	20.83	85.25	69.20	21.91	22.63
10. 0.50	22.75	EM (0.25 L)	82.89	82.39	11.92	22.38	80.81	69.20	16.86	23.18
New LSD at 0.05 level			3.71	1.73	2.82	1.54	3.47	5.18	3.09	1.87

*EM: effective microorganisms

Preharvest fruit drop percentage

As shown in Table 3, the preharvest fruit drop percentage generally, ranged from 9.61 to 27.79 in the first season and 9.87 to 30.79 in the second one. The results show that fertilization treatments had significant effect on preharvest fruit drop (%) in both seasons. The highest preharvest fruit drop (27.79 and 29.99 % in the first season and 28.59 and 30.79 %) in the second one came from the treatments of 0.5 kg MN without organic N with Biogein or EM biofertilizers.

Total Yield and its Components

Total yield/ tree

The effect of fertilization on yield are presented in Table 4. Generally, the values varied between 25.57 kg to 93.33 kg in the first season and 51.83 kg to 116.14 kg in the second one. The differences between the tested treatments were significant in the two seasons. Mineral fertilization at rate 1 kg with organic N or biofertilizers increased total yield/tree in the two seasons. The highest values (93.33 and 87.89 kg in the first season and 116.14 and 110.35 kg in the second one) came from the treatment 1 kg mineral N with Biogein or EM without organic N, respectively. On the other hand, fertilization with the mineral N 0.5 kg + biofertilizer Biogein or EM, only tended to be the lowermost values (25.57 and 27.08) in the first season and (51.83 and 46.72) in the second one, compared with 1 kg mineral N without organic and biofertilizer.

Number of fruit per tree

Data presented in Table 4 show the effect of fertilization treatments on number of fruits/tree of Washington navel orange. The differences between the studied treatments were significant in both seasons. Mineral N fertilization at 1kg with Biogein or EM without organic N recorded the uppermost values (312 and 294) fruit/tree in the first season and (405 and 400) fruit/tree in the second one as compared with 1 kg mineral N without organic or biofertilizer in the both seasons. Generally, treatment of 1 kg mineral N with organic N or biofertilizer increased number of fruits/ tree in the two seasons as compared with 1kg mineral N without organic N or biofertilizer. The other treatments tended to a significant decrease in the number of fruits/ tree in both seasons. The least values (111and 118 in the first season and 227 and

Table 4. Effect of some fertilization treatments on yield (kg/tree) and yield components of Washington navel orange trees (2004 and 2005 seasons)

Treatments				First season			Second season		
	Mineral N (MN)kg/tree	Cattle manure (kg/tree)	Biofertilizers	Total yield (kg/tree)	No. of fruit /tree	Fruit weight (g)	Total yield (kg/tree)	No. of fruit / tree	Fruit weight (g)
1.	1.00	0.0	0.0	60.25	215.08	280.21	96.39	371.31	258.17
2.	1.00	22.75	0.0	78.44	271.11	289.44	100.17	388.07	259.81
3.	1.00	0.0	Biogein (100g)	93.33	312.21	299.13	116.14	405.10	286.77
4.	1.00	0.0	EM* (0.25 L)	87.89	294.16	298.96	110.35	400.14	275.88
5.	0.75	0.0	Biogein (100g)	59.05	211.27	279.86	94.04	371.21	253.48
6.	0.75	0.0	EM (0.25 L)	58.00	207.00	280.21	86.63	351.12	246.80
7.	0.50	0.0	Biogein (100g)	25.57	111.30	230.32	51.83	227.19	228.31
8.	0.50	0.0	EM (0.25 L)	27.08	118.17	229.55	46.72	212.24	220.37
9.	0.50	22.75	Biogein (100g)	47.49	177.05	268.32	63.71	259.27	245.99
10.	0.50	22.75	EM (0.25 L)	42.64	169.17	252.31	59.53	244.15	243.99
New LSD at 0.05 level				3.74	10.53	27.24	5.17	13.61	32.16

212 fruit/tree in the second one) came from the treatments 0.50 kg mineral N with Biogein or EM without organic N as compared with 1kg mineral N without organic and biofertilizer in both seasons.

Fruit weight

It is clear from Table 4 that the tested fertilization treatments significantly affected fruit weight in the two seasons. The treatments of 1kg mineral N with organic only and Biogein or EM only recorded highest values (289.44 and 299.13 and 298.96 g) in the first season and (259.81, 286.77 and 275.88 g) in the second one and with insignificant differences as compared with 1kg mineral N without organic N or biofertilizer. The other treatments decreased fruit weight in both seasons. The lowermost values (229.53 and 220.37 g) in the first and second seasons, respectively, came from the treatment 0.50 kg mineral N + EM without organic N as compared with 1kg mineral N without organic N and biofertilizer in the both seasons. The differences between using Biogein and EM with any rate of mineral N were insignificant in the two seasons.

Fruit Physical Properties

Pulp fresh weight

Table 5 clarifies that the tested treatments significantly affected pulp fresh weight in the two seasons. The highest values (219.36 and 216.02 g) in the first season came from treatment 1 kg mineral N with organic N without biofertilizer and treatment of 0.50 kg mineral N with organic N and EM, while in the second one the highest values (209.30 and 206.08g) came from treatment of 1 kg mineral N+ EM without organic N and treatment of 0.50 with organic N and Biogein. The least values were 152.26 and 185.6 g in the first and second season from treatment 0.50 kg mineral N + EM without organic N and 0.75 kg mineral N + Biogein without organic N. Significant differences can be shown between the treatments 1 kg MN+ organic N without biofertilizers and 1 kg MN+ EM without organic N in both seasons. The treatments of 0.75 and 0.50 kg mineral N+ biofertilizers (Biogein and EM) without organic N decreased pulp fresh weight in the second season and the treatment of 0.50 kg mineral N+EM without organic N in the first season only.

Table 5. Effect of some fertilization treatments on physical characters of Washington navel orange fruits (2004 and 2005 seasons)

Treatments			First season			Second season		
Mineral N (MN) kg/tree	Cattle manure (kg/tree)	Biofertilizers (Bio)	Pulp fresh weight (g)	Peel fresh weight (g)	Peel/ pulp ratio	Pulp fresh weight (g)	Peel fresh weight (g)	Peel/ pulp ratio
1. 1.00	0.0	0.0	187.32	95.57	0.510	197.80	60.37	0.305
2. 1.00	22.75	0.0	219.36	90.08	0.320	203.21	56.60	0.279
3. 1.00	0.0	Biogein (100g)	213.08	86.05	0.404	198.20	88.36	0.446
4. 1.00	0.0	EM* (0.25 L)	206.53	92.43	0.448	209.30	66.58	0.318
5. 0.75	0.0	Biogein (100g)	206.99	72.87	0.352	185.60	67.88	0.366
6. 0.75	0.0	EM (0.25 L)	188.23	91.98	0.489	197.00	49.80	0.253
7. 0.50	0.0	Biogein (100g)	190.93	39.21	0.205	186.67	41.64	0.223
8. 0.50	0.0	EM (0.25 L)	152.26	77.27	0.508	188.34	32.03	0.170
9. 0.50	22.75	Biogein (100g)	202.98	65.34	0.322	206.08	39.91	0.193
10. 0.50	22.75	EM (0.25 L)	216.02	37.29	0.173	197.94	44.38	0.224
New LSD at 0.05 level			14.70	4.86	0.030	4.32	3.94	0.020

Peel fresh weight

The peel fresh weight in the fruit Table 5 decreased with all treatments in the first season and in the second one except the treatments of 1 kg mineral N with biofertilizer without organic N and the level of 0.75 kg mineral N with Biogein without organic N. The differences between the tested treatments were significant in both seasons. Treatments recorded its uppermost values (92.89 and 92.43 and 91.98 g) in the first season were 1 kg MN without organic N and biofertilizer and 1 and 0.75 kg mineral N without organic N as compared with least values (39.39 and 36.29 g) in the treatments 0.50 kg MN+ Biogein without organic N and 0.50 MN with EM and organic N. While in the second season the highest values (88.36, 66.58 and 67.88 g) recorded from 1 kg MN with biofertilizers (Biogein and EM) without organic N and the treatment 0.75 kg MN+ Biogein without organic N as compared with the least values (32.03 and 39.91 g) from the treatments 0.50kg MN +EM or Biogein without or with organic N.

Peel: pulp ratio

It is clear from Table 5 that the tested fertilization treatments affected peel/pulp ratio in the two seasons. Anyhow, the values of studied fertilization treatments was of negative trend on peel/ pulp ratio in both seasons, except treatments 1 and 0.75 kg mineral N with Biogein without organic N and 1 kg mineral N+EM without organic N in the second season, these three treatments increased peel/ pulp ratio as compared with the treatment of 1 kg MN without organic N and biofertilizers in the second season only. The least values were in the treatment of 0.5 kg mineral N+EM with or without organic N as compared with the treatment of 1kg mineral N without organic N and biofertilizers in the both seasons. The uppermost peel/pulp ratio was from application of 1 kg MN only (0.515) in the first season and from 1 kg MN+ Biogein only (0.446) in the second one.

Chemical Fruit Constituents of the Fruit Juice

Vitamin C content

From Table 6, the values of vitamin C varied between 61.96 and 74.97 in the first season and from 65.0 to 73.23 mg/100 ml in the second one. The treatments of 1kg mineral N with organic N or EM only recorded highest values

of vitamin C (74.10 and 74.97 and 73.23 and 73.23 mg /100 ml) in the first and second seasons, respectively, as compared with the treatment of 1 kg mineral N without organic N or biofertilizer in the both seasons. In addition, these two treatments gave equal values of vitamin C (73.23 mg/100 ml) in the second season only. The other treatments decreased vitamin C content in fruit juice in the two seasons. The least values (61.96 and 65.00 mg/100 ml) in the first and second season, respectively, were from 0.75 kg mineral N+ Biogein without organic N in the first season and from 0.50 kg mineral N+EM without organic N in the second season. Generally, the differences between using Biogein and EM with 0.75 and 0.50 kg mineral N with or without organic N were insignificantly in the two seasons.

Total soluble solids content (TSS %)

Total soluble solids content in juice of Washington navel orange fruits were significantly affected by the tested fertilization treatments in the two seasons.

Table 6. The treatments of 1 and 0.75 kg mineral N with biofertilizers and without organic N recorded significant increment of TSS content in the first season, but were insignificant in the second one. In addition, the treatment of 0.50 kg mineral N with organic N and EM tended to significant increment in TSS of juice fruit (12.8 and 13.2 % in the first and second seasons, respectively). The mineral N at 1kg without organic N and biofertilizer recorded TSS % equal from 0.75 kg mineral N with EM without organic N in the first season and equal from 0.50 kg MN with Biogein in the second season. The treatment of 0.50 kg mineral n + EM without organic N decreased TSS % in the first season, while 0.75 kg MN+EM without organic N and 1 kg MN+ organic N without biofertilizer in the second season decreased TSS content.

Total acidity percentage

It is clear from Table 6 that the tested fertilization treatments gave significant differences in total acidity (%) in fruit juice in the two seasons. Generally, total acidity percentage ranged from 0.150 to 0.198 % in the first season and from 0.124 to 0.194 % in the second one. The treatment of 0.75 kg mineral N+ Biogein without organic N and the treatment of 0.50 kg mineral N with organic N and EM increased total acidity with significant differences as

Table 6. Effect of some fertilization treatments on fruit chemical constituents of Washington navel orange trees (2004 and 2005 seasons)

Treatment			First season				Second season			
Mineral N (MN) kg/tree	Cattle manure (kg/tree)	Biofertilizers (Bio)	Vit C (mg/100 ml juice)	TSS (%)	Total acidity (%)	TSS/acid ratio	Vit C (mg/100 ml juice)	TSS (%)	Total acidity (%)	TSS/ acid ratio
1. 1.00	**0.0**	**0.0**	69.33	11.5	0.181	63.89	71.93	12.2	0.163	74.85
2. 1.00	**22.75**	**0.0**	71.10	11.8	0.150	78.67	73.23	12.0	0.154	77.92
3. 1.00	**0.0**	**Biogein (100g)**	64.13	12.4	0.176	70.45	65.87	12.8	0.194	65.98
4. 1.00	**0.0**	**EM* (0.25 l)**	74.97	12.2	0.186	65.83	73.23	12.7	0.153	83.01
5. 0.75	**0.0**	**Biogein (100g)**	61.96	12.3	0.195	63.08	65.43	12.3	0.190	64.93
6. 0.75	**0.0**	**EM (0.25 l)**	65.00	11.5	0.192	64.89	69.77	11.7	0.130	90.00
7. 0.50	**0.0**	**Biogein (100g)**	61.53	11.9	0.184	64.69	65.43	12.2	0.150	81.33
8. 0.50	**0.0**	**EM (0.25 l)**	64.13	11.3	0198	55.69	65.00	13.2	0.134	56.44
9. 0.50	**22.75**	**Biogein (100g)**	64.13	11.6	0.167	69.46	69.33	12.8	0.124	57.42
10. 0.50	**22.75**	**EM (0.25 l)**	65.67	12.8	0.192	66.46	70.20	13.2	0.176	75.05
NEW LSD AT 0.05 LEVEL			NS	0.70	0.01	3.05	5.92	0.91	0.01	3.36

compared with 1kg mineral N without organic and biofertilizer in the two seasons. The highest total acidity (0.198 %) came from 0.50 kg mineral N+EM without organic N in the first season and (0.194 %) from 1 kg mineral N+ Biogein without organic N in the second season. However, least values (0.150 %) recorded from 1 kg MN+ organic N without biofertilizer in the first season and (0.124%) from 0.50 MN with organic N and Biogein in the second one. The other treatment varied between the highest and lowest values in both seasons.

TSS/ acid ratio

It is quite evident from Table 6 that the tested treatments significantly affected TSS/ acid ratio of Washington navel orange fruits during the two seasons. Ratio of TSS/ acid varied between 55.69 to 78.67 in the first season and from 56.44 to 90.00 in the second one. Treatments of 1kg mineral N with organic N without biofertilizer, 1 and 0.75 kg mineral

N with EM without organic N, 0.50 kg mineral N+ Biogein without organic N and the treatment of 0.50 kg mineral N+ EM+ organic N increased TSS/ acid ratio as compared with 1kg mineral N without organic and biofertilizer in both seasons. On the other hand, the treatments of 0.75 kg mineral N + Biogein without organic and 0.50 kg mineral N +EM without organic N decreased TSS/ acid ratio as compared with 1 kg mineral N without organic and biofertilizer in both seasons.

Leaf Mineral Content

As shown in Table 7, the tested treatments had significant effect on leaf mineral content (NPK) in the two seasons of study.

Treatments of 1kg MN+ organic N or biofertilizers (Biogein and EM) increased N% (3.17, 3.37 and 3.20 %) in the first season and (3.07, 3.78 and 3.76 %) in the second season as compared with other treatments in both seasons.

The least values of N (2.36 and 2.56 %) in the first and second seasons, respectively, came from treatment of 0.5 kg mineral N +EM without organic N in the two seasons. Application of 0.75 and 0.50 kg MN with or without organic N decreased N and P % as compared with 1 kg MN without organic N and biofertilizers tended to increase P% as compared with other treatments in the two seasons. The lowermost of P%

Table 7. Effect of some fertilization treatments on leaf N,P and K percentages of Washington navel orange trees (2004 and 2005 seasons)

Treatments				First season			Second season		
	Mineral N (MN)kg/tree	Cattle manure (kg/tree)	Biofertilization (Bio)	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
1.	1.00	0.0	0.0	2.77	0.32	1.89	3.00	0.25	1.75
2.	1.00	22.75	0.0	3.17	0.32	1.72	3.07	0.26	1.73
3.	1.00	0.0	Biogein (100g)	3.37	0.36	1.83	3.78	0.29	1.45
4.	1.00	0.0	EM* (0.25 L)	3.20	0.34	1.82	3.76	0.29	1.51
5.	0.75	0.0	Biogein (100g)	2.67	0.30	1.42	2.98	0.22	1.49
6.	0.75	0.0	EM (0.25 L)	2.63	0.28	1.48	2.97	0.23	1.40
7.	0.50	0.0	Biogein (100g)	2.44	0.20	1.34	2.68	0.13	1.33
8.	0.50	0.0	EM (0.25 L)	2.36	0.21	1.30	2.56	0.12	1.34
9.	0.50	22.75	Biogein (100g)	2.61	0.26	1.33	2.78	0.18	1.39
10.	0.50	22.75	EM (0.25 L)	2.60	0.24	1.29	2.78	0.15	1.39
New LSD at 0.05 level				0.23	0.02	0.02	0.12	0.02	0.07

(0.20 and 0.12 %) recorded from 0.50 kg MN + Biogein or EM without organic N in the first and second seasons, respectively.

All tested treatments decreased K% as compared with 1 kg mineral N without organic N and biofertilizer. The least values of K% came from 0.50 kg MN+EM with organic N in the first season and from 0.50 kg MN+ Biogein without organic N in the second season.

DISCUSSION

Fruit Set Percentage

Data showed that the rate of 1 kg MN with organic or biofertilizers tended to increase of fruit set percentage in the two seasons of study. The rate of 0.75 kg MN with biofertilizers only gave fruit set (%) nearly from the rate of 1 kg MN only in the two seasons. These results agreed with those reported by Ebrahiem and Mohamed (2000) and Tayeh *et al.* (2003).

Therefore, application of organic and mineral nitrogen fertilizers together may increase the exchangeable water soluble of NPK, and the uptake of these elements (Cooke, 1972), consequently increasing cell division and cell enlargement as a result, might be reflected on the plant growth of Washington Navel orange. Biofertilizers may increase the contents of growth regulators such as IAA and Cytokines which stimulate plant growth (Li *et al.*, 1998).

Floral Aspects

From the obtained results it is clear that level of 0.5 kg mineral N with biofertilizers increased flower drop , while the 1kg and 0.75 mineral N with organic or biofertilizers decreased it as compared with mineral N only. In addition the level 0.5 kg with organic and biofertilizers decreased flower drop as compared with mineral N alone in both seasons.

June drop was decreased by using 1kg or 0.75 kg mineral N with organic N or biofertilizers, in addition to 0.5 kg mineral N with organic and biofertilizers gave the same effect in the two seasons compared with the mineral N alone. The reduction in June drop was in agreement with Tayeh *et al.* (2003) on Valencia orange trees.

Biofertilizers which contains efficient strain of nitrogen fixing and phosphate solublization bacteria could be used to decrease

chemical fertilizers. Moreover, these bacteria cells increases the availability of nutrients in a form which can be easily assimilated by plants (Subba Roa, 1993). The superiority of inoculation with the biofertilizers might be due much to the vital role of bacteria that present in the applied biofertilizers and capable of contributing some hormone substances, i.e., gibberellins, auxins and cytokinins (Tien *et. al.*, 1970; Bouton *et. al.*, 1985; Cacciari *et al.*, 1989). These phytohormones may stimulate the cell elongation and development and hence plant growth (Paleg, 1985).

Total Yield and Its Components

From the obtained results it is clear that total yield, number of fruit/tree, fruit weight and fruit size were increased in the treatments of 1 kg mineral N with organic N or biofertilizers only as compared with other treatments in the two seasons. These findings were in line with) El-Salhy *et al.* (2002), Tayeh *et al.* (2003), Dudi *et al.* (2004), El-Migeed *et al.* (2007), Mansour *et al.* (2007), Medhi *et al.* (2007) and Hassan and Abd El-Basit (2008) on orange.

The effect of chemical fertilizers and the used biofertilizers on fruit weight, and number of fruit could be attributed to its role in increasing amino acids content which considered as a constituent of proteins and other compounds that share in the development of new tissues (Tiwary *et al.*, 1999). Applying, biofertilizers increased microorganisms in soil which convert the ability of mobilizing the unavailabile forms of nutrients elements to available forms (Ishak, 1989). Numerous investigations explained the important role of biofertilizers in reducing soil pH and increasing N, P soil contents and lowering the pH availability for growing plants or by mineralization (Singh *et al.*, 1992). In addition, the effect of NPK and the biofertilizers increased cell division and enlargement and consequently increased vegetative growth which reflected on increasing the yield and yield components as finally result from the physiological processes, Abd El- Naby (2000),Geetha and Nair (2000).

Farmyard manure contains many species of living organisms which release phytohormones as GA_3, IAA and CYT which stimulates plant growth, absorption of nutrients and photosynthesis processes (Reyndres and Vlassake,1982).

Fruit Physical Properties

Data also clarify that the combination between mineral N and organic or biofertilizers and also combined with these fertilizers insignificantly increased pulp weight, was in agreement with Abou-Sayed Ahmed (1997) and Sheta (2002).

Application of organic and mineral nitrogen fertilizers together may increase the exchangeable water soluble of NPK, and the uptake of these elements (Cooke, 1972), consequently increasing cell division and cell enlargement as well as, this might be reflected on the plant growth. Applying, biofertilizers increased microorganisms in soil which convert the ability of mobilizing the unavailability forms of nutrients elements to available forms (Ishak, 1989). The microorganisms produce growth promoting substance which increase the plant growth. This increase in plant growth may increase photosynthetic rates leading to an increase of assimilation rates. So that, the fruit weight and number of fruits increased. Numerous investigators explained the important role of biofertilizers in reducing soil pH and increasing N and P soil contents and lowering the pH available for growing plants or by mineralization (Singh *et al.*, 1992).

Chemical Constituents of the Fruit Juice

Data showed that the TSS was significantly affected by the tested fertilizing treatments as compared with mineral fertilization only. TSS was increased with the most fertilizing treatments in the two seasons.

These results agreed with those reported by Wu Xiao *et al.* (2000) and GU-Zuliang *et al.* (2002).

Total acidity was decreased in most treatments of fertilization with mineral N and organic or biofertilizers in the two seasons as compared with the treatment of mineral N. These results are in line with El-Salhy *et al.* (2002).

The increment in TSS/ acid ratio was in line with Abou-Sayed Ahmed (1997).

Also, it is clear that vitamin C (ascorbic acid) values were increased in some fertilizing treatments (1 kg mineral N with organic and EM) in the two seasons. These results agreed with those reported by El-Migeed *et al.* (2007).

The effect of the used organic or bio and mineral fertilizers on increasing TSS, TSS/acid ratio and decreasing the percentage of

acidity in the pulp could be due to their beneficial effect on the total leaf area of the plant which reflected in more carbohydrates production through photosynthesis process. From the physiological view, the obtained results could be explained in the light of the role of the biofertilizers as constituents of the prymidins which are in turn constituents of chlorophyll (Joo *et al.*, 1999; Magda-Mostafa, 2002). In addition, the role of the biofertilizers in increasing the uptake of nutrients which advanced fruit ripening in terms of a decrease in pulp acidity and an increase in TSS.

Leaf Mineral Contents

The favorable effect of biofertilizer on chemical constituents of orange leaves may be due to the fact that non-symbiotic bacteria have the ability to supply the plants with N, certain micronutrients and phytohormones that could stimulate nutrients absorption and photosynthesis and thereby increase chemical contents in different plant tissues (Bashan and Holguin, 1997). In this connection , Kapulnik *et al.* (1981) reported the effect of inoculation with Azospirillum spp may be due to different mechanisms; N-fixation, production of plant growth substances and enhancement uptake of nitrate, phosphate and potassium. Biogein and nitrobein could be used as sources for fixing nitrogen in the soil. Several processes other than N_2 fixation could account for these positive effects, including production of growth regulators, improvement of nutrient uptake by the plant (Techan, 1988).

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استخدام التسميد الحيوي والعضوي لتقليل معدل التسميد المعدني وتحسين إنتاج أشجار البرتقال

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فى تجربة حقلية خلال موسمى عامي ٢٠٠٤ و ٢٠٠٥ تم إضافة ١٠ توليفات من الأسمدة النيتروجينية المعدنية والعضوية والحيوية لأشجار برتقال بسرة مثمرة نامية فى مركز بلبيس- محافظة الشرقية وتروى بنظام الرى بالغمر.

أضيف إلى معاملة الكنترول كيلو جرام واحد نيتروجين معدني بدون أسمدة عضوية أو حيوية. وكانت التوليفات (المعاملات) الأخري عبارة عن ١، ٠,٧٥، ٠,٥ كجم نيتروجين معدنى مع أو بدون أسمدة عضوية أو حيوية [بيوجين أو EM (كائنات حية دقيقة نشطة)].

أوضحت النتائج أن التوليفات المحتوية على ١ كجم نيتروجين معدني + السماد العضوى أو الحيوى (بيوجين أو EM) أدت إلي زيادة المحصول، ونسبة عقد الثمار، ونسبة الثمار المتبقية، وعدد الثمار/شجرة و وزن الثمرة واللب، ومحتوى الأوراق من النيتروجين، وبالإضافة الى ذلك أدت هذه التوليفات إلي نقص نسبة تساقط الأزهار والثميرات وتساقط يونيو وتساقط ما قبل الجمع، وتخلص الدراسة إلى أن أفضل النتائج المتعلقة بالمحصول ومكوناته قد تحققت من إضافة ١كجم نيتروجين معدني + المخصب الحيوي (بيوجين أو EM) أو التسميد العضوي، وعلى الجانب الآخر فإن إضافة ٠,٧٥ كجم نيتروجين معدني + المخصب الحيوي بيوجين (لتقليل معدل التسميد النيتروجينى) قد أعطت نتائج قريبة من الكنترول وبدون وجود فروق معنوية بينهما لصفات نسبة العقد والثمار المتبقية وعدد الثمار على الشجرة ووزن الثمرة والمحصول ومحتوى الأوراق من النيتروجين.