

IMPACT OF ORGANIC AND INORGANIC NITROGEN FERTILIZERS ON WASHINGTON NAVEL ORANGE TREES. I. VEGETATIVE GROWTH, YIELD AND SOIL PROPERTIES

H. A. Ennab⁽¹⁾, M. A. El Shemy⁽²⁾ and M. H. Abd El Aziz⁽²⁾
Citrus Research Department⁽¹⁾ and Handling Research Department⁽²⁾
Horticulture Research Institute, Agriculture Research Center, Giza, Egypt

Received: Jul. 22, 2019

Accepted: Aug. 25, 2019

ABSTRACT: *Poultry manure has a salutary effect on soil fertility, increase plant nutrients and improving the soil conditions for citrus growth, productivity and ensure economic yield with a good quality. Therefore, a field experiment was conducted during 2017 and 2018 seasons on 20 year old Washington navel orange trees grown in a private orchard in Kafr El Sheikh Governorate, Egypt. This study aims to evaluating the effect of poultry manure and ammonium sulphate alone or in combination on soil chemical properties, vegetative growth and yield of Washington navel orange trees. The treatments consist of T₁ (100% inorganic nitrogen), T₂ (66.6% inorganic nitrogen + 33.3% organic nitrogen), T₃ (50% inorganic nitrogen + 50% organic nitrogen), T₄ (33.3% inorganic nitrogen + 66.6% organic nitrogen) and T₅ (100% organic nitrogen). Results indicated that, combined application of organic and inorganic nitrogen fertilizer especially T₄ (203.8 kg/feddan ammonium sulphate + 3.64 ton/feddan poultry manure) and T₃ (305.8 kg/feddan ammonium sulphate + 2.73 ton/feddan poultry manure) resulted in significant increase in NH₄⁺ N, NO₃⁻ N, organic matter and Zn; and decreased pH, cadmium, lead and electrical conductivity of soil. Moreover, the treatments increased leaf content values of N, P, K, Ca, Fe, Mn and Zn in both seasons. Data also indicated that application of 305.8 kg/feddan ammonium sulphate + 2.73 ton/feddan poultry manure (T₃) and application of 203.8 kg/feddan ammonium sulphate + 3.64 ton/feddan poultry manure (T₄) gave the highest values of tree size and vegetative growth in terms of shoot number/branch, shoot length, leaves number per shoot and leaf area of Washington navel orange trees compared to mineral nitrogen fertilizers only. As for yield and fruit quality, treatment of T₃ (50% inorganic nitrogen + 50% organic nitrogen), T₄ (33.3% inorganic nitrogen + 66.6% organic nitrogen) produced the highest yield and improve fruit quality in terms of fruit weight, fruit size and fruit firmness. This treatment also increased SSC%, SSC/acid ratio and vitamin C and reduced acidity, nitrate and nitrite in fruit juice. In general, combined application of 305.8 kg/feddan ammonium sulphate + 2.73 ton/feddan poultry manure (T₃) was recommended for improving soil chemical properties and the best growth, yield, fruit quality and nutritional status of Washington navel orange trees.*

Key words: *Citrus sinensis, poultry manure, ammonium sulphate, fruit yield, leaf area.*

INTRODUCTION

Nitrogen is one of the most important mineral nutrients for Washington navel orange tree growth and development. Nitrogen is essential in the synthesis of enzymes, vitamins, chlorophyll molecules, and is involved in nucleic and amino acid synthesis and protein

production as well as interferes with the uptake of cations and anions (Fernandes and Rossiello 1995). So, nitrogen has an important role prerequisite for obtaining high yields and good quality produce from Washington navel orange. Chemical fertilizers are commonly used as source of nitrogen because they can ensure

quick availability for trees. However, continuous application of inorganic nitrogen fertilizers not only increases the cost to out of reach for small farmers but also causes soil deterioration and pollution of the environment. Pollution problem resulted from leaching inorganic nitrogenous compounds such NH_4^+ , NH_3 , NO_2^- , HNO_2 , NO_3^- in to ground and surface waters, which has toxicological implications for animals and humans (Camargo and Alonso, 2006 and Wong et al., 2015). The organic manure applications supports farmers through reducing the cost of production and reduce the adverse effects of synthetic fertilizers on human health and the environment (Ibe et al., 2011 and Bakshi et al., 2018). In this respect, poultry manure is a good alternative to reducing the use of chemical nitrogen fertilizers, which increase soil nitrogen storage, mineralization, improving soil, water, and air quality (Nahm, 2003 and Amanullah et al., 2007). Moreover, using poultry manure as a source of nitrogen have numerous benefits as a source of macro and micronutrients, increasing soil organic matter, improves soil structure and increases the water-holding capacity in sandy soils and improves drainage in clay soils. On other words, poultry manure has a great importance for sustainable production and improve the soil physical, chemical and biological properties (Canali et al., 2004; Sainju et al., 2010 and Kobierski et al., 2017). Previous studies emphasized the

beneficial of poultry manure alone or combined with mineral fertilizer in citrus orchards for avoiding pollution and promoting growth, yield and fruit quality (Ferguson 1994; Rapisarda et al., 2010; Ibe et al., 2011 and Cerda et al., 2012).

Therefore, the objective of this study was to evaluating the beneficial effects of poultry manure as a source of organic nitrogen and inorganic nitrogen alone or together on some soil properties, growth, and yield as well as fruit quality of Washington navel orange trees.

MATERIALS AND METHODS

This experiment was conducted during 2017 and 2018 seasons in a private orchard at Kafr El Sheikh Governorate, Egypt, on 20 years old Washington navel orange trees (*Citrus sinensis* L.) budded on sour orange (*Citrus aurantium* L.) rootstock, planted at spacing of 5 × 5 meter apart in clay soil under surface irrigation system. Soil samples at 0 – 30 and 30 – 60 cm depth before treatments and samples from poultry manure used in this study were taken for physical and chemical analysis according to Page et al., (1982), the data have been shown in Table (2). Forty five trees uniform in growth, vigour and productivity were selected, and arranged in a randomized complete block design, each treatment replicated three times with three trees per replicate. The experiment involved five treatments as shown in Table (1).

Table (1): Treatment details of nitrogen fertilization sources, calculated as basic of 126 units /feddan/year or 750 g N/tree/year

Treatment number	Treatment details	Ammonium sulphate 20.6 % N kg/feddan	Poultry manure 2.3 % N ton/feddan
T ₁	100% inorganic	611.6 (3.64 kg/tree)	-----
T ₂	66.6% inorganic + 33.3% organic	407.7 (2.42 kg/tree)	1.82 (10.8 kg/tree)
T ₃	50% inorganic + 50% organic	305.8 (1.82 kg/tree)	2.73 (16.2 kg/tree)
T ₄	33.3% inorganic + 66.6% organic	203.8 (1.21 kg/tree)	3.64 (21.6 kg/tree)
T ₅	100% organic	-----	5.46 (32.5 kg/tree)

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Table (2): Analysis of poultry manure, and some physical and chemical characters of the experimental soil

Soil analysis			Poultry manure analysis	
parameters	Soil depth cm		Parameters	Values
	0 – 30	30 – 60		
Sand %	6.84	6.84	Weight of m ³ kg	495.32
Silt %	33.87	30.74	Moisture %	18.45
Clay %	59.29	62.42	Organic matter %	35.42
Texture	Clayey	Clayey	Organic carbon %	26.33
pH 1:2.5	8.18	8.20	pH 1:10	6.73
EC dSm ⁻¹ 1:5	1.20	0.98	EC dSm ⁻¹ 1:5	0.89
Organic matter %	1.30	0.98	C/N ratio	11.44
K ⁺ meq/l	0.50	0.43	N %	2.30
Ca ⁺⁺ meq/l	4.70	4.53	P %	0.91
Mg ⁺⁺ meq/l	3.77	3.35	K %	1.36
Na ⁺ meq/l	12.87	11.48	Ca %	0.180
HCO ₃ ⁻ meq/l	4.40	4.31	Mg %	0.180
Cl ⁻ meq/l	6.69	6.23	Fe ppm	241.75
SO ₄ ⁻ meq/l	10.75	9.25	Mn ppm	127.17
CO ₃ ⁻	0.00	0.00	Zn ppm	152.76
Total N , %	0.155	0.112	--	--
Available P, mg/kg soil	15.25	7.90	--	--
Available K, mg/kg soil	1155	800	--	--

Ammonium sulphate {(20.6 %N), mineral N} was divided into three equal doses that added at the first week of March, June and August. Also, 200 kg calcium super phosphate {(15.5%P₂O₅), mineral P} was added once in December and 190 kg potassium sulphate {(48%K₂O), mineral K} was applied at two equal doses on March and late June. Potassium sulphate and Calcium super phosphate were applied to all treatments as a source of K and P in both seasons. The poultry manure was obtained from Poultry Department, Sakha Animal Production Research station, Kafr El Sheikh, Egypt; it was broadcasted and incorporated into the root zone of tree in winter service at late December in both seasons.

The following data was recorded:

1. Soil properties:

At the end of the experiment, soil samples were collected from each

treatment, dried and sieved through 2 mm for analysis of pH, organic matter%, EC, Cd, Pb and Zn. The pH of soil samples was measured in 1:2.5 soils: distilled water suspension with the help of pH meter and organic matter was measured by chromic acid digestion method (Wilde *et al.*, 1985). Electrical conductivity (EC), NH₄⁺ -N, NO₃⁻ -N Cadmium (Cd), lead (Pd), and Zinc (Zn) were analyzed according to (Page *et al.*, 1982).

2. Leaf nutrient contents:

Leaf samples were collected from each replicate, cleaned, washed and oven dried at 70°C to a constant weight, then ground and digested according to Evenhuis and DeWaard (1980) by using H₂SO₄ and H₂O₂ to determine the elements N, P, K, Ca and Mg. Total nitrogen % was determined by using the micro-kjeldahl method as described by

Pregl (1945), Phosphorus % was determined colorematically as described by Murphy and Riley (1962), Potassium % was estimated by using flame photometer as described by Brown and Lilleland (1974), Ca, Mg, Fe, Mn and Zn were assayed with Atomic Absorption spectrophotometer (Unican SP 1900) according to Chapman and Pratt (1961).

3. Tree size and vegetative growth:

Percent of increase in tree height and canopy volume were calculated according to the following equation:

$$\text{Percent of increase in variable} = [(X_1 - X_0)/X_0] \times 100$$

Where, X_1 : Final tree height or canopy volume at December; X_0 : Initial tree height or canopy volume at January. Whereas, canopy volume was calculated according to the following equation: Canopy volume = $0.528 \times H \times D^2$. Whereas, H = tree height, D = tree diameter, the formula given by Castle (1983). Shoot number/branch, shoot length (cm), leaves number/shoot and leaf area was measured in both seasons.

4. Final fruit set and preharvest fruit drop %:

Final fruit set % was calculated by using the following equation:

$$\text{Final fruit set \%} = \frac{\text{No. of fruits at end of June}}{\text{total number of flower}} \times 100$$

Preharvest fruit drop % was calculated as the equation:

$$\text{Preharvest drop \%} = \frac{\text{No. of mature fruits}}{\text{total number of setted fruits}} \times 100.$$

5. Fruit yield:

Yield was harvested at December 18th and 24th in 2017 and 2018, respectively. Yield of each replicate was determined as number and weight (kg) of fruits/tree.

6. Fruit quality:

Fruit quality was determining as follow: fruit weight (g), fruit size (cm³),

fruit firmness was measured by fruit pressure tester on the two opposite sides of the fruits, and the average of the fruit firmness was calculated as (kg/cm²) and fruit juice content % was calculated as follow {weight of extracted juice ÷ fruit weight}×100. Juice quality was determined as soluble solids content (SSC %), total acidity and vitamin C. Nitrate (NO₃) and nitrite (NO₂) content (ppm/100 ml juice) in fruit juice were determined according to (A.O.A.C., 1990).

Statistical analysis was done as analysis of variance according to Snedecor and Cochran (1990), and the differences among treatment means were compared with Duncan multiple range tests at 5% level according Duncan (1955).

RESULTS AND DISCUSSION

1. Soil properties:

Data presented in Figure (1) show the effect of organic nitrogen fertilizer rates combined with doses of mineral nitrogen on chemical properties of clay soil after harvest yield of Washington navel orange trees. The results in Figure (1A) showed that, all treatments had significant effect on organic matter status of soil; organic matter percentage in the soil was gradually increased by increasing quantity applied of poultry manure per feddan. Application of 100% organic nitrogen (T₅) gave the highest organic matter percentage followed by 33.3 inorganic nitrogen + 66.6 organic nitrogen (T₄), whereas treatment of T₁ (100% inorganic nitrogen) recorded the lowest value of organic matter percentage in soil. These observations were corroborated with the findings of Ferguson (1994) and Kobierski *et al.*, (2017) they concluded that, application of poultry manure for long term resulted in a significant increase in soil content of organic matter and organic carbon.

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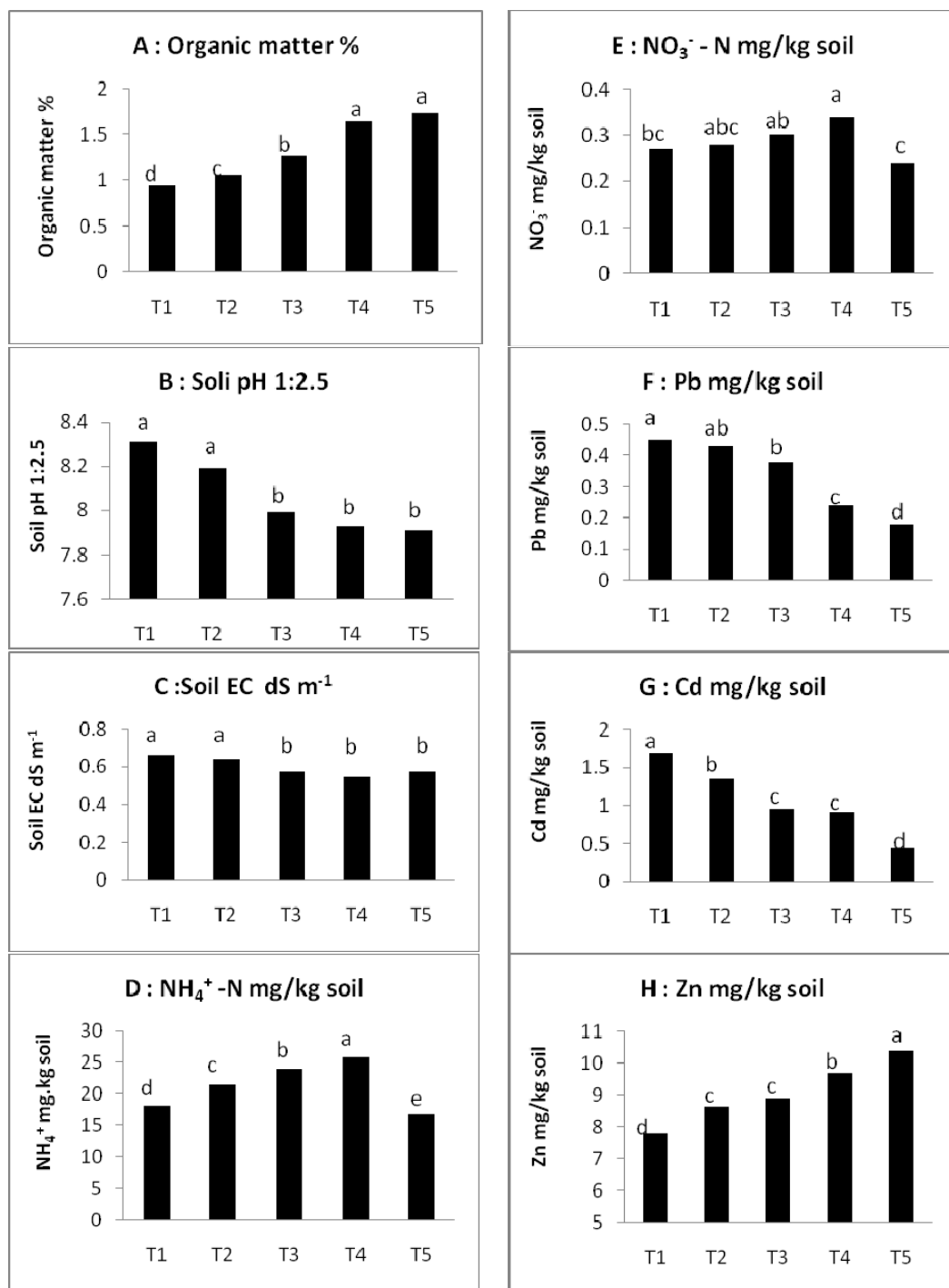


Figure (1). Effect of organic and inorganic nitrogen fertilizers on organic matter % (A), pH (B), EC (C), NH₄⁺-N (D), NO₃⁻-N (E), Pb (F), Cd (G) and Zn (H) at the end of experiment of Washington navel orange trees.

(T₁: 100% inorganic; T₂: 66.6% inorganic + 33.6% organic; T₃: 50% inorganic + 50% organic; T₄: 33.3% inorganic + 66.6% organic; T₅: 100% organic)

Combined application of organic nitrogen and mineral nitrogen in different percentages were slightly decreased soil pH and electrical conductivity (EC dSm⁻¹) compared with ammonium sulphate as a source of nitrogen only (Figures, 1B and 1C). The highest pH and electrical conductivity (EC dSm⁻¹) were recorded in T₁ (100% inorganic nitrogen) and T₂ (66.6% inorganic nitrogen + 33.3 organic nitrogen) with significant differences between them and other treatments. Treatments of T₃ (50% inorganic nitrogen + 50% organic nitrogen), T₄ (33.3 inorganic nitrogen + 66.6 organic nitrogen) and T₅ (100% organic nitrogen) gave approximately the same values of pH and electrical conductivity (EC dSm⁻¹) without significant differences among them. Similar results were obtained by Ferguson (1994) who revealed that, application of 10 and 20 ton per acre chicken manure led to decrease soil pH from 7.4 to 6.4 and 7.2 to 6.5, respectively.

As shown in Figures (1D) and (1E), soil content of NH₄⁺-N and NO₃⁻-N were significantly affected by all treatments at the end of experiment. The combined application of 33.3 inorganic nitrogen + 66.6 organic nitrogen (T₄) had the highest value of NH₄⁺-N and NO₃⁻-N followed by application of 50% inorganic nitrogen + 50% organic nitrogen (T₃) and application of 66.6% inorganic nitrogen + 33.3 organic nitrogen (T₂), respectively. On contrary that, the lowest value of NH₄⁺-N and NO₃⁻-N were observed on sole application of 100% organic nitrogen (T₅). Similar results were obtained by Delgado *et al.*, (2006) and Sainju *et al.*, (2010).

The results in Figures (1F) and (1G) indicated that, heavy metals such Pb and Cd were significantly decreased with increasing percentages of poultry manure applications. Treatments of T₅ (100% organic nitrogen), T₄ (33.3

inorganic nitrogen + 66.6 organic nitrogen) and T₃ (50% inorganic nitrogen + 50% organic nitrogen) led to reduce heavy metals content in the soil. The highest values of Pb and Cd were found in application of 100% inorganic nitrogen (T₁). On the other side, Zn was increased with increasing poultry manure level (Figure, 1H). These results are in harmony with those obtained by Ajayi *et al.*, (2012) using different fertilizers in citrus and vegetable farms fertilization and they found that trace elements concentration in the soil was belonged to type fertilizer used and organic fertilizers reduce heavy metals.

Generally, it is clear from Figure (1) that, soil organic matter percentage, pH, EC, NH₄⁺-N, NO₃⁻-N, Zn, Pb and Cd were positively affected by added poultry manure. Improving soil chemical properties have had a positive and significant impact on the nutritional status of trees, which are reflected on tree growth and production. This explain agree with those obtained by Ogundijo *et al.*, (2014) they indicate that yield of some crops was increased with improving soil chemical properties by application of 10 ton/ hectare poultry manure. Moreover, soil pH and EC had positive and significant correlation with organic matter content in soil suggesting that increased organic matter led to decrease pH and EC in soil. On the other hand, organic matter, NH₄⁺-N and NO₃⁻-N contents were gradually increased with increasing poultry manure percentages fertilization in the soil. As for heavy metals, a negative and significant correlation was observed between organic fertilizer doses and heavy metals (Cd and Pb). Heavy metals decreased with the increase of organic fertilizer doses. These results are in agreement with findings of Ibe *et al.*, (2011) and Cerda *et al.*, (2012).

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So, it can be concluded that, combined application of organic and inorganic nitrogen fertilizers improved the soil chemical properties especially T₄ (33.3 inorganic nitrogen + 66.6 organic nitrogen) and T₃ (50% inorganic nitrogen + 50% organic nitrogen) compared to other treatments. This is because poultry manure not only adds organic matter and macro and micronutrients to soil, but also improves the physical properties of soil. Moreover, availability of nitrogen (NH₄⁺-N and NO₃⁻-N) was increased with the increase of organic fertilizer, this is important for improvement tree growth and development as well as high yield. similar results were obtained by Sharma *et al.*, (2016) who found that, application of 50 % poultry manure + 50% urea improved soil organic carbon%, N, P, Ca and Mg after fruit harvest, increased leaf

mineral content as well as gave best growth and highest fruit yield of Guava.

2. Leaf mineral content:

It is evident from data in Tables (3 and 4) that, application of recommended nitrogen through poultry manure and ammonium sulphate enhanced leaf mineral content of Washington navel orange trees. It is also clear that, Washington navel orange trees fertilized with T₃ (50% inorganic nitrogen + 50% organic nitrogen), T₄ (33.3% inorganic nitrogen + 66.6 organic nitrogen) and T₁ (100% inorganic nitrogen) had higher N, P, K and Ca than other treatments. The results show significant differences among treatments in both seasons as for N, P, K and Ca, while the differences were not significant as for Mg in both seasons.

Table 3: Effect of organic and inorganic nitrogen fertilizers on leaf mineral content of Washington navel orange trees.

Treatments	N %		P %	
	2017	2018	2017	2018
T ₁ : 100% inorganic	2.45 a	2.53 a	0.222 a	0.225 b
T ₂ : 66.6% inorganic + 33.6% organic	2.16 c	2.23 c	0.212 b	0.218 c
T ₃ : 50% inorganic + 50% organic	2.35 b	2.53 a	0.223 a	0.233 a
T ₄ : 33.3% inorganic + 66.6% organic	2.32 b	2.44 b	0.224 a	0.219 c
T ₅ : 100% organic	2.11 c	2.17 d	0.215 b	0.218 c
Treatments	K %		Ca %	
	2017	2018	2017	2018
T ₁ : 100% inorganic	1.80 c	1.85 c	2.33 c	2.41 c
T ₂ : 66.6% inorganic + 33.6% organic	1.84 bc	1.95 b	2.35 c	2.43 c
T ₃ : 50% inorganic + 50% organic	1.91 abc	2.07 a	2.71 b	2.70 b
T ₄ : 33.3% inorganic + 66.6% organic	1.95 ab	2.10 a	2.79 b	2.75 ab
T ₅ : 100% organic	2.00 a	2.12 a	2.96 a	2.83 a

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

Table 4: Effect of organic and inorganic nitrogen fertilizers on leaf mineral content of Washington navel orange trees

Treatments	Mg %		Fe ppm	
	2017	2018	2017	2018
T ₁ : 100% inorganic	0.44 a	0.44 a	50.25 c	57.63 d
T ₂ : 66.6% inorganic + 33.6% organic	0.43 a	0.43 a	55.91 c	65.76 c
T ₃ : 50% inorganic + 50% organic	0.45 a	0.44 a	70.27 b	74.06 b
T ₄ : 33.3% inorganic + 66.6% organic	0.44 a	0.43 a	68.38 b	72.27 b
T ₅ : 100% organic	0.44 a	0.43 a	85.28 a	90.29 a
Treatments	Mn ppm		Zn ppm	
	2017	2018/19	2017	2018
T ₁ : 100% inorganic	28.00 b	29.25 c	25.64 d	24.83 c
T ₂ : 66.6% inorganic + 33.6% organic	27.83 b	28.21 c	28.18 c	29.88 b
T ₃ : 50% inorganic + 50% organic	37.53 a	38.62 a	31.37 b	32.46 ab
T ₄ : 33.3% inorganic + 66.6% organic	36.54 a	38.37 a	35.09 a	34.86 a
T ₅ : 100% organic	34.41 a	34.94 b	35.81 a	35.79 a

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

Moreover, treatments included poultry manure as organic fertilization especially T₅ (100% organic nitrogen), T₄ (33.3% inorganic nitrogen + 66.6 organic nitrogen) and T₃ (50% inorganic nitrogen + 50% organic nitrogen) raised leaf Fe, Mn and Zn content compared to other treatments and 100% mineral nitrogen only (T₁). This may be due to organic fertilizer decomposition released; organic acids which decrease soil pH and increased Fe, Mn, Zn availability. These results were similar to those obtained by Mansour and Shaaban (2007) and Ahmed *et al.*, (2017) who noted that leaf analysis of Washington navel orange and Kinnow trees showed a high level of N, P and K when treated with organic nitrogen combined with dose of mineral nitrogen. Sharma *et al.*, (2016) concluded that, soil application of 50%N poultry manure + 50%N urea on guava trees recorded the highest leaf N, P, K, Ca and Mg compared with mineral nitrogen only. With regard to micronutrients, results in Table (4) showed that, leaf Fe, Mn and Zn were

improved with the application of poultry manure fertilizer. These results were similar with those reported by Ennab (2016) who revealed that Eureka lemon trees fertilized with a combination between farmyard manure and doses of mineral NPK had significantly effective in enhancing leaf Fe, Mn and Zn contents compared to the application of mineral NPK only. So, nutrients content in leaves were significantly increased with organic manure fertilizers, especially application of poultry manure at 2.73 ton/feddan + 305.8 kg/feddan ammonium sulphate(T₃) and poultry manure at 3.64 ton/feddan poultry manure + 203.8 kg/feddan ammonium sulphate(T₄). In generally, it could be concluded from Figure (1) and Tables (3 and 4) that, application of poultry manure and dose of mineral nitrogen enhancing soil organic matter percentage, pH, EC, NH₄⁺-N and NO₃⁻-N, and improving nutrient uptake of Washington navel orange trees.

3. Tree size and vegetative growth:

Results presented in Figure (2) and Table (5) showed that, soil application of recommended nitrogen through poultry manure and dose of mineral nitrogen had a significant effect on tree size and vegetative growth parameters at the end of experiment. It is clear from Figure (2) that different treatments of organic and inorganic nitrogen fertilizers had a significantly influenced the tree height growth% and canopy volume growth% of Washington navel orange. The maximum tree height growth% and canopy volume growth % were recorded under the soil application of 50% inorganic nitrogen + 50% organic nitrogen (T₃) followed by treatment T₄ (33.3% inorganic nitrogen + 66.6% organic nitrogen), whereas the minimum tree height growth% and canopy volume growth % were recorded with T₁ (100% inorganic nitrogen) and T₅ (100% organic nitrogen). Similar results have been reported by Dahiya *et al.*, (2013) and Ahmed *et al.*, (2017). Also, Garhwal *et al.*, (2014) show that application of 80 kg farm yard manure + 750 g nitrogen per tree significantly resulted in maximum increase in tree height and canopy volume of Kinnow mandarin tree.

Also, data in Table (5) indicated that, shoot number per branch, shoot length, leaves number per shoot and leaf area were significantly affected by various treatments in the present study. The highest values of vegetative growth parameters were obtained with T₁ (100% inorganic nitrogen) and T₃ (50% inorganic nitrogen + 50% organic nitrogen) without significant differences between them in both seasons. On contrary, using 100% organic nitrogen (T₅) produced the lowest significant values of vegetative growth

parameters as compared to other treatments in both seasons. Whereas, the trees that received T₂ (66.6% mineral nitrogen + 33.3% organic nitrogen) and T₄ (33.3% mineral nitrogen + 66.6% organic nitrogen) gave intermediate values of most vegetative growth parameters without significant differences between them in both seasons. Similar results were obtained by Barakat *et al.*, (2012) and Lal and Dayal (2014) on citrus. In this respect, Khehra and Bal (2014) observed that, lemon trees fertilized with farmyard manure 150 Kg/tree + inorganic fertilizer 525g/tree + Azotobacter 18g/tree proved to be most effective in improving vegetative growth in terms of plant height, canopy volume, trunk girth as compared to control treatment.

Generally, it is obvious from Figure (2) and Table (5) that, tree size and growth vigour of Washington navel orange were significantly enhanced by applying organic and inorganic nitrogen fertilization especially application of 2.73 ton/feddan poultry manure + 305.8 kg/feddan ammonium sulphate (T₃) followed by application of 3.64 ton/feddan poultry manure + 203.8 kg/feddan ammonium sulphate (T₄). The obtained increase in vegetative growth as a result of T₃ and T₄ treatments maybe due to improved nutritional status and physical properties of the soil caused by the addition of poultry manure. This made the tree to uptake water and mineral nutrients better, resulting in its increased tree size and growth parameters. Moreover, poultry manure improves chemical properties of soil, which provides better conditions for tree growth and development. The findings are in line with the results obtained by Li *et al.*, (2017) and our data in Figure (1).

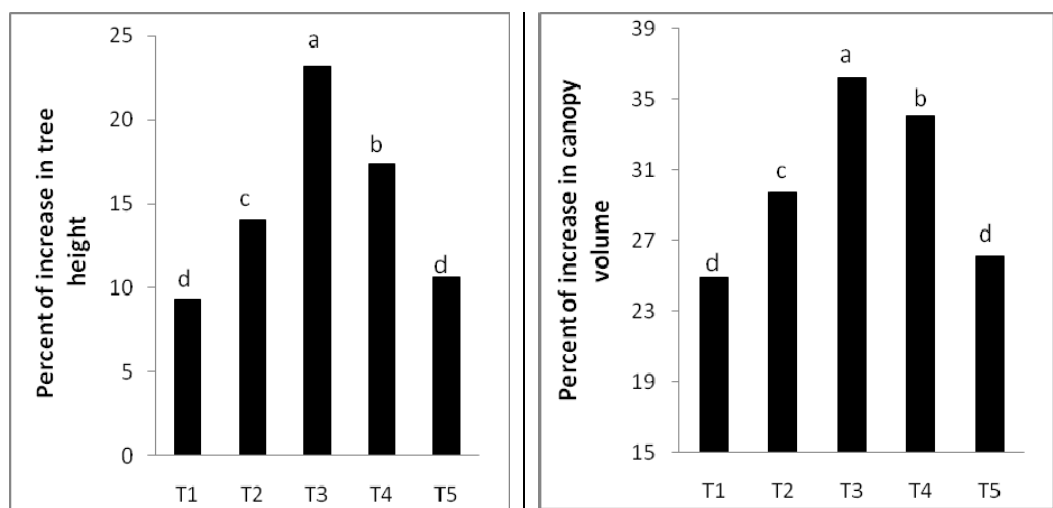


Figure 2. Effect of organic and inorganic nitrogen fertilizers on percent of increase in tree height and canopy volume at the end of experiment of Washington navel orange trees

(T₁: 100% inorganic; T₂: 66.6% inorganic + 33.6% organic; T₃: 50% inorganic + 50% organic; T₄: 33.3% inorganic + 66.6% organic; T₅: 100% organic)

Table 5: Effect of organic and inorganic nitrogen fertilizers on some growth parameters of Washington navel orange trees

Treatments	Shoot number per branch		Shoot length (cm)	
	2017	2018	2017	2018
T ₁ : 100% inorganic	27.28 a	28.51 a	38.39 a	39.64 a
T ₂ : 66.6% inorganic + 33.6% organic	25.67 b	26.44 b	31.65 c	35.48 b
T ₃ : 50% inorganic + 50% organic	26.44 ab	27.31 ab	37.04 a	38.77 a
T ₄ : 33.3% inorganic + 66.6% organic	25.33 b	26.31 b	34.06 b	36.43 b
T ₅ : 100% organic	23.77 c	24.43 c	29.41 d	30.66 c

Treatments	Leaves number per shoot		Leaf area (cm ²)	
	2017	2018	2017	2018
T ₁ : 100% inorganic	18.74 c	20.19 b	21.15 b	22.27 bc
T ₂ : 66.6% inorganic + 33.6% organic	18.88 c	23.52 a	22.85 a	23.23 b
T ₃ : 50% inorganic + 50% organic	27.13 a	24.19 a	23.42 a	25.86 a
T ₄ : 33.3% inorganic + 66.6% organic	23.66 b	23.85 a	23.32 a	25.45 a
T ₅ : 100% organic	15.94 d	15.20 c	20.61 b	20.91 c

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

4. Final fruit set and preharvest fruit drop percentages:

It appeared from Figure (3) that, final fruit set and preharvest fruit drop

percentages were significantly improved by the different fertilization treatments in both seasons. As for final fruit set percentage, its clear that, T₃ (50% mineral

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nitrogen + 50% organic nitrogen), T₄ (33.3% mineral nitrogen + 66.6% organic nitrogen) and T₅ (100% organic nitrogen) exhibited the highest final fruit set in both seasons, respectively. The differences were not significant among them in both seasons. On the other hand, T₁ (100% inorganic nitrogen) and T₂ (66.6% mineral nitrogen + 33.3% organic nitrogen) gave the lowest values of final fruit set percentage in both seasons. This may be due to organic fertilizer contain all the micronutrients essentially for trees in balanced state of and/or microorganisms included with organic fertilizer gave stimulating hormones cases improved fruit set and preharvest fruit drop. These results are in harmony with those obtained by Ahmed *et al.*, (2013) and Ennab, (2016) on Balady mandarin and Eureka lemon. In this respect, El Aidy *et al.*, (2018) revealed that application of half nutrient requirements as mineral NPK and the other half from organic source (compost) in combination with 150 or 200 ml biofertilizers had positive effect on fruit

set % of Valencia orange trees as compared with mineral fertilizers only. Also, the data illustrated in Figure (3) cleared that, the lowest percentages of preharvest fruit drop were found on trees fertilized by T₃, T₄ and T₅ in both seasons. On contrary, the highest fruit drop percentage was observed on treatment T₁ and T₂ respectively. Similar results were obtained by El Saady and El-Abd, (2012) and Ahmed *et al.*, (2013) they reported that organic, biofertilizers and NPK alone or combined together significantly decreased the percentages of June drop and preharvest drop in navel orange trees.

So, it can be concluded that, final fruit set and preharvest fruit drop of Washington navel orange trees were positively affected by organic nitrogen as poultry manure with doses of mineral nitrogen fertilizers in both seasons. In this respect, organic and inorganic nitrogen gave the best fruit set and also reduced fruit drop especially T₄ and T₃ compared to other treatments.

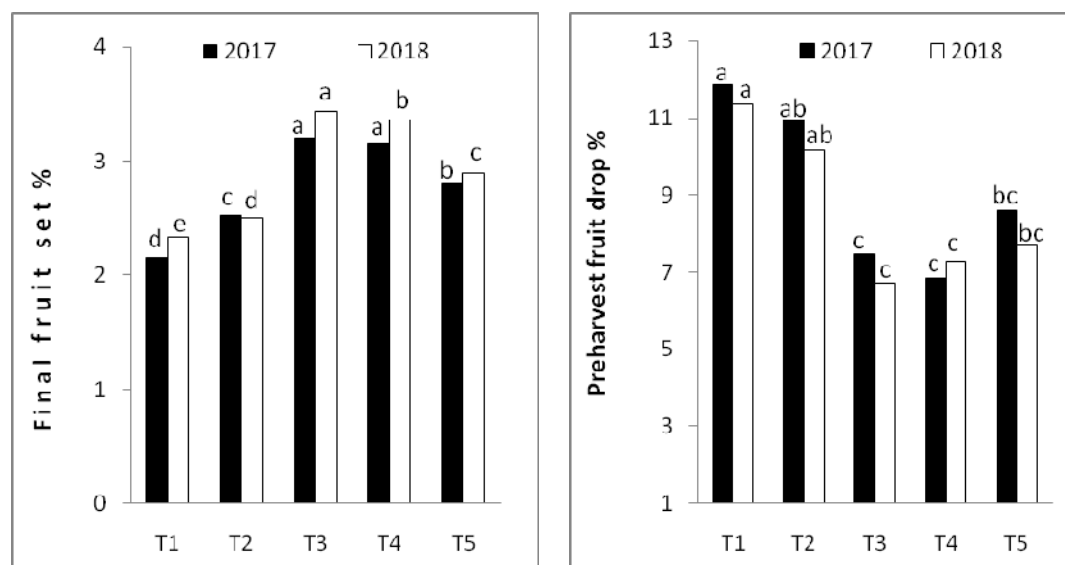


Figure (3). Effect of organic and inorganic nitrogen fertilizers on final fruit set and preharvest fruit drop percentages of Washington navel orange trees.

(T₁: 100% inorganic; T₂: 66.6% inorganic + 33.6% organic; T₃: 50% inorganic + 50% organic; T₄: 33.3% inorganic + 66.6% organic; T₅: 100% organic)

5. Yield:

Results in Table (6) showed that, application of poultry manure with nitrogen dose were significantly increased fruit yield of Washington navel orange trees expressed as number of fruits/tree and kg/tree in both seasons. Treatments of T₃ (50% inorganic nitrogen + 50% organic nitrogen) and T₄ (33.3% inorganic nitrogen + 66.6% organic nitrogen) tended to gave the highest values of yield as number of fruits/tree and kg/tree without significant differences between them in both seasons. On contrary, using 100% inorganic nitrogen (T₁) produced the lowest values of yield in both seasons. In this respect, T₅ (100% organic nitrogen) produced moderate yield in both seasons. These results are in agreement with those obtained by El Aidy *et al.*, (2018). In this respect, Garhwal *et al.*, (2014) on Kinnow mandarin, they reported that, number of fruits per tree and average weight of fruits significantly increased with application of farmyard manure and doses of mineral nitrogen as compared with mineral nitrogen only. Also, Ennab *et al.*, (2018) revealed that Costata persimmon tree fertilized with 50% mineral nitrogen plus 25% organic manure + 25 g/tree biofertilizers bearing higher yield (kg/tree) than that fertilized with 100% mineral nitrogen only. The beneficial effect of organic and inorganic nitrogen fertilizers on improving yield of Washington navel orange trees maybe due to positive effect on nutrients uptake (Tables 3 and 4) which reflected on active vegetative growth parameters in Figure (2) and Table (5). Also the positive response of yield as a result of poultry manure treatments maybe due to increase soil organic matter, increase soil microorganisms activities, thus it can fix atmospheric nitrogen, increase phosphorus availability in soil and enhanced elements uptake by

Washington navel orange tree, that reflected to tree's ability to grow and increase productivity. Also, yield was increase as a result of increasing fruit set and decreasing fruit drop percentages. This conclusion agrees with the result obtained by Ennab, (2016) and our data in Figure (3).

6. Fruit quality:

6.1. Physical characters:

Data in Table 7 show the effect of organic and inorganic nitrogen fertilizers on physical fruit quality in terms of fruit weight, size, juice % and fruit firmness of Washington navel orange trees in both seasons. Trees fertilized with T₃ (50% inorganic nitrogen + 50% organic nitrogen), T₄ (33.3% inorganic nitrogen + 66.6% organic nitrogen) and T₂ (66.6% inorganic nitrogen + 33.3% organic nitrogen) had the highest fruit juice content as well as the largest and heaviest fruit without significant differences among them in both seasons. With regard the effect of treatments on fruit firmness, T₄ (33.3% inorganic nitrogen + 66.6% organic nitrogen) and T₅ (100 % organic nitrogen) gave the highest values of fruit firmness in both seasons. Whereas, T₁ (100 % mineral nitrogen) gave the least values of fruit weight, size, juice % and firmness with significant differences between T₁ and other treatments in most cases in both seasons. These results agree with those obtained by Abd El Migeed *et al.*, (2007), Ahmed *et al.*, (2013) and Ibrahim and Maklad, (2014). Generally, it is clear from Table 7 that, high juice quantity as well as heaviest and largest fruits with a good fruit firmness were harvested from trees that treated by T₃ (50% inorganic nitrogen + 50% organic nitrogen) and T₄ (33.3% inorganic nitrogen + 66.6% organic nitrogen) in both seasons.

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Table 6: Effect of organic and inorganic nitrogen fertilizers on yield of Washington navel orange trees

Treatments	No. of fruits/tree		Yield as kg/tree	
	2017	2018	2017	2018
T ₁ : 100% inorganic	279.15 b	273.37 d	62.58 c	65.25 c
T ₂ : 66.6% inorganic + 33.6% organic	290.74 b	286.29 c	79.85 b	79.86 b
T ₃ : 50% inorganic + 50% organic	323.73 a	322.63 a	90.02 a	91.87 a
T ₄ : 33.3% inorganic + 66.6% organic	315.65 a	322.54 a	86.38 a	90.43 a
T ₅ : 100% organic	290.44 b	298.73 b	66.87 c	73.41 bc

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

Table 7: Effect of organic and inorganic nitrogen fertilizers on physical fruit quality of Washington navel orange trees

Treatments	Fruit weight (g)		Fruit size (cm ³)	
	2017	2018	2017	2018
T ₁ : 100% inorganic	223.49 b	238.68 b	236.78 c	261.40 c
T ₂ : 66.6% inorganic + 33.6% organic	274.65 a	278.48 a	299.34 a	305.19 a
T ₃ : 50% inorganic + 50% organic	278.06 a	284.74 a	303.06 a	312.04 a
T ₄ : 33.3% inorganic + 66.6% organic	273.67 a	280.38 a	298.27 a	307.26 a
T ₅ : 100% organic	230.00 b	246.60 b	250.68 b	270.24 b

Treatments	Juice %		Fruit firmness (kg/cm ²)	
	2017	2018	2017	2018
T ₁ : 100% inorganic	66.00 b	57.69 c	55.17 e	59.34 e
T ₂ : 66.6% inorganic + 33.6% organic	81.16 a	78.68 a	72.83 d	77.26 c
T ₃ : 50% inorganic + 50% organic	82.14 a	80.55 a	84.75 b	85.33 a
T ₄ : 33.3% inorganic + 66.6% organic	80.71 a	79.15 a	91.46 a	79.86 b
T ₅ : 100% organic	67.90 b	69.41 b	78.80 c	85.52 a

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

6.2. Chemical characters:

6.2.1. SSC %, acidity % SSC/acid ratio and vitamin C:

Results in Table 8 showed that, organic and inorganic nitrogen fertilizers had significantly effect on chemical fruit quality in terms of SSC %, acidity % SSC/acid ratio and vitamin C of Washington navel oranges on both seasons. Fertilization of Washington navel orange trees with T₃ (50% inorganic nitrogen + 50% organic nitrogen) produced fruits which had the highest

SSC%, SSC/acid ratio and vitamin C and lowest acidity followed by T₅ (100% organic nitrogen) and T₄ (33.6% inorganic nitrogen + 66.6% organic nitrogen) in both seasons. Whereas, T₁ (100 % inorganic nitrogen) gave the lowest values of SSC%, SSC/acid ratio and vitamin C and the highest values of acidity in both seasons. These results agree with those obtained by Mansour and Shaaban, (2007) and Ahmed *et al.*, (2017).

Table 8: Effect of organic and inorganic nitrogen fertilizers on chemical fruit quality of Washington navel orange trees

Treatments	SSC %		Acidity %	
	2017	2018	2017	2018
T ₁ : 100% inorganic	10.75 c	10.35 c	1.18 a	1.16 a
T ₂ : 66.6% inorganic + 33.6% organic	11.55 b	11.18 b	1.14 b	1.14 b
T ₃ : 50% inorganic + 50% organic	12.15 a	11.61 a	1.12 bc	1.13 b
T ₄ : 33.3% inorganic + 66.6% organic	11.49 b	11.14 b	1.11 c	1.11 c
T ₅ : 100% organic	11.77 b	11.50 a	1.10 c	1.11 c

Treatments	SSC/acid ratio		Vitamin C mg/100 ml	
	2017	2018	2017	2018
T ₁ : 100% inorganic	9.11 e	8.93 d	54.93 a	52.33 bc
T ₂ : 66.6% inorganic + 33.6% organic	10.13 d	9.80 c	55.78 a	54.96 ab
T ₃ : 50% inorganic + 50% organic	10.84 a	10.27 a	53.86 ab	56.61 a
T ₄ : 33.3% inorganic + 66.6% organic	10.32 c	10.01 b	50.23 b	49.57 c
T ₅ : 100% organic	10.67 b	10.36 a	53.14 ab	50.45 c

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

6.2.2. Nitrate and nitrite contents:

Results in Figure 4 revealed that, fruit juice nitrate and nitrite contents were significantly decreased by using different combination treatments as average of both seasons comparing with 100% mineral nitrogen, which gave the highest values of nitrate and nitrite contents followed by T₂ (66.6% mineral nitrogen + 33.3% organic nitrogen). Meanwhile, trees fertilized by T₃, T₄ and T₅ produced fruits with low nitrate and nitrite contents (Figure 4). These results are in line with those obtained by Abd El Migeed *et al.*, (2007), Ahmed *et al.*, (2013) and Ennab *et al.*, (2018). They concluded that, trees fertilizing by organic, biofertilizers with 50% doses of mineral nitrogen led to reduced nitrate and nitrite values in fruit juice comparing with 100% mineral nitrogen fertilizer. This conclusion agrees with our results in Figure 4 which cleared that nitrate and nitrite in fruit juice were gradually decreased with increasing organic fertilizers percentages to replacing mineral nitrogen fertilization. This phenomenon was much pronounced in treatments of T₃, T₄ and T₅ which had a

beneficial effect on reducing nitrate and nitrite in fruit juice.

Generally, it is obvious from Tables 2 and 3 and Figure 1 that, application of recommended nitrogen fertilization through poultry manure and doses of mineral nitrogen are able to consistently improve fruit quality in terms of fruit weight, size, juice quantity, length, firmness, SSC, acidity, SSC/acid ratio, vitamin C, nitrate and nitrite of Washington navel oranges compared to mineral nitrogen only. In this respect, Washington navel orange trees received 305.8 kg/feddan ammonium sulphate + 2.73 ton/feddan poultry manure (T₃) produced best fruit quality such high juice quantity as well as heaviest and largest fruits with a good fruit firmness compared to other treatments. This treatment also increased SSC%, SSC/acid ratio and vitamin C and reducing acidity, nitrate and nitrite in fruit juice. These results agree with those obtained by Abd El Migeed *et al.*, (2007), Sharma *et al.*, (2016) and El Aidy *et al.*, (2018).

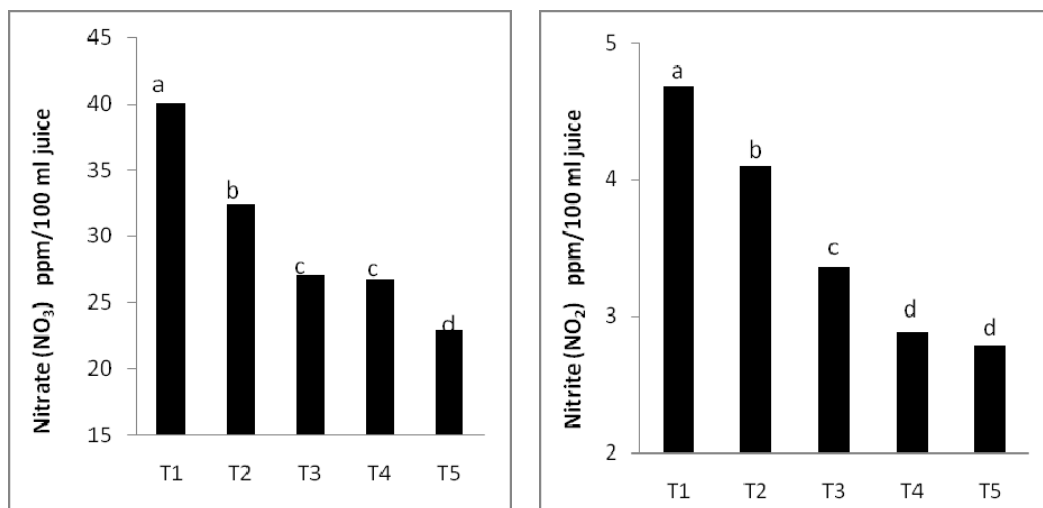


Figure 4. Effect of organic and inorganic nitrogen fertilizers on average values of both seasons of nitrate and nitrite in fruit juice ppm/100 ml juice of Washington navel oranges

(T₁: 100% inorganic; T₂: 66.6% inorganic + 33.6% organic; T₃: 50% inorganic + 50% organic; T₄: 33.3% inorganic + 66.6% organic; T₅: 100% organic)

Conclusion

Consequently from the previously mentioned results, it was clear the main role of organic nitrogen with different doses of mineral nitrogen on Washington navel orange trees grown in clay soil, for supply nitrogen which indispensable for improvement of growth and the nutritional status of the Washington navel orange trees and production of maximum yield. Also, combined of organic and inorganic nitrogen could compensate 50% of mineral nitrogen without significant reduction in yield. Data also indicated that application of organic poultry manure resulted in significant decrease in pH, electrical conductivity, Cd and Pb, whereas, increase organic matter, NH₄⁺, NO₃⁻ and Zn in soil. Therefore, this treatment is recommended (50% mineral nitrogen + 50% organic nitrogen). This improved soil chemical properties and gave the best growth, yield, fruit quality and nutritional status of Washington navel orange trees.

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تأثير الأسمدة النيتروجينية العضوية والمعدنية على أشجار البرتقال أبو سرّة أ. النمو الخضري و المحصول و خواص التربة

حسن أبو الفتوح عناب^(١)، مرفت عبد المجيد الشيمي^(٢)، مها حسيب عبدالعزيز^(٢)

^(١) قسم بحوث الموالج ، ^(٢) قسم بحوث تداول الفاكهة

معهد بحوث البساتين - مركز البحوث الزراعية- الجيزة- مصر

الملخص العربي

سبلة الدواجن لها تأثير مفيد على خصوبة التربة حيث ترفع مستوى المغذيات في التربة و تعمل على تحسين ظروف التربة لتلائم نمو الموالج وإنتاج محصول عالي ذو جودة عالية. لذلك أجريت تجربة حقلية خلال مواسم ٢٠١٧ و ٢٠١٨ على أشجار البرتقال أبو سرّة عمرها ٢٠ سنة مطعومة على أصل النارج و مسافة الزراعة ٥ × ٥ متر في مزرعة خاصة بمحافظة كفر الشيخ، مصر. تهدف هذه الدراسة إلى تقييم تأثير التسميد بسبلة الدواجن وكبريتات الأمونيوم على الخواص الكيميائية للتربة و النمو الخضري و المحصول لأشجار البرتقال أبو سرّة. إشملت التجربة على خمس معاملات هي: المعاملة الأولى ١٠٠ % نيتروجين معدني، المعاملة الثانية ٦٦,٦ % نيتروجين معدني + ٣٣,٣ % نيتروجين عضوي، المعاملة الثالثة ٥٠ % نيتروجين معدني + ٥٠ % نيتروجين عضوي، المعاملة الرابعة ٣٣,٣ % نيتروجين معدني + ٦٦,٦ % نيتروجين عضوي، المعاملة الخامسة ١٠٠ % نيتروجين عضوي بحيث تعطي كل معاملة المعدل الموصى به من عنصر النيتروجين. ويمكن تلخيص أهم النتائج في النقاط التالية:

- أدى الاستخدام المشترك للسماد النيتروجيني العضوي والمعدني و خاصة المعاملة الرابعة [٢٠٣,٨ كجم كبريتات أمونيوم مع ٣,٦٤ طن سبلة دواجن للفدان] و المعاملة الثالثة [٣٠٥,٨ كجم كبريتات أمونيوم مع ٢,٧٣ طن سبلة دواجن للفدان] الى زيادة معنوية في محتوى التربة من المادة العضوية و الأمونيوم و النترات و عنصر الزنك و انخفضت درجة الحموضة و عنصرى الكاديوم و الرصاص و كذلك درجة التوصيل الكهربى في التربة. علاوة على ذلك ، أظهر تحليل أوراق البرتقال أبو سرّة زيادة في محتواها من النيتروجين و الفسفور و البوتاسيوم و الكالسيوم و الماغنسيوم و الحديد و الزنك و المنجنيز في كلا الموسمين.
- أدى تسميد أشجار البرتقال أبو سرّة بالمعاملة الرابعة [٢٠٣,٨ كجم كبريتات أمونيوم مع ٣,٦٤ طن سبلة دواجن للفدان] و المعاملة الثالثة [٣٠٥,٨ كجم كبريتات أمونيوم مع ٢,٧٣ طن سبلة دواجن للفدان] الى زيادة في حجم الأشجار و كذلك أعطت أعلى قيم للنمو الخضري ممثلاً في عدد النموات على الفرع و طول النمو و عدد الأوراق على النمو و المساحة الورقية بالمقارنة مع تسميد الأشجار بالنيتروجين المعدني فقط .
- أما بالنسبة للمحصول وجودة الثمار، فقد وجد أن المعاملة الثالثة ٥٠ % نيتروجين معدني + ٥٠ % نيتروجين عضوي و المعاملة الرابعة ٣٣,٣ % نيتروجين معدني + ٦٦,٦ % نيتروجين عضوي أعطت أعلى محصول من حيث عدد الثمار لكل شجرة و وزن الثمار لكل شجرة بالكيلو جرام وكذلك اعطت ثمار ذات حجم ووزن كبير بالإضافة الى صلابة عالية وذلك عن المقارنة بباقي المعاملات. كما أدت هذه المعاملة إلى زيادة النسبة المؤية للمواد الصلبة الذائبة و نسبة المواد الصلبة الذائبة الى الحموضة و فيتامين C وحدث نقص طفيف في النسبة المؤية للحموضة بينما أدت الى تقليل تركيز النترات و النتريت في عصير الثمار و بناء عليها، يمكن التوصية باستخدام المعاملة الثالثة وهي اضافة ٣٠٥,٨ كجم / فدان كبريتات أمونيوم + ٢,٧٣ طن / فدان من سبلة الدواجن و ذلك لدورها في تحسين الخصائص الكيميائية للتربة و أعطت أفضل نمو و أعلى محصول و حسنت جودة الثمار و الحالة الغذائية لأشجار البرتقال أبو سرّة .

أسماء السادة المحكمين

أ.د/ محى الدين إبراهيم سلامة كلية الزراعة - جامعة كفر الشيخ

أ.د/ مجدى رايح محمد رايح كلية الزراعة - جامعة المنوفية