

REPLACING NITROGEN FERTILIZATION BY USING ORGANIC AND BIOFERTILIZERS ON COSTATA PERSIMMON TREES.

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ABSTRACT

*The present study was conducted during 2015, 2016 and 2017 seasons to study the effect of replacing mineral nitrogen fertilization by organic nitrogen and biofertilizers on Costata persimmon trees, under calcareous soil conditions. The treatments consist of T₁ (100% mineral nitrogen), T₂ (75% mineral nitrogen + 25% organic nitrogen), T₃ (50% mineral nitrogen + 25 % organic nitrogen + biofertilizer), T₄ (25% mineral nitrogen + 50 % organic nitrogen + biofertilizer) and T₅ (100% organic nitrogen). Rice straw compost was used as a source of organic nitrogen and N₂-fixing free living bacteria namely *Azotobacter chroococcum* and *Azospirillum lipoferum* as a source of biofertilizers. The obtained results can be summarized as follows: Treatment of 50% mineral nitrogen + 25% organic nitrogen with biofertilizers gave the highest values of vegetative growth in terms of shoot number/branch, shoot length, leaf numbers per shoot and leaf area of Costata persimmon trees compared to mineral nitrogen fertilizers only. Moreover, treatments included organic and biofertilizers were raising leaf content values of chlorophyll, N, P, K, Ca, Fe, Mn and Zn especially in the second season. As for yield, treatment of 50% mineral nitrogen + 25% organic nitrogen + biofertilizer and 75 % mineral nitrogen + 25% organic nitrogen produced the highest yield in terms of number of fruits/tree, weight (kg/tree) and total yield (ton/feddan). All treatments led to improving properties of fruit quality especially treatment of 50% mineral nitrogen +25% organic nitrogen +biofertilizers. Also, treatments containing organic and biofertilizer led to reducing nitrate and nitrite values in fruit juice comparing with 100% mineral nitrogen fertilizer.*

Conclusively, this treatment is recommended: (50% mineral nitrogen +25% organic nitrogen +biofertilizers). This treatment gave

the best growth, yield, fruit quality and nutritional status of Costata persimmon trees.

Key words: *Diospyros kaki*, compost, biofertilizers, nutritional status, quality, nitrate, nitrite.

INTRODUCTION

Japanese persimmon (*Diospyros kaki*, L.) is one of the most promising deciduous fruit species in Egypt, due to its low chilling requirements, adapts to the warm climate and increasing demands of local consumption. So, persimmon increased rapidly and cultivation spreads in many area in Egypt. Such extension in cultivated area encourages establishing more studies to finding out a good alternative to reduce uses of chemical fertilizers to maintain clean environment, free from pollution and to produce healthy fruits, free from chemicals and safe on human health (Ennab, 2016). Nitrogen fertilization is one of the most important elements for growth, reproductive behavior and ensure economic yield with a good quality of Costata persimmon trees (Choi *et al.*, 2013). Meanwhile, mineral nitrogen fertilizers causes the accumulation of harmful residual substances like NO₃ and NO₂ which have deleterious effects on soil, water and atmosphere pollution, and reflected on animal and human health. Also, it had adversely affected the soil fertility, water quality, yield and quality of the products (Mohammadi and Ziarati, 2016). In order to improve productivity and access to safe fruits for local consumer and high exportation potential as well as reduce the costs, the farmers should be tend to minimizing intensive amounts of chemical fertilizers especially mineral nitrogen fertilization through satisfying the nitrogen requirement from organic nitrogen and biofertilization (Suhag, 2016). Using organic nitrogen such compost or fresh organic manure and biofertilizers have numerous benefits such as a valuable source of many nutrients like macro and microelements, 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, organic manures and biofertilizers has a great importance for sustainable production and to improve the soil physical, chemical and biological properties (Zayan *et al.*, 2016). Moreover, compost and biofertilizers are a good alternative to reduce uses of mineral nitrogen fertilizers on different fruit crops (Abou Grah, 2004; Abd El Migeed *et al.*, 2007; Mansour and Shaaban, 2007 and Salama *et al.*, 2012). In this respect, several studies were accomplished for producing organic fruits through Clean Agriculture which avoiding partially the application of chemicals fertilizers and encouraging the application of organic

and biofertilizers (Masoud, 2012; Ahmed *et al.*, 2013 & 2015 and Mikhael and Aziz, 2016 a & b).

Therefore, this investigation was conducted to study the effect of replacing mineral nitrogen fertilization by organic nitrogen and biofertilizers added on Costata persimmon trees under calcareous soil conditions.

MATERIALS AND METHODS

The present study was carried out during 2015, 2016 and 2017 seasons in a private orchard at Abu El-Matamir, El-Bohaira governorate, Egypt, on eight years old Costata persimmon (*Diospyros kaki*, L.) trees budded on Tarabuls (*Diospyrous lotus*) rootstock, planted at 4 × 4 meter apart in calcareous soil under flood irrigation system. The first year was considered as a preliminary trail, and data was recorded in 2016 & 2017 seasons. The results of soil and rice straw compost analysis according to Page *et al.*, (1982) are given in Table 1. Forty five trees uniform in growth, vigour and productivity were selected, and subjected to the same cultural practices commonly adopted on the orchard, except those dealing with application of organic and inorganic nitrogen as well as biofertilizers. Trees were arranged in a randomized complete block design, each treatment replicated three time with three tree per replicate.

Five treatments were chosen to study the effect of replacing mineral nitrogen fertilization by organic nitrogen and biofertilizers compared with 100% mineral nitrogen as follows:

- T₁**:100% recommended doses of mineral nitrogen as 300g N/tree/year via ammonium nitrate 33.5% N at rate of 900 g/tree/year.
- T₂**: 75% mineral nitrogen from recommended doses via ammonium nitrate 33.5% N at rate of 675 g/tree/year + 25% organic nitrogen via rice straw compost 1.58% N at rate of 4.75 kg/tree/year.
- T₃**: 50% mineral nitrogen from recommended doses via ammonium nitrate 33.5% N at rate of 450 g/tree/year + 25% organic nitrogen via rice straw compost 1.58% N at rate of 4.75 kg/tree/year, + 25g/tree/year biofertilizers.
- T₄**: 25% mineral nitrogen from recommended doses via ammonium nitrate 33.5% N at rate of 225 g/tree/year + 50% organic nitrogen via rice straw compost 1.58% N at rate of 9.5 kg/tree/year, + 25g/tree/year biofertilizers.
- T₅**:100% organic nitrogen via rice straw compost 1.58% N at rate of 19 kg/tree/year.

Table (1): Analysis of rice straw compost and physical, chemical of the experimental soil.

parameters	Soil analysis		Rice straw compost	
	Soil depth cm		Parameters	Value
	0 – 30	30 – 60		
Sand %	76.28	77.88	weight of dry kg/m ³	583.5
Silt %	15.26	15.12	Moisture %	23.8
Clay %	8.46	7.00	Organic matter %	38.21
Texture	Sandy	Sandy	Organic carbon %	22.18
pH 1:2.5	8.10	8.20	pH 1:10	7.30
EC dSm ⁻¹ 1:5	0.44	0.33	EC dSm ⁻¹ 1:5	1.35
Organic mater %	1.15	0.89	C/N ratio	14.04
K ⁺ meq/l	0.57	0.49	N %	1.58
Ca ⁺⁺ meq/l	3.13	2.82	P %	2.32
Mg ⁺⁺ meq/l	2.29	1.64	K %	2.58
Na ⁺ meq/l	2.96	2.33	Ca %	1.78
HCO ₃ ⁻ meq/l	1.06	0.81	Mg %	0.93
Cl ⁻ meq/l	4.27	3.94	Fe ppm	633
SO ₄ ⁻ meq/l	3.62	2.53	Mn ppm	99
CaCO ₃	15.7	16.3	Zn ppm	38
CO ₃ ⁻	0.00	0.00	Cu ppm	26

Amount of mineral nitrogen as ammonium nitrate (33.5% N) was divided in to three doses and added as, 50% at late February, 25% at the end of June and 25% at the end of July. Also, 625g/tree/year potassium sulphate 48% K₂O was applied on two doses, at mid April and mid June. Whereas, 1.12 kg/tree/year super phosphate 15.5% P₂O₅ was added once in early February. Potassium sulphate and super phosphate were applied to all treatments as a source of K and P in both seasons. Rice straw compost 1.58% N as a source of organic nitrogen was broadcasted and incorporated into the root zone of tree in winter service at late December in both seasons. A mixture of N₂-fixing free living bacteria namely *Azotobacter chroococcum* and *Azospirillum lipoferum* (5 x 10⁷ cfu/g peat moss) as biofertilizers was added in the first week of March in both seasons. Rice straw compost and bacteria were obtained from Soil Microbiology Department, Sakha Agric. Res. Station, Kafr El-Sheikh governorate, Egypt.

Four branches on each tree were selected and tagged in four directions for measuring and determination the following data:

1. Vegetative growth:

In the first week of August, shoots formed in branch were counted, and 12 shoots on each replicate were sampled from tagged branches to measuring shoot length (cm) and leaves number per shoot was recorded,

also twenty mature leaves were sampled from shoots to determining leaf area (cm²) using a leaf area meter Model Li 3100 area- meter.

2. *Nutritional status:*

Samples of Twenty mature leaves taken to determined leaf area, five leaves taken from this samples to determine chlorophyll a, b and its total by using N, N dimethyl formamide according to Moran and Porath (1980). The remaining leaf samples were dried at 70°C to a constant weight, then ground and digested according to Jackson (1967) by using the mixture of concentrated Sulfuric acid (H₂SO₄) + per chloric (HClO₄) (5: 1) to determine the elements N, P, K, Ca, Mg, Fe, Mn and Zn. Total nitrogen % was determined by using the micro-kjeldahl method as described by Pregl (1945), Phosphorus % was determined coloremometrically as described by Murphy and Riley (1962), Potassium % was estimated by using flame photometer as described by Brown and Lillelland (1974), Ca, Mg, Fe, Mn and Zn were assayed with Atomic Absorption spectrophotometer (Unican SP 1900) according to Chapman and Pratt (1961).

3. *Final fruit set and final fruit drop percentages:*

Number of flowers, fruitlets at initial set (i.e. 15 days after full bloom) and fruit at harvest time were counted on the selected main branches for calculated final fruit set and fruit drop percentages by the following equations:

$$\text{Final fruit set \%} = \frac{\text{No. of harvested fruits}}{\text{No. of flowers}} \times 100$$

$$\begin{aligned} \text{Final fruit drop \%} \\ &= \frac{\text{No. of fruitlets at initial set} - \text{No. of harvested fruits}}{\text{No. of fruitlets at initial set}} \\ &\times 100 \end{aligned}$$

4. *Yield:*

Yield was harvested at September 7th and 29th in 2016 and 2017, respectively. Yield of each replicate was determined as number and weight (kg) of fruits/tree, and total yield as ton/feddan.

5. *Fruit quality:*

Ten fruit samples were taken at random from each replicate to determine fruit quality as follow: fruit weight (g), fruit length and diameter (cm), and fruit firmness (lb/inch²) was measured at two opposite sides on the equator of each fruit using pressure tester at 5/16 plunger. Total soluble solids (TSS%) was determined by hand refractometer, total acidity as malic acid, total tannin content in fruit juice, nitrate (NO₃) and nitrite (NO₂)

content (mg/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 least significant differences (L.S.D. at 5% level) was used to compare the main values.

RESULTS AND DISCUSSION

1. *Vegetative growth:*

Results presented in Table (2) showed that, mineral nitrogen, organic nitrogen and biofertilizers had positive effect on vegetative growth parameters in terms of shoot number/branch, shoot length leaves number per shoot and leaf area of Costata persimmon trees in both seasons. Fertilizing Costata persimmon trees with T₁ (100 % mineral nitrogen) and T₃ (50% mineral nitrogen + 25% organic nitrogen + biofertilizer) tended to give the highest values of vegetative growth parameters without significant differences between them in both seasons. On contrary, using 100% rice straw compost as a source of nitrogen only produced the lowest significant values of vegetative growth parameters as compared to other treatments in both seasons. Whereas that, T₂ (75% mineral nitrogen + 25% organic nitrogen) and T₄ (25% mineral nitrogen + 50% organic nitrogen + biofertilizer) gave intermediate values of most vegetative growth parameters without significant differences between them in both seasons. These results are in harmony with those obtained by Shah *et al.*, (2006); Abd El Wahab, (2011) and Ahmed *et al.*, (2015). They concluded that, soil application of 50% organic nitrogen + 50% mineral nitrogen gave the highest significant values of vegetative growth i.e., shoot length leaves number per shoot, leaf area and leaf dry weight on different fruit species. In this respect, Mikhael and Aziz (2016a) who revealed that Anna apple trees fertilized with 50% organic manure + 50% mineral fertilizer gave the highest significant values of vegetative growth in terms of shoot length, shoot diameter, leaf area and leaf dry weight.

Generally, it is obvious from data in Table (2) that, tree vigour and vegetative growth of Costata persimmon trees were significantly improved by using combination among mineral nitrogen, organic nitrogen and biofertilizers especially treatment of 50% mineral nitrogen + 25% organic nitrogen + biofertilizer. This increment in vegetative growth as a result of treatments may be due to stimulating availability of nutrients, organic matter and reducing soil pH as well as natural hormones present in the combination

of mineral and organic nitrogen fertilizers with biofertilizers. This might also be attributed to the improved nitrogen use efficiency and consequently improved nitrogen uptake by trees resulting into faster cell division and cell elongation; and consequently increased the tree growth and size. These observations were corroborated with the findings of El Salhy *et al.*, (2010) and Mansour *et al.*, (2013). In this respect, Gabr and Nour El-Din (2012) concluded that nitrogen-fixing bacteria *Azospirillum lipoferum* enhancing the nitrogen and produce natural hormones like gibberellins and cytokines that are responsible for plant growth promotion that occurs upon inoculation onto plants.

Table (2). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on some growth parameters of Costata persimmon trees.

Treatments	Shoot number per branch		Shoot length (cm)		Leaves number per shoot		Leaf area (cm ²)	
	2016	2017	2016	2017	2016	2017	2016	2017
T₁	17.28	18.55	72.42	74.18	21.47	22.37	32.28	34.00
T₂	15.67	16.45	68.88	70.20	20.25	20.90	28.90	29.55
T₃	16.44	17.32	70.98	73.33	20.60	21.37	31.77	32.88
T₄	15.33	16.11	68.65	69.77	20.15	20.77	27.52	28.19
T₅	13.77	14.23	63.86	65.28	18.76	19.41	26.38	26.83
LSD at 5%	1.10	1.39	1.58	1.94	0.90	0.78	1.08	1.53

T₁:100 % Mineral nitrogen; T₂: 75% Mineral nitrogen + 25% Organic nitrogen; T₃: 50% Mineral nitrogen + 25% Organic nitrogen + Biofertilizer; T₄: 25% Mineral nitrogen + 50% Organic nitrogen + Biofertilizer and T₅:100% Organic nitrogen.

2. Nutritional status:

Leaf chlorophyll content (µg/cm²):

Regarding the effect of mineral and organic nitrogen and biofertilizers on leaf chlorophyll content of Costata persimmon trees, results in Table (3) clearly showed that, chlorophyll a, b and its total content were significantly improved with nitrogen fertilization treatments in both seasons. Costata persimmon trees fertilized with T₅ (100% organic nitrogen) and T₃ (50% mineral nitrogen + 25% organic nitrogen + biofertilizer) recorded the highest values of chlorophyll a, b and its total content in both seasons, respectively. On the other hand, T₁ (100 % mineral nitrogen) and T₂ (75% mineral nitrogen + 25% organic nitrogen) recorded the least values of leaf chlorophyll content in both seasons. Whereas, T₄ (25% mineral nitrogen + 50% organic nitrogen + biofertilizer) gave intermediate values in this respect. These results are similar to those of previous studies (Ahmed *et al.*, 2013 and El Gioushy and Baiea 2015). The increment in leaf chlorophyll

content as a result of treatments might be due to soil application of compost and biofertilizers led to increasing soil organic matter, improves soil structure and increases the water-holding capacity, which reflected to improve availability of macro and micronutrients especially N, Mg and Fe. This explanation agree with our data in Tables (3 and 4) and Wassel *et al.*, (2015) who concluded that soil application of farmyard manure, compost and chicken manure improved leaf chlorophyll a, b and its total content on Fig trees.

Table (3). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on leaf chlorophyll content of Costata persimmon trees.

Treatments	Leaf chlorophyll content as $\mu\text{g}/\text{cm}^2$					
	a		b		Total	
	2016	2017	2016	2017	2016	2017
T ₁	62.46	63.14	28.14	28.55	90.60	91.69
T ₂	63.65	64.53	28.79	28.80	92.44	93.33
T ₃	65.71	67.15	29.76	30.18	95.47	97.33
T ₄	64.46	65.43	29.33	29.66	93.79	95.09
T ₅	66.80	68.21	30.17	31.35	96.97	99.56
LSD at 5%	1.85	2.11	0.78	0.11	2.25	2.16

T₁:100 % Mineral nitrogen; T₂: 75% Mineral nitrogen + 25% Organic nitrogen; T₃: 50% Mineral nitrogen + 25% Organic nitrogen + Biofertilizer; T₄: 25% Mineral nitrogen + 50% Organic nitrogen + Biofertilizer and T₅:100% Organic nitrogen.

Leaf mineral content:

Generally, it is obvious from results in Tables (4 and 5) that, application of mineral, organic and biofertilizers enhanced leaf mineral content of Costata persimmon trees. It is also clear that leaf mineral content in the second season proved better compared to first season. Moreover, the results in Tables (4 and 5) revealed that most mineral in leaves is located in adequate range for Costata persimmon growth and productivity under all treatments, these results came true with Wahba, (2002) and George *et al.*, (2005). Anyhow, data in Tables (4 and 5) showed that, Costata persimmon trees fertilized with T₁ (100 % mineral nitrogen), T₃ (50% mineral nitrogen + 25% organic nitrogen + biofertilizer) and T₄ (25% mineral nitrogen + 50% organic nitrogen + biofertilizer) had higher N, P, K, Ca and Mg than other treatments. Also, treatment of T₅ (100% organic nitrogen) gave lowest values of leaf N, P, K, Ca and Mg contents in both seasons. The results show significant differences among treatments in both seasons as for N and Ca, while the differences were not significant as for P, K and Mg in both seasons. Moreover, treatments included organic fertilization especially T₅,

T₃ and T₄ raised leaf Fe, Mn and Zn content compared to other treatments and 100% mineral nitrogen only. These results were similar to those obtained by Abd El Migeed *et al.*, (2007) and Mansour and Shaaban (2007) who noted that leaf analysis of Washington navel orange trees showed a high level of N, P and K when treated with nitrogen through mineral at 50% plus 25% compost plus biofertilizers. El-Khawaga, (2012) concluded that, soil application of compost enriched with actinomyces at 25 to 50 % and *Bacillus polymyxa* as a source of nitrogen on mango trees led to improve uptake of N, P and K comparing with using mineral nitrogen only. As regard to micronutrients showed in Table (5) that the uptake of Fe, Mn and Zn were improved with the application of organic and bio fertilizers. These results were similar with those reported by Mikhael and Aziz (2016a) who revealed that Anna apple trees fertilized with a combination between organic and mineral nitrogen sources had significantly effective in enhancing leaf Fe, Mn and Zn contents compared to the application of nitrogen in the mineral source only.

Table (4). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on leaf macronutrients of Costata persimmon trees.

Treatments	N %		P %		K %		Ca %		Mg %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
T ₁	2.31	2.43	0.172	0.178	2.36	2.34	2.16	2.22	0.64	0.64
T ₂	1.95	2.21	0.163	0.181	2.33	2.33	2.01	2.12	0.63	0.63
T ₃	2.12	2.43	0.172	0.186	2.36	2.44	2.28	2.31	0.65	0.64
T ₄	2.12	2.33	0.174	0.174	2.34	2.36	2.10	2.13	0.64	0.63
T ₅	1.88	2.19	0.156	0.172	2.27	2.32	1.98	1.90	0.63	0.62
LSD at 5%	0.10	0.13	ns	ns	ns	ns	0.11	0.16	ns	ns

Table (5). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on leaf micronutrients of Costata persimmon trees.

Treatments	Fe ppm		Mn ppm		Zn ppm	
	2017	2016	2016	2017	2016	2017
T ₁	75.4	77.2	46.3	45.4	17.8	18.7
T ₂	75.9	81.8	54.7	58.3	18.8	19.7
T ₃	85.2	97.8	58.7	69.8	20.1	22.1
T ₄	79.3	88.6	56.6	60.4	19.9	20.2
T ₅	87.6	90.6	72.1	75.2	20.1	21.1
LSD at 5%	4.45	3.95	1.54	4.86	0.80	1.53

T₁:100 % Mineral nitrogen; T₂: 75% Mineral nitrogen + 25% Organic nitrogen; T₃: 50% Mineral nitrogen + 25% Organic nitrogen + Biofertilizer; T₄: 25% Mineral nitrogen + 50% Organic nitrogen + Biofertilizer and T₅:100% Organic nitrogen.

Generally, it is obvious from Tables (2, 3, 4 and 5) that, vegetative growth and nutritional status of Costata persimmon trees were significantly enhanced by rice straw compost and biofertilizers as a source of nitrogen under calcareous soil. This result can be attributed to influencing soil fertility as: raise the soil microbial population including beneficial microorganisms, better soil structure, enhance the cation exchange capacity and decreased soil pH. This beneficial reflected to enhancing the availability of macro and micronutrients. Therefore, it can be concluded from Tables (2, 3, 4 and 5) that, soil application of 50% mineral nitrogen plus 25% rice straw compost with biofertilizers improving vegetative growth and nutritional status of Costata persimmon trees compared to mineral nitrogen fertilizers only without significant differences on most cases.

3. Final fruit set and final fruit drop percentages:

It appeared from Figure (1) that, final fruit set and final 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 nitrogen + 25% organic nitrogen + biofertilizer) exhibited the high final fruit set followed by T₂ (75% mineral nitrogen + 25% organic nitrogen) and T₄ (25% mineral nitrogen + 50% organic nitrogen + biofertilizer) in both seasons. The differences were not significant among them in both seasons. On the other hand, T₅ (100% organic nitrogen) gave the lowest values of final fruit set percentage in both seasons. 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, Mikhael and Aziz (2016b) revealed that mixed 50% organic and 50% inorganic nitrogen fertilizers had positive effect on fruit set % of apple trees as compared with mineral nitrogen fertilizers only. Also, the data illustrated in Fig. (1) that, the lowest percentage of final fruit drop were found on trees fertilized by T₃, T₂ and T₄ respectively in both seasons. On contrary, the highest fruit drop percentage was observed on treatment T₁ and T₅ respectively. Similar results were obtained by El Saady and El-Abd, (2012) and Ahmed *et al.*, (2013) they reported organic, biofertilizers and NPK alone or combined together significantly decreased the percentages of June drop and preharvest drop in navel orange. So, it can be concluded that, final fruit set and final fruit drop of Costata persimmon trees were positively affected by organic and biofertilizers with doses of mineral nitrogen fertilizers in both seasons. In this respect, organic and bio-fertilizers gave the best fruit set and also reduced final fruit drop especially T₄ and T₃ compared to other treatments.

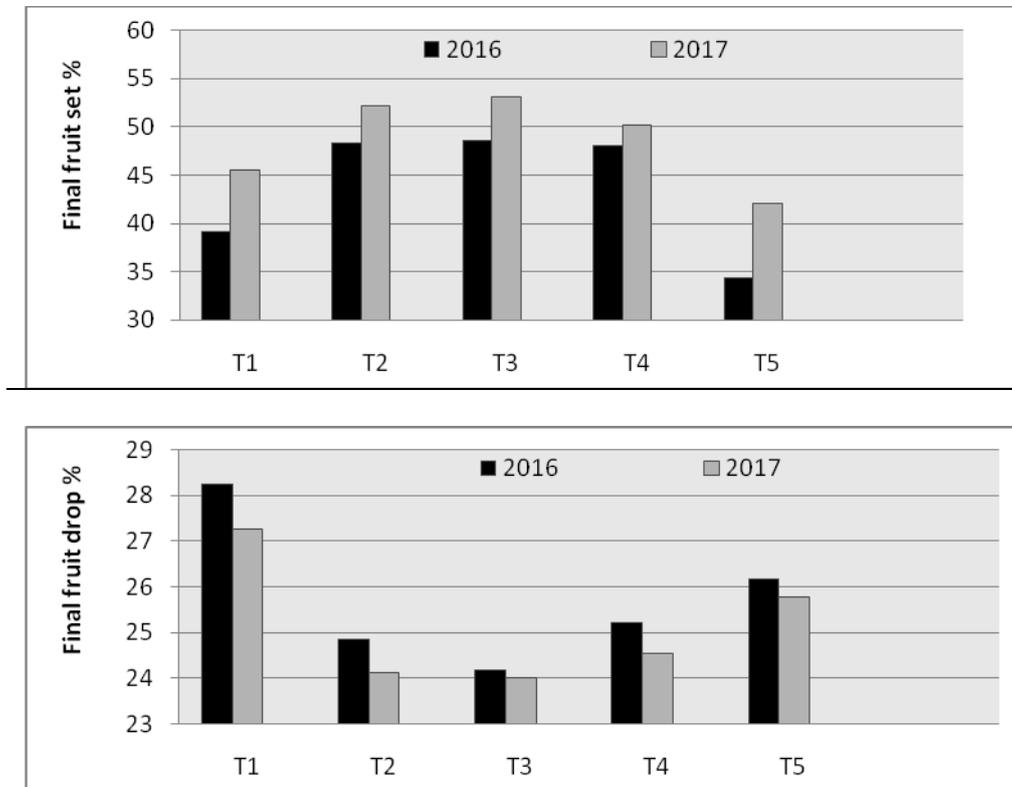


Figure (1). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on fruit set % and fruit drop % of Costata persimmon trees.

T₁:100 % mineral nitrogen; T₂: 75% mineral nitrogen + 25% organic nitrogen; T₃: 50% mineral nitrogen + 25% organic nitrogen + biofertilizer; T₄: 25% mineral nitrogen + 50% organic nitrogen + biofertilizer and T₅:100% organic nitrogen.

4. Yield:

Results in Table (6) showed that, rice straw compost and biofertilizers treatments with nitrogen dose were significantly increased fruit yield of Costata persimmon expressed as number of fruits/tree, kg/tree and total yield as ton/feddan in both seasons. Treatments of T₃ (50% mineral nitrogen + 25% organic nitrogen + biofertilizer) and T₂ (75% mineral nitrogen + 25% organic nitrogen) tended to gave the highest values of yield as number of fruits/tree, kg/tree and ton/feddan without significant differences between them in both seasons. On contrary, using 100% rice straw compost as a source of nitrogen only produced the lowest values of yield in both seasons. In this respect, T₄ (25% mineral nitrogen + 50% organic nitrogen +

biofertilizer) and T₁ (100 % mineral nitrogen) produced moderate yield in both seasons. These results are in agreement with those obtained by Mansour and Shaaban (2007). In this respect, Dheware and Waghmare, (2009) on sweet orange, they reported that, number of fruits per tree and average weight of fruits significantly increased with organic, inorganic fertilizers and inoculation by *Azospirillum*. Also, Mikhael and Aziz (2016b) revealed that Anna apple tree fertilized with 50% mineral nitrogen plus 50% organic manure bearing higher yield (kg/tree) than that fertilized with 100% mineral nitrogen only. The beneficial effect of organic and biofertilizers on improving yield of Costata persimmon maybe due to positive effect on nutrients uptake (Tables 4 and 5) which reflected on active vegetative growth parameters in Table (2). Also the positive response of yield as a result of biofertilizers treatments maybe due to the high ability of these microbes in nitrogen fixation and the secretion of several compounds that increase soil fertility, and organic matter increase bacteria activity, number of this bacteria, thus it can fix atmospheric nitrogen, increase phosphorus availability in soil and enhanced absorb elements by Costata persimmon 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. These conclusions agree with the result obtained by Wassel *et al.*, (2015) and our data in Fig. (1).

Table (6). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on yield of Costata persimmon trees.

Treatments	Fruit number/tree		Kg/tree		Ton/feddan	
	2016	2017	2016	2017	2016	2017
T ₁	239.8	243.8	29.55	31.17	7.68	8.10
T ₂	265.6	258.2	34.90	35.53	9.07	9.23
T ₃	253.6	249.3	35.33	35.98	9.18	9.35
T ₄	238.7	259.3	30.70	33.83	7.98	8.79
T ₅	232.8	239.2	28.22	29.17	7.33	7.58
LSD at 5%	1.51	8.88	2.23	0.87	0.23	0.34

T₁:100 % Mineral nitrogen; T₂: 75% Mineral nitrogen + 25% Organic nitrogen; T₃: 50% Mineral nitrogen + 25% Organic nitrogen + Biofertilizer; T₄: 25% Mineral nitrogen + 50% Organic nitrogen + Biofertilizer and T₅:100% Organic nitrogen.

5. Fruit quality:

Physical characters:

Data in Table (7) show the effect of application of mineral, organic nitrogen and biofertilizers on physical fruit quality in terms of fruit weight, length, and diameter and fruit firmness of Costata persimmon trees in both

Table (7). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on physical fruit quality of Costata persimmon trees.

Treatments	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)		Fruit firmness (lb/inch ²)	
	2016	2017	2016	2017	2016	2017	2016	2017
T ₁	123.19	127.82	6.22	6.33	6.45	6.56	20.79	19.76
T ₂	131.40	137.56	5.71	5.93	5.94	6.16	17.53	16.79
T ₃	139.27	144.30	7.03	7.18	7.24	7.39	19.06	18.41
T ₄	128.60	130.42	5.63	5.87	5.86	6.11	18.79	18.22
T ₅	121.21	121.94	5.25	5.43	5.49	5.68	23.44	22.60
LSD at 5%	1.50	1.84	0.15	0.08	0.42	0.23	0.84	0.72

T₁:100 % Mineral nitrogen; T₂: 75% Mineral nitrogen + 25% Organic nitrogen; T₃: 50% Mineral nitrogen + 25% Organic nitrogen + Biofertilizer; T₄: 25% Mineral nitrogen + 50% Organic nitrogen + Biofertilizer and T₅:100% Organic nitrogen.

seasons. As for fruit weight, trees fertilized by T₃ (50% mineral nitrogen + 25% organic nitrogen + biofertilizer) had the heaviest fruit weight followed by those fertilized by T₂, T₄, T₁ and T₅ in both seasons, respectively. The differences were significant among treatments in both seasons. Similar results were obtained by Mansour *et al.*, (2013) and El Sehrawy, (2015). With regard the effect of treatments on fruit length and diameter, T₃ (50% mineral nitrogen + 25% organic nitrogen + biofertilizer) gave the highest values of fruit length and diameter followed by T₁ (100 % mineral nitrogen) with significant differences between them in both seasons. T₂ (75% mineral nitrogen + 25% organic nitrogen) and T₄ (25% mineral nitrogen + 50% organic nitrogen + biofertilizer) gave intermediate values in this respect. Whereas, T₅ (100% organic nitrogen) gave the least values of fruit length and diameter in both seasons. These results agree with those obtained by Mikhael and Aziz (2016b). Also, it's clear from Table (7) that, Costata persimmon fertilized by T₅ (100% organic nitrogen) had the highest fruit firmness followed by T₁ (100% mineral nitrogen) in both seasons. On the other hand, T₂ (75% mineral nitrogen + 25% organic nitrogen) gave the lowest values of fruit firmness in both seasons. These results agree with those obtained by Salama *et al.*, (2012).

Generally, it is clear from Table (7) that, heaviest and largest fruits with a good fruit firmness were harvest from trees treated T₃ (50% mineral nitrogen + 25% organic nitrogen + biofertilizer), T₂ (75% mineral nitrogen + 25% organic nitrogen) and T₄ (25% mineral nitrogen + 50% organic nitrogen + biofertilizer) in both seasons.

Chemical characters:

Results in Table (8) show the effect of soil application of mineral and organic nitrogen as well as biofertilizers on chemical fruit quality in terms of TSS %, acidity % and total tannins % of Costata persimmon trees in both seasons. Fertilization of Costata persimmon trees with T₅ (100% organic nitrogen) produced fruits had the highest TSS% and lowest acidity and total tannins followed by T₃ (50% mineral nitrogen + 25% organic nitrogen + biofertilizer) and T₄ (25% mineral nitrogen + 50% organic nitrogen + biofertilizer) in both seasons. Whereas, T₁ (100 % mineral nitrogen) gave the lowest values of TSS and the highest values of acidity and total tannins in both seasons. These results agree with those obtained by Salama *et al.*, (2012), Mansour *et al.*, (2013), El Sehrawy, (2015) and Mikhael and Aziz (2016b).

Table (8). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on some chemical fruit quality of Costata persimmon trees.

Treatments	TSS %		Acidity %		Total tannins mg/100 ml juice	
	2016	2017	2016	2017	2016	2017
T ₁	19.72	20.69	0.39	0.39	2.46	2.55
T ₂	20.78	22.10	0.35	0.35	2.10	2.21
T ₃	22.46	23.26	0.32	0.33	1.96	2.06
T ₄	21.78	21.94	0.32	0.32	2.07	2.19
T ₅	24.73	25.73	0.29	0.30	2.22	2.32
LSD at 5%	0.31	0.73	0.01	0.05	0.15	0.10

T₁:100 % Mineral nitrogen; T₂: 75% Mineral nitrogen + 25% Organic nitrogen; T₃: 50% Mineral nitrogen + 25% Organic nitrogen + Biofertilizer; T₄: 25% Mineral nitrogen + 50% Organic nitrogen + Biofertilizer and T₅:100% Organic nitrogen.

Nitrate and nitrite contents:

Fertilizers types and its amounts used especially mineral nitrogen fertilizers influence on the concentration of nitrate and nitrite in fruit juice. In order to improve productivity and access to safe fruits for local consumer and high exportation potential, tree nutrition should be depending on minimizing amounts of chemical fertilizers especially mineral nitrogen fertilizer through satisfying the nitrogen requirement from organic nitrogen and biofertilization. So, our results in Figure (2) revealed that, fruit juice nitrate and nitrite contents were significantly decreased by different treatments in the two seasons comparing with 100% mineral nitrogen, which gave the highest values on nitrate and nitrite contents (2.80 and 2.74 mg/100

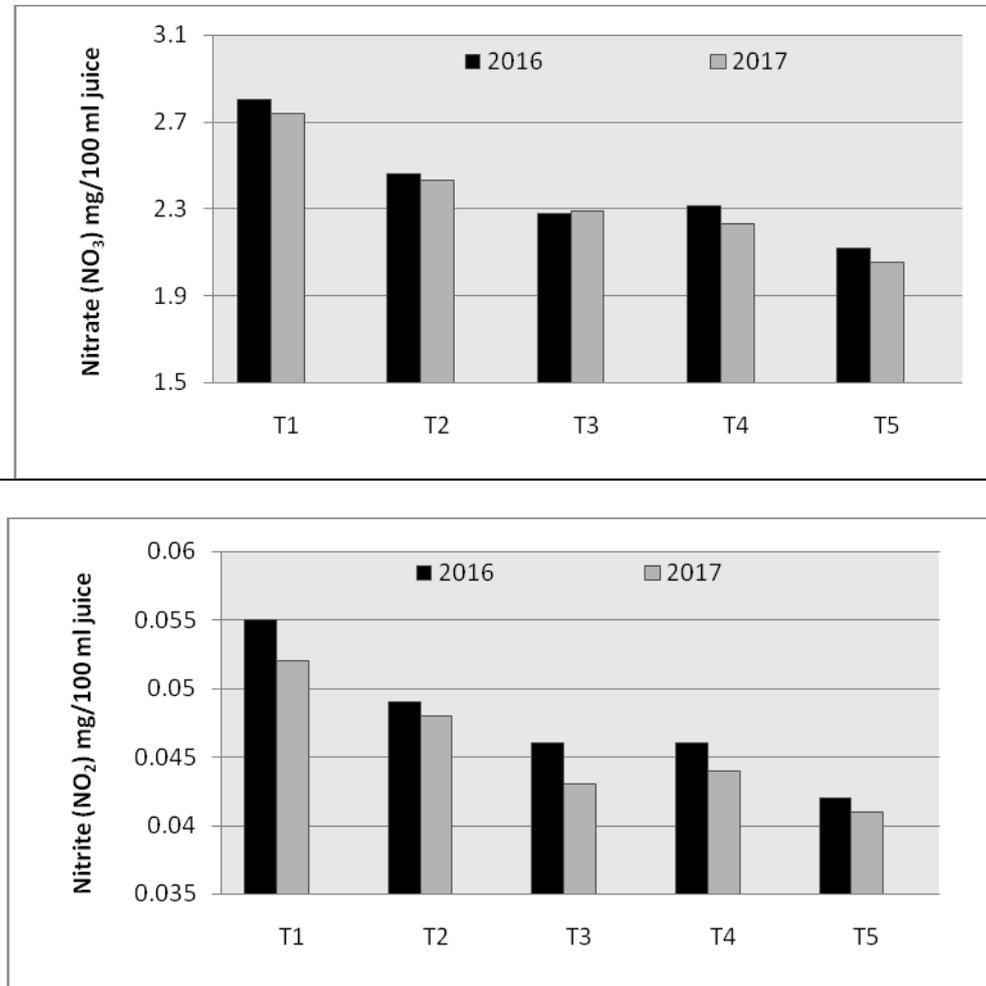


Figure (2). Effect of replacing mineral nitrogen by organic nitrogen and biofertilizers on nitrate and nitrite in fruit juice mg/100 juice of Costata persimmon trees.
 T₁:100 % Mineral nitrogen; T₂: 75% Mineral nitrogen + 25% Organic nitrogen; T₃: 50% Mineral nitrogen + 25% Organic nitrogen + Biofertilizer; T₄: 25% Mineral nitrogen + 50% Organic nitrogen + Biofertilizer and T₅:100% Organic nitrogen.

ml juice), (0.055 and 0.052 mg/100 ml juice) followed by 75% mineral nitrogen + 25% organic nitrogen (2.46 and 2.43 mg/100 ml juice), (0.049 and 0.048 mg/100 ml juice). Meanwhile, trees fertilized by 100% organic and 50% mineral nitrogen + 25% organic nitrogen + biofertilizers produced

fruits with low nitrate and nitrite contents in both seasons. These results agree with those obtained by Abd El Wahab, (2011), Ahmed *et al.*, (2015), El Sehrawy, (2015) and Mikhael and Aziz (2016b). 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 agree with our results in Fig. (2) which cleared that values of replacing nitrogen fertilization partially through using only 50% mineral nitrogen + 25% organic nitrogen + biofertilizer instead of 100% mineral nitrogen had a beneficial effect on reducing nitrate and nitrite in fruit juice.

Generally, it is obvious from Tables (7 and 8) and Fig. (2) that, fertilization with organic nitrogen and biofertilizers, with doses of mineral nitrogen are able to consistently improve fruit quality in terms of fruit weight, length, diameter, firmness, TSS, acidity, total tannins, nitrate and nitrite of Costata persimmon trees compared to mineral nitrogen only. In this respect, 50% mineral nitrogen + 25% organic nitrogen + biofertilizers produced best fruit quality compared to other treatments. These results agree with those obtained by Abd El Migeed *et al.*, (2007) and Abd El Wahab (2011).

Conclusively, consequently from the previously mentioned results, it was clear the main role of organic nitrogen and biofertilizers with different doses of mineral nitrogen on Costata persimmon trees grown in calcareous soil, for supply nitrogen which indispensable for improvement of growth and the nutritional status of the Costata persimmon trees and production of maximum yield with a good quality. Also, organic nitrogen and biofertilizers could compensate 50% of mineral nitrogen without significant reduction in yield. Therefore, this treatment is recommended (50% mineral nitrogen + 25% organic nitrogen + biofertilizers). This treatment gave the best growth, yield, fruit quality and nutritional status of Costata persimmon trees.

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الحد من التسميد النيتروجيني باستخدام الأسمدة العضوية والحيوية على أشجار الكاكي صنف كوستاتا

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أجريت هذه الدراسة خلال مواسم 2015 و 2016 و 2017 لدراسة تأثير إحلال النيتروجين العضوى و الاسمدة الحيوية محل جزء أو كل السماد النيتروجينى المعدنى فى تسميد أشجار الكاكي صنف كوستاتا تحت ظروف التربة الجيرية. إشتملت المعاملات على الآتى: المعاملة الاولى 100% نيتروجين معدنى، المعاملة الثانية 75% نيتروجين معدنى + 25% نيتروجين عضوى، المعاملة الثالثة 50% نيتروجين معدنى + 25% نيتروجين عضوى + السماد الحيوى، المعاملة الرابعة 25% نيتروجين معدنى + 50% نيتروجين عضوى + السماد الحيوى، المعاملة الخامسة 100% نيتروجين عضوى. أستخدم كومبست قش الارز كمصدر للسماد العضوى و خليط من بكتريا حرة تثبت النيتروجين الجوى هي أزوتوبكتر وأزوسبريليم كمصدر للسماد الحيوى.

و يمكن تلخيص النتائج التي تم الحصول عليها على النحو التالي:

- تسميد أشجار الكاكي صنف كوستاتا 50% نيتروجين معدنى + 25% نيتروجين عضوى + السماد الحيوى أعطت أعلى قيم للنمو الخضري و المتمثل في عدد النموات على الفرع و طول النمو و عدد الأوراق على النمو و المساحة الورقية بالمقارنة مع تسميد الأشجار بالاسمدة النيتروجينية المعدنية فقط .
- أدت المعاملات التي إشتملت على السماد العضوى و الاسمدة الحيوية إلى زيادة محتوى الأوراق من الكلوروفيل و النيتروجين و الفسفور و البوتاسيوم و الكالسيوم و الحديد و الماغنسيوم و المنجنيز و خاصة في الموسم الثاني .
- أما بالنسبة للمحصول، فقد وجد أن المعاملة 50% نيتروجين معدنى + 25% نيتروجين عضوى + السماد الحيوى و المعاملة 75% نيتروجين معدنى + 25% نيتروجين عضوى أعطت أعلى محصول من حيث عدد الثمار لكل شجرة و وزن الثمار لكل شجرة و محصول الفدان بالطن.

- أدت جميع المعاملات إلى تحسين خصائص جودة الثمار و خاصة معاملة 50% نيتروجين معدني + 25% نيتروجين عضوي + السماد الحيوي.
 - أيضا، أدت المعاملات المحتوية على أسمدة عضوية إلى خفض قيم النترات والنيتريت في عصير الثمار.
- التوصية:** يوصى بهذه المعاملة و هي التسميد 50%سماد نيتروجيني معدني + 25% نيتروجيني عضوي + الأسمدة الحيوية. حيث أعطت هذه المعاملة أفضل نمو وأعلى محصول بجودة عالية وأحسن حالة غذائية لأشجار الكاكي صنف كوستاتا.