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EFFECT OF ORGANIC MANURE AND HUMIC ACID ON PRODUCTIVITY AND FRUIT QUALITY OF CACTUS PEAR

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A field experiment was conducted during 2018 and 2019 seasons on El-shamia cactus pear plants orchard about eight years old, grown in sandy soil under drip irrigation system from a well located in Abu Ghaleb area, "Cairo-Alexandria desert road" about 50 km from Cairo, Egypt. The aim of study was the evaluation of the effect of cattle manure soil application rates; i.e. 20, 30 and 40 kg/plant and humic acid at 3 rates; i.e. 0, 10 and 20 g/plant as well as their interactions on growth, cladodes nutrients content, yield and fruit quality and investment ratio of cactus pear plants. Resulted showed that increasing cattle manure rates induced a progressive enhancement of the growth, cladodes nutrients content, yield and fruit quality. Moreover, humic acid at 20 g/plant surpassed the other two tested rates in enhancing the previously mentioned studied traits. Furthermore, cattle manure and humic acid as well as their combinations had positive effects on net profit and investment ratio. Finally, it is preferable to apply cattle manure at 40 kg/plant combined with humic acid at 20 g/plant to enhance growth, yield and fruit quality as well as cladodes nutrients content of El-shamia cactus pear. Besides, cattle manure at 30 kg/plant combined with humic acid at 20 g/plant attained the highest value of total revenue per feddan, net profit per feddan and investment ratio. The effects of cattle manure and humic acid as well as their combinations were cumulative and the second season was better than the first season in productivity and net profit as well as investment ratio.

Keywords: *Opuntia ficus-indica*, cattle manure, humic acid, productivity, nutrients content, cladodes, fruit quality, economic analysis

INTRODUCTION

Opuntia ficus-indica L. is commonly known as cactus pear or prickly pear and it belongs the Cactaceae family. It is one of the most important fruit crops in arid and semi-arid reigns. Cactus pear has high adaptability to

versatile conditions especially drought stress (Nobel, 1994 and Nefzaoui and Ben Salem, 2002). It has good nutritional value so that it used as food and as sources of antioxidants (Asma et al., 2017). Additionally, it plays an important role in feeding ruminant species in arid and semi-arid areas (Arba et al., 2002). Cactus pear fruit has medicinal properties especially in traditional systems from time immemorial (Leem et al., 2016 and Gouws et al., 2019). Cactus pear is one of the crops with a high economic return. It is also used as a barrier fence or as a windbreak and in sand dune stabilization. Cactus pear is cultivated in marginal arid and semi-arid lands where water for irrigation is a limiting factor (Nobel, 1994 and Nefzaoui and Ben Salem, 2002). The most widely grown cultivars of cactus pear in Egypt are El-shamia and Farola cultivars. In Egypt, cactus pears are planted by intensive cultivation system from 300 to 500 plants/feddan in new reclamation soil. The supply of organic manure to the soil improves its chemical, physical and biological properties. Organic manures supply some nutrients for plants as well as the carbon containing compounds are food for microorganisms. Furthermore, organic manure application results in slow release of nutrients compared with chemicals fertilizers and can promote suppression of pathogens (Geense et al., 2015). Manures often improve the structure of soils; they may do this directly through their action as bulky diluents in compacted soils or indirectly when the waste products of animals or microorganisms cement soil particles together. These structural improvements increase the amount of water useful to crops that soil can hold; they also improve aeration and drainage and encourage good root growth by providing enough pores of the right sizes and preventing the soil from becoming too rigid when dry or completely over logged and devoid of air when wet. There are several sources of organic manure, but the most used everywhere are cattle manure, poultry and sheep manure. The increment in the cattle manure doses applied to the soil improves the structural characteristics of the cactus pear and improves its nutritive value (Donato et al., 2016). However, fruit yield can be increased by using horticultural practices such as fertilization (Zegbe et al., 2014). This research is one of the first researches in Egypt, which study the growth and production of cactus pears under the organic fertilization system. And it is the first time to use humic acid in cactus pear orchard. In Egypt, there is not enough information to produce optimal fruit yield of cactus pear under organic fertilization. The research focuses on adding cattle manure as a source of nutrients for plants. Besides, humic acid can raise the efficiency of cattle manure to attempt reaching commercial production under organic production system. Cactus pear is different in its nutritional requirements than other fruit trees; it has a little nutritional requirement. The plant also stores water and nutrients in cladodes. The question is does the organic cactus pear orchard gives profitable commercial production? Besides, manures were found to improve soil biological properties (Chai et al., 1988) and soil fertility leading to increase crop yield (Lal and Mathur, 1989). The use of different doses of

organic manures such as cattle manure as a fertilizer in improving yield and other traits of *Opuntia* spp. have been reported previously. Silva et al. (2016) mentioned that organic manure improved productivity of cactus pear. Moreover, cattle manure application at 60 tons/ha improved growth and it gave the largest thickness, length and width of cladodes of *Opuntia* (Salazar-Sosa et al., 2018). Humic acid is a good natural resource that can be used as an alternative to synthetic fertilizers. Moreover, it reduces the requirement of other fertilizers for crop production. It increases the water holding capacity of soils. It also improves the soil structure and physical properties of soil. Moreover, it is promoting the chelation of many elements and making these available to plants (Biondi et al., 1994). In addition, humic acid reduced water evaporation and increase its use by plants. Fertilization with 60 g/tree humic acid plus 10 g/tree active dry yeast as a soil application increased yield, fruit quality and nutritional status of Aggizy olive (El-Sayed, 2013). Moreover, humic acid caused the highest values of leaf N, P, K and Zn content of Khithary olive cultivar (Mayi and Saeed, 2015). Therefore, the aim of this work was to evaluate the effect of cattle manure rates and humic acid levels as well as their interactions on plant growth, cladodes nutrients content, yield and fruit quality of cactus pear as well as investment ratio of production of El-shamia cactus pear.

MATERIALS AND METHODS

A preliminary experiment was carried out during 2017. This study was conducted during two successive seasons of 2018 and 2019 at orchard located on Abu Ghaleb area, "Cairo-Alexandria desert road" about 50 km from Cairo, Egypt. Eight years old El-shamia cactus pear plants (*Opuntia ficus-indica* L.) grown in sandy soil and spaced 3.5 x 3.0 m apart (about 400 plants/feddan) subjected to drip irrigation system from a well. Physical and chemical analyses of the experimental soil are shown in table (1). Meanwhile, the chemical analyses of the used water for irrigation is recorded in table (2). The plants were thirty-six healthy plants nearly uniform in shape and size and productivity and received the same horticultural practices. The present study was a factorial experiment with two factors; the first factor consisted of 3 rates of cattle manure i.e. 20 kg/plant (200 g/actual nitrogen/plant), 30 kg/plant (300 g/actual nitrogen/plant) and 40 kg/plant (400 g/actual nitrogen/plant) and the second one involved 3 rates of humic acid (0, 10 and 20 g/plant) as soil application. The experiment was designed as a randomized complete block design with four replicates for each treatment and each replicate was represented by one plant. Well decomposed cattle manure was applied in trench application; in the first week of January of both seasons in two trenches (80 cm length x 40 cm width x 30 cm depth), digged on both sides of the plant one meter apart from the plant stem in the direction of irrigation furrows. Humic acid was divided in two equal doses and added at two times, firstly, at

the last week of February, and secondly, after 3 weeks of full blooming, at the first week of May in both seasons under drip irrigation. Chemical analysis of cattle manure is represented in table (3).

Table (1). Analysis of experimental soil in 2018 and 2019 seasons.

Soil depth (cm)	Texture class	pH soil past	E.C (dSm^{-1})	Organic matter %	Soluble cations (meq/l)				soluble anions (meq/l)			
					Ca^{++}	K^{+}	Na^{+}	Mg^{++}	Cl^{-}	$SO_4^{=}$	HCO_3^{-}	$CO_3^{=}$
0-30	Sand	6.9	1.5	0.21	6.7	0.4	4.8	3.5	6.2	7.1	3.1	-
30-60	Sand	7.4	1.2	0.19	1.2	0.2	0.7	0.9	0.7	1.8	0.5	-

Table (2). Chemical analysis of water used for irrigation.

pH	E.C (dSm^{-1})	O.M %	Soluble cations (meq/l)				Soluble anions (meq/l)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
7.1	0.93	0.7	1.60	1.21	6.25	0.28	0	0.20	8.21	0.93

Table (3). Chemical analysis of cattle manure.

N %	P %	K %	Ca %	Mg %	Fe (ppm)	Mn (ppm)	Zn (ppm)
1.0	0.05	0.04	0.25	0.46	124	6.0	1.6

The ordinary fertilization program which was used in each plant with cattle manure was 0.5 kg/plant of triple calcium super phosphate (45% P_2O_5) added with cattle manure in each trench in both seasons of study in the first week of January. Response of cactus pear plants to the two factors and their interaction were evaluated through the following determinations:

1. Vegetative Growth

At the end of September plant height (cm), plant canopy volume (cm^3), cladode length (cm), cladode width (cm), cladode area (cm^2) were measured and recorded.

2. Plant Canopy Volume

Plant canopy volume (m^3) was calculated according to the following formula:

$$\text{Plant canopy volume} = (\pi)\ (\text{tree height})\ (\text{radius}^2)$$

Each tree was measured for crown radius (m) in eight directions (every 45°) beginning with magnetic north, around the entire plant circumference. Radiuses were measured from the center of the trunk with a compass and a plummet placed in the most external point of the profile for each considered direction (Smith et al., 1997). The resulting measurements were summed, and tree canopy volume was determined.

3. Cladodes Area

Cladode area (cm^2) was determined according to Barros et al. (2016).
Cladodes area (cm^2) = cladode length (cm) x cladode width (cm) x 0.693
Where: 0.693 - correction factor for the ellipse shape of the cladode.

4. Cladodes Nutrients Content

Cladode samples were collected for the determination of the contents of macro and micronutrients in the tissue in the end of September. Ten samples of cladodes (with approximately 20 g of mass of cladodes not bearing fruit) were collected from the middle section of the plants per each treatment. Samples were sliced, dried, ground and digested according to Parkinson and Allen (1975). Nitrogen was determined by the micro-kjeldahl method of Bremner (1965). Phosphorus was calorimetrically determined using Spekol spectrophotometer at wavelength 882 UV according to Matt (1968). Potassium was determined by flame-photometer according to Jackson (1958). Calcium and magnesium were determined by titration against versenate solution (Na-EDTA) method as described by Chapman and Pratt (1961). Iron, Manganese and zinc were determined by using the Atomic Absorption Spectrophotometer "GBC 932 AA".

5. Yield

At harvest time yield (kg/tree) per plant was weighed and recorded.

6. Fruit Physical and Chemical Properties

Ten fruits were taken at harvest time from each treated plant for determination of the following physical and chemical properties: fruit weight (g), pulp weight (g) and peel weight (g). Furthermore, total soluble solids (T.S.S.) was determined by Hand refractometer and ascorbic acid (mg ascorbic acid/100 ml juice) according to A.O.A.C. (1995).

7. Economic Analysis

Economic data contained cost items, selling price, total production, amount of treatments and its price. Fixed annual cost (EGP per year), variable costs (EGP per year) were calculated in each treatment. Note: The cactus pear yield are not sold per ton per feddan, but is sold from the orchard on the basis of the number of packages filled with fruits per feddan. It is sold to the consumer as a single fruit. Besides, yield per feddan per each treatment was calculated on the basis of feddan with 400 plants.

The cost of experimental treatments was based on feddan (cactus pear spaced 3.5 x 3.0 m apart, 400 plant/feddan). Sale price of cactus pear at harvest time based on total number of the packages filled with fruits for sale and the package weight of fruits of almost 12 kg.

Total number of package in one ton (1000 kg) = 1000 kg fruits / the package weight (12 kg) = 83.3 packages/one ton of fruits yield.

Total number of package for yield tons/feddan = yield (tons/feddan) x Total number of package in one ton (83.3 packages/one ton).

From this we can get the price of total cactus pear fruits production/feddan.

Total revenue (L.E.)/feddan= (Total number of fruits package for total yield tons/feddan X sale price the package of fruits) and the price of each package was 35 EGP in the first season and 40 EGP in the second season.

For comparison between treatments, approximately net profit (EGP /feddan./year) was calculated according to Heady and Jensen (1961). Income was calculated as:
Total costs (EGP) = total variable costs + total fixed costs
Net profit /feddan = (total revenue from fruits yield sale, EGP /feddan) – (total costs, EGP /feddan).
Thus, it can calculated the investment ratio,
Investment Ratio = (total revenue, EGP / total costs, EGP) according to Johnston (1984) and Heady (1963).

Statistical Analysis

The obtained data in 2018 and 2019 seasons were subjected to analysis of variance according to Clarke and Kempson (1997). Means were differentiated using Range test at the 0.05 level (Duncan, 1955).

RESULTS AND DISCUSSION

1. Plant Height

Data presented in table (4) demonstrate that cattle manure fertilization at 40 kg/plant enhanced plant height more than 30 kg and 20 kg cattle manure/feddan in both seasons, respectively. Moreover, 40 kg cattle manure/plant proved to be superiority in both seasons of study. Generally, humic acid at 20 g/plant enhanced plant height than the two tested treatments. Furthermore, the interaction between cattle manure rates and humic acid concentrations exerted that 40 kg cattle manure/plant plus humic acid at 20 g/plant proved to be the most effective combination in enhancing plant height of El-shamia cactus pear plants. On the contrary, 20 kg cattle manure/plant applied without humic acid gave the lowest values of plant height in both seasons of study.

Table (4). Effect of cattle manure, humic acid and their interactions on plant height (cm) of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
20	130.41 h	136.41 g	143.59 f	136.81 C	131.76 h	137.86 g	145.29 f	138.30 C
30	171.91 e	177.17 d	181.92 b	176.67 B	170.20 e	178.32 c	183.71 b	177.41 B
40	172.37 e	179.38 c	184.38 a	178.71 A	174.58 d	182.64 b	185.92 a	181.05 A
Mean	157.90 C	164.32 B	169.97 A		158.85 C	166.27 B	171.64 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

2. Plant Canopy Volume

Data presented in table (5) indicate that 40 kg cattle manure/plant produced higher plant canopy volume than the two tested rates of cattle manure in both seasons of study. Moreover, humic acid applications at 20 g/plant induced high positive effect on plant canopy volume than the other two

tested concentrations in both seasons. However, the interaction between cattle manure rates and humic acid concentrations showed that combinations of cattle manure rates and humic acid concentrations exerted high positive effect on plant canopy volume in both seasons. Generally, combinations of 40 kg cattle manure/plant with humic acid at 20 g/plant showed superiority in this concern.

Table (5). Effect of cattle manure, humic acid and their interactions on plant canopy volume (m^3) of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
20	2.83 h	3.16 g	3.74 f	3.24 C	3.18 h	3.54 g	4.17 g	3.63 C
30	4.74 e	5.15 d	5.66 c	5.18 B	5.31 e	5.80 d	6.44 c	5.85 B
40	5.65 c	6.10 b	6.55 a	6.10 A	6.38 c	6.89 b	7.41 a	6.89 a
Mean	4.41 C	4.81 B	5.32 A		4.96 C	5.41 B	6.01A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3. Cladodes Length

Table (6) reveals that 40 kg cattle manure/plant produced longer cladodes length than 30 kg and 20 kg cattle manure/plant in both seasons, respectively. However, 20 g humic acid/plant gave higher value of cladodes length than the two tested treatments in both seasons. As for the interaction between cattle manure rates and humic acid concentrations, in the first season, 30 kg cattle manure/plant combined with 20 g humic acid/plant and 40 kg cattle manure/plant combined with 10 g and/or 20 g humic acid/plant had significant similar values of cladodes length and surpassed other tested combinations in this respect. In the second season, 40 kg cattle manure/plant combined with 20 g humic acid/plant showed superiority in this concern.

Table (6). Effect of cattle manure, humic acid and their interactions on cladodes length (cm) of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
20	26.17 f	27.17 e	29.17 d	27.50 C	29.08 f	29.51 f	31.61 e	30.07 B
30	31.88 c	33.21 b	34.21 a	33.10 B	32.08 de	33.51 c	34.61 b	33.40 B
40	32.42 c	34.03 a	34.43 a	33.62 A	32.71 d	34.34 b	37.68 a	34.91 A
Mean	30.15 C	31.47 B	32.60 A		31.29 C	32. 45 B	34.63 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

4. Cladodes Width

Data presented in table (7) illustrate that 40 kg cattle manure/plant gave wider cladodes/plant than 30 kg and 20 kg cattle manure/plant in both seasons, respectively. However, in the first season, humic acid had no significant effect on wider cladodes/plant, but in the second season, 20 g

humic acid/plant gave the highest positive effect on cladode width. Moreover, in the first season, 30 kg cattle manure/plant combined with 20 g humic acid/plant and 40 kg cattle manure/plant applied without humic acid as well as 40 kg cattle manure/plant combined with 10 g and/or 20 g humic acid/plant gave similar and high values as well as surpassed other tested combinations in this respect. In the second season, 40 kg cattle manure/plant combined with 20 g humic acid/plant proved to be the superior treatment in this respect.

Table (7). Effect of cattle manure, humic acid and their interactions on cladodes width (cm) of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
20	12.71 b	13.34 ab	13.84 ab	13.29 B	14.17 f	14.50 ef	14.59def	14.42 C
30	13.41 ab	14.16 ab	14.61 a	14.06 AB	15.17cde	15.21cde	15.92 bc	15.43 B
40	14.08 a	14.51 a	14.81 a	14.62 A	15.37 cd	16.30 ab	17.03 a	16.23 A
Mean	13.55 A	14.00 A	14.42 A		14.90 B	15.34 B	15.84A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

5. Cladodes Area

Data presented in table (8) indicates that cattle manure fertilizer rates significantly increased cladodes area in both seasons of study. Generally, 40 kg cattle manure/plant proved to be the superior treatment in this concern. Moreover, humic acid doses significantly increased cladodes area in both seasons of study. Shortly, in the first season, 10 g and 20 g humic acid/plant gave similar and high positive effect on cladodes area. In the second season, 20 g humic acid/plant showed superiority in this concern. Furthermore, the interaction between cattle manure rates and humic acid concentrations showed that in the first season 30 kg cattle manure/plant combined with 20 g humic acid/plant and 40 kg cattle manure/plant combined with 10 g humic acid/plant as well as 40 kg cattle manure/plant plus 20 g humic acid/plant gave similar and the highest values of cladodes area. Generally, in the second season, 40 kg cattle manure/plant combined with 20 g humic acid/plant proved to be the superior application in this concern.

Table (8). Effect of cattle manure, humic acid and their interactions on cladodes area (cm^2) of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
20	230.30 e	251.08 de	280.02 cd	253.80 C	285.63 e	296.78 e	319.64 d	300.68 C
30	296.34 bc	326.15 ab	346.30 a	323.04 B	337.33 cd	353.25 c	382.11 b	357.56 B
40	326.60 ab	342.49 a	353.42 a	340.84 A	348.48 c	388.31 b	444.82 a	393.87 A
Mean	284.41 B	306.57 A	326.69 A		323.81 C	346.11 B	382.19 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

The improved effect of cattle manure on vegetative growth of cactus pear may be attributed to the fact that manure often improve the structure of soil, this structural improvement increases the amount of water useful to crops that soils can hold; they also improve aeration and drainage and encourage good root growth. Consequently, the positive effects of cattle manure on growth may be due to its prospective physical effects on soil conditions, and the nutrients it supplies and as well as the way it supplies the nutrients (Donato et al., 2016). In addition, organic manure increases the soil content of IAA and cytokinins and stimulates plant growth (Li et al., 1998). All of these improvements reflected on enhancement vegetative growth and root system growth of cactus pear. The results of cattle manure in enhancing plant vegetative growth are confirmed by the findings of Donato et al. (2016) and Silva et al. (2016) on cactus pear. The enhancement effect of humic acid on vegetative growth may be attributed to that humic acid plays important roles on plants through stimulation of root growth and increase of water and nutrient uptake by vegetable crops (Cimrin and Yilmaz, 2005). Moreover, it stimulates plant growth through accelerated cell division and enhances the uptake of nutrients and water (Chen et al., 2004 and Hussein and Hassan, 2011) and humic acid has similar effect like IAA on plants in this concern (O'Donnell, 1973). These mechanisms refer to the influence of humic acid on plants in addition to its influence on soil fertility are also very important (Nardi et al., 2002 and Fahramand et al., 2014). It happens through the improvement of soil physical, chemical, and biological properties (Nardi et al., 2002 and Mikkelsen, 2005) that increase water holding capacity (McDonnell et al., 2001). Humic acid is used for soil reclamation purposes (Pettit, 2004). All of these reflected in increasing photosynthesis rate and in this way improving growth parameters. The obtained results of humic acid treatments concerning vegetative growth are in harmony with the findings of Mayi et al. (2014). They showed that application of humic acid stimulates growth in olive. Moreover, humic acid soil application improved vegetative growth of apricot (Fathy et al., 2010) and this was confirmed by Eissa et al. (2007) on peach and apricot. The obtained results of interaction between manure and humic acid on vegetative growth are in harmony with the findings of Razavi-Nasab et al. (2019) on pistachio.

6. Cladodes Macro-nutrients Content

Data reported in table (9) mention that increasing in cattle manure rates led to increasing cladodes nitrogen and phosphorus contents of El-shamia cactus pear plants in both seasons. Generally, 40 kg cattle manure/plant proved to be the superior rate in this concern. Both 40 kg cattle manure/plant and 30 kg cattle manure/plant gave similar and high positive effect on cladodes potassium, calcium and magnesium contents than 20 kg cattle manure/plant in both seasons. Moreover, 20 g humic acid/plant gave the highest cladodes nitrogen, phosphorus, potassium, calcium and magnesium

contents than the two tested concentrations in the two seasons. Furthermore, the interaction between cattle manure rates and humic acid concentrations showed that 40 kg cattle manure/plant combined with 20 g humic acid/plant enhanced cladodes nitrogen, phosphorus, potassium, calcium and magnesium contents against for 20 kg cattle manure/plant applied without humic acid/plant in both seasons, respectively. Other tested combinations gave intermediate values in this concern.

Table (9). Effect of cattle manure, humic acid and their interactions on some cladodes macro-nutrients content of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
Nitrogen content (%)								
20	0.46 f	0.52 e	0.60 d	0.52 C	0.56 h	0.62 g	0.71 f	0.63 C
30	0.63 bc	0.65 bc	0.65 bc	0.64 B	0.73 e	0.74 d	0.76 c	0.74 B
40	0.67 bc	0.68 ab	0.70 a	0.68 A	0.77 c	0.81 b	0.83 a	0.81 A
Mean	0.58 C	0.62B	0.65 A		0.68 C	0.75 B	0.76 A	
Phosphours content (%)								
20	0.10 g	0.14 f	0.16 e	0.13 C	0.11 i	0.16 h	0.18 g	0.15 C
30	0.18 d	0.18 d	0.19 d	0.18 B	0.20 f	0.22 e	0.23 d	0.22 B
40	0.21 c	0.23 b	0.24 a	0.23 A	0.24 c	0.26 b	0.27 a	0.26 A
Mean	0.16 C	0.18 B	0.19 A		0.18 C	0.21 B	0.22 A	
Potassium content (%)								
20	2.50 d	2.50 d	2.61 c	2.53 B	2.61 g	2.65 f	2.67 e	2.64 B
30	2.54 c	2.58 b	2.61 a	2.57 A	2.70 d	2.74 b	2.76 a	2.73 A
40	2.54 c	2.58 b	2.61 a	2.58 A	2.71 cd	2.73 bc	2.76 a	2.74 A
Mean	2.52 C	2.55 B	2.61 A		2.67 C	2.70 B	2.73 A	
Calcium content (%)								
20	5.59 c	5.71 b	5.81 a	5.70 A	6.35 e	6.41 d	6.46 d	6.40 B
30	5.61 c	5.73 b	5.82 a	5.72 A	6.95 c	7.07 b	7.16 a	7.06 A
40	5.61 c	5.70 b	5.87 a	5.73 A	6.95 c	7.04 b	7.21 a	7.07 A
Mean	5.60 C	5.71 B	5.83 A		6.75 C	6.84 B	6.94 A	
Magnesium content (%)								
20	0.83 g	0.84 f	0.86 e	0.84 B	0.88 f	0.89 e	0.91 d	0.89 B
30	0.88 d	0.90 b	0.91 ab	0.90 A	0.95 c	0.98 b	1.00 a	0.98 A
40	0.89 c	0.89 c	0.91 a	0.90 A	0.98 b	0.98 b	1.00 a	0.98 A
Mean	0.87 C	0.88 B	0.89 A		0.94 C	0.95 B	0.97 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

7. Cladodes Micro-nutrients Content

It is obvious from table (10) that both 30 kg and 40 kg cattle manure/plant had significantly similar effect on increasing cladodes iron content than 20 kg cattle manure/plant in both seasons. However, cattle manure rates failed to induce any significant effect on cladodes manganese

content in both seasons. Increasing cattle manure rates led to increasing cladodes zinc content of El-shamia cactus pear plants in both seasons. Moreover, 20 g humic acid/plant exerted the highest cladodes iron and manganese contents than the other two tested concentrations of humic acid in both seasons. This concentration proved to be the superior treatment in this concern, but humic acid treatments failed to induce any significant effect on cladodes zinc content in both seasons. Furthermore, the interaction between the two tested factors indicated that 40 kg cattle manure/plant combined with 20 g humic acid/plant proved to be the best combination on iron manganese and zinc contents in the two seasons. Other combinations gave intermediate values in this respect.

Table (10). Effect of cattle manure, humic acid and their interactions on some cladodes micro-nutrients content of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
				Iron content (%)				
20	39.82 d	41.01 cd	42.77 bc	41.20 B	40.94 d	42.13 cd	43.89 bc	42.32 B
30	43.48 bc	44.06 abc	44.80 ab	44.11 A	44.60 abc	45.38 ab	46.23 ab	45.40 A
40	45.33 ab	45.51 ab	46.71 a	45.85 A	46.87 ab	46.93 ab	46.98 a	46.92 A
Mean	42.87 B	43.52 AB	44.76 A		44.13 B	44.81 AB	45.70 A	
				Manganese (ppm)				
20	515.24 c	560.60 b	565.65 a	547.16 A	515.28 c	560.68 b	565.73 a	547.24 A
30	515.13 c	560.59 b	566.45 a	547.39 A	516.35 c	560.68 b	566.39 a	547.77 A
40	515.12 c	560.57 b	566.53 a	547.41 A	516.35 c	561.72 b	566.68 a	548.25 A
Mean	515.17 C	560.59 B	566.21 A		515.95 C	561.40 B	566.27 A	
				Zinc content (%)				
20	15.33 d	16.02 cd	16.67 bcd	16.00 C	15.94 d	16.63 cd	17.29 bcd	16.62 C
30	17.09 abc	17.29 abc	17.40 abc	17.26 B	17.62 abc	17.68 abc	18.15 ab	17.81 B
40	17.82 ab	18.42 a	18.46 a	18.23 A	18.53 ab	18.56 ab	18.90 a	18.67 A
Mean	16.74 A	17.24 A	17.51 A		17.36 A	17.62 A	18.11 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level

The improvement in cladodes nutrients content may be attributed to firstly, cattle manure positive effect on physical conditions of the soil that creates favourable conditions for root growth and nutrients absorption; it supplies many nutrients, and it facilitates the absorption of fixed nutrients by plant roots (Donato et al., 2016). Secondly, manure increases the cation exchange (CEC) of the medium, which made cationic nutrients become available to roots. That reflected on enhancement of cladodes growth and root system growth in cactus pear (Matallo et al., 2002). The addition of organic manure to the soil promotes greater mobility of soluble organic forms of nutrients in the soil compared with the applications in the form of mineral

fertilizers. Therefore, a higher concentration of nutrients in the soil allowed greater absorption and a probable higher accumulation in the cladodes (Souza et al., 2006 and Novais et al., 2007). Moreover, the greater absorption is due to the higher availability of nutrients from the manure because manure reduces the acidity and makes nutrients more available (Caetano and Carvalho, 2006). The results of cattle manure in enhancing cladodes nutrients content are confirmed by the findings of Donato et al. (2016), who found that the increment in the cattle manure rates applied to the soil improves cladodes nutrients content of the cactus pear. Moreover, Donato et al. (2016) reported that the increase in cattle manure doses increases the contents of phosphorus, nitrogen, potassium and sulfur in the cladodes of cactus pear. In addition, the increase in N, P and K contents in the cladodes of cactus pear due to the increment in the manure doses applied to the soil is expected, because approximately 95% of soil N is associated with the organic matter and 50% of P in the biosphere is found in organic forms (Novais et al., 2007 and Dubeux et al., 2010). The improvement of humic acid on cladodes nutrients content may be attributed that application of humic acid stimulates the absorption of nutrients through stimulating root growth and increases the rate of absorption of nutrients on root surfaces as well as their penetration into the cells of the plant tissue (Varanini and Pinton, 2001 and Vaccaro et al., 2009). Besides, humic acid has similar effect like cytokinin and gibberellin on olive and pear trees (Fawzi et al., 2007). Moreover, humic acid has similar effect like IAA in plants (Nardi et al., 2002). The obtained results of humic acid application on cladodes nutrients content are in harmony with the findings of Salama et al. (2020) on pomegranate trees and Razavi-Nasab et al. (2019) on pistachio. Besides, Danyaei et al. (2017) found that humic acid application enhanced leaf N, P, K, Fe, Mn, Zn and Cu content of olive. The obtained results of interaction between manure and humic acid on cladodes nutrients content go in line with the findings of Barakat et al. (2012) on Newhall navel orange and Razavi-Nasab et al. (2019) on pistachio.

8. Yield

It is clear from table (11) indicates that cattle manure rates succeeded in improving fruit yield (kg/plant) in both seasons. Generally, in the first season, 30 kg and 40 kg cattle manure/plant were significantly similar in increasing the yield than 20 kg cattle manure/plant. Whereas, in the second season, 40 kg cattle manure/plant induced high positive effect on fruit yield than the two tested rates. Furthermore, humic acid at 20 g humic acid/plant succeeded in improving fruit yield and surpassed other concentrations in both seasons. The interaction between the two tested factors showed that cattle manure rates combined with humic acid concentrations succeeded in improving fruit yield in both seasons. Generally, 30 kg and/or 40 kg cattle manure/plant combined with 20 g humic acid/plant gave similar and high

positive effect on fruit yield than the other tested combinations in both seasons.

Table (11). Effect of cattle manure, humic acid and their interactions on yield (kg/plant) and some fruit quality of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
				Yield (kg/plant)				
20	11.88 f	15.38 e	18.38 f	15.21 B	14.17 f	18.11 e	21.18 d	17.82 C
30	21.73 c	26.18 b	32.50 a	26.80 A	22.57 cd	27.35 b	33.93 a	27.95 B
40	22.04 c	26.73 b	33.12 a	27.30 A	23.68 c	27.68 b	34.36 a	28.57 A
Mean	18.55 C	22.76 B	28.00 A		20.14 C	24.38 B	29.83 A	
				Fruit weight (g)				
20	123.00 e	133.46 d	133.30 d	130.03 A	126.10 g	138.53 f	142.73 e	135.79 C
30	133.82 d	135.80 c	137.65 b	135.76 B	145.50 d	147.12 c	149.67 b	147.43 B
40	135.85 c	136.17 bc	139.40 a	137.14 A	147.00 cd	149.33 b	154.31 a	150.21 A
Mean	130.89 C	135.20 B	136.84 A		139.53 C	144.99 B	148.90 A	
				Peel weight (g)				
20	51.39 g	52.45 fg	53.00 ef	52.28 C	53.53 g	54.27 fg	54.74 ef	54.18 C
30	54.26 de	54.65 cd	55.47 bcd	54.79 B	55.43 e	56.68 d	58.91 b	57.01 B
40	55.71 bc	56.61 b	58.05 a	56.79 A	56.67 d	57.70 c	59.84 a	58.07 A
Mean	53.79 C	54.57 B	55.51 A		55.21 C	56.21 B	57.83 A	
				Pulp weight (g)				
20	71.31 d	80.52 b	80.28 b	77.37 C	72.56 e	84.46 d	87.77 c	81.60 C
30	77.96 c	80.52 b	81.50 b	79.99 B	90.22 b	89.51 bc	90.06 b	89.93 B
40	81.07 b	81.95 b	83.56 a	82.19 A	90.22 b	91.70 b	94.76 a	92.22 A
Mean	76.78 B	80.99 A	81.78 A		84.33 C	88.55 B	90.86 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

The obtained results on the effect of cattle manure on yield are in harmony with the findings of Silva et al. (2016) on cactus pear. The improvement of humic acid application on yield may be attributed to that humic acid has similar effect like auxins and increasing nutrient uptake (Nardi et al., 2002). On the other hand, humic acid improved growth parameters and accumulation of all the macro and microelement in the fruit (Abdel Fatah et al., 2008). Those results were associated to the enhancement of yield. The obtained results regarding the effect of humic acid on yield go in line with the findings of Olyaie Torshiz et al. (2017) on pomegranate. In addition, El-Sayed. (2013) found that humic acid application improved yield of Aggizy olive trees. The obtained results of interaction between manure and humic acid on yield go in line with the findings of Mansour (2018) on pomegranate.

9. Fruit Quality

9.1. Fruit weight

It is clear from table (11) that increasing cattle manure rates increased fruit weight (g) in both seasons. Moreover, 40 kg cattle manure/plant had significantly increased fruit weight than 20 kg and 30 kg cattle manure/plant and proved to be the superior rate in both seasons. However, humic acid treatments increased fruit weight than the two tested concentrations in both seasons. However, 20 g humic acid/plant gave the highest values of fruit weight in both seasons. Furthermore, the interaction between the two tested factors showed that 40 kg cattle manure/plant combined with 20 g humic acid/plant gave the highest fruit weight and surpassed other combinations in both seasons.

9.2. Peel weight

Table (11) illustrates that 40 kg cattle manure/plant produced the highest values of peel weight (g), followed by 30 kg cattle manure/plant and 20 kg cattle manure/plant in both seasons, respectively. Moreover, humic acid at 20 g/plant exerted high positive effect on peel weight and surpassed other tested rates in both seasons. On the other hand, the interaction between the two tested factors showed that 40 kg cattle manure/plant combined with 20 g humic acid/plant gave the highest values of peel weight and surpassed other tested combinations in both seasons. Other tested combinations gave intermediate values in this concern.

9.3. Pulp weight

Table (11) reveals that 40 kg cattle manure/plant gave high pulp weight (g) than the two tested rates in both seasons. Moreover, in the first seasons, 20 g humic acid/plant and 10 g humic acid/plant exerted similar and significant effect of pulp weight as compared without humic acid. Moreover, in the second season, 20 g humic acid/plant gave the highest values of pulp weight. The interaction between the two tested factors gave a pronounced effect on pulp weight in both seasons. Generally, 40 kg cattle manure/plant combined with 20 g humic acid/plant surpassed other tested combinations. Other tested combinations gave intermediate values in this concern.

9.4. Fruit T.S.S.

It is clear from table (12) illustrates that 40 kg cattle manure/plant exerted the highest value of TSS (%) as compared with 30 kg and 40 kg cattle manure/plant in both seasons. Furthermore, humic acid concentrations increased T.S.S. Humic acid at 20 g /plant surpassed other tested concentrations in both seasons. Moreover, 40 kg cattle manure/plant combined with 20 g humic acid/plant gave the highest values of T.S.S. and surpassed other combinations in both seasons.

Table (12). Effect of cattle manure, humic acid and their interactions on fruit T.S.S. and ascorbic content (mg/ 100 ml juice) of El-shamia cactus pear plants (2018 and 2019 seasons).

Cattle manure (kg/plant)	2018				2019			
	Humic acid (g/plant)				Humic acid (g/plant)			
	0	10	20	Mean	0	10	20	Mean
	Fruit T.S.S.							
20	8.45 e	8.48 d	8.49 cd	8.47 C	8.36 d	8.59 c	8.61 bc	8.52 C
30	8.49 cd	8.51 bcd	8.52 bc	8.50 B	8.61 bc	8.61 bc	8.62 b	8.61 B
40	8.53 b	8.54 b	8.57 a	8.54 A	8.63 ab	8.63 ab	8.66 a	8.64 A
Mean	8.49 C	8.51 B	8.52 A		8.53 C	8.61 B	8.63 A	
	Acid content (mg/ 100 ml juice)							
20	14.43 f	14.52 e	14.78 d	14.58 B	15.35 g	15.40 f	15.41 f	15.38 C
30	15.13 c	15.41 ab	15.39 ab	15.31 A	16.70 e	16.73 d	16.76 c	16.37 B
40	15.21 c	15.36 b	15.45 a	15.34 A	16.80 b	16.82 b	16.85 a	16.28 A
Mean	14.92 C	15.09 B	15.20 A		16.28 C	16.31 B	16.34 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

9.5. Fruit ascorbic acid content

It is clear from table (12) that in the first season, 30 kg and 40 kg cattle manure/plant gave similar and high positive effect on fruit ascorbic acid content (mg ascorbic acid/100 ml juice) as compared with 20 kg cattle manure/feddan. Whereas, in the second season, 40 kg cattle manure/plant exerted high positive effect on ascorbic acid and proved to be the superior treatment in this respect. Moreover, humic acid concentrations induced high positive effect on ascorbic acid in both seasons. Generally, 20 g humic acid/plant gave the highest values of fruit ascorbic acid content in both seasons. However, the interaction between the two tested factors showed that cattle manure rates combined with humic acid concentrations succeeded in increasing ascorbic acid content in both seasons. Generally, 40 kg cattle manure/plant combined with 20 g humic acid/plant induced high positive effect on fruit ascorbic acid content and surpassed other combinations.

The improvement in fruit quality may be attributed to that cattle manure enhanced cladodes growth and root system growth in cactus pear (Matallo et al., 2002). The addition of organic manure to the soil induced high concentrations of nutrients in the soil and allowed greater absorption and probable high accumulation in the cladodes (Souza et al., 2006 and Novais et al., 2007). Also, the stimulation effect of cattle manure on absorbed nutrients reflected on photosynthesis process then produced more carbohydrates which certainly reflected positively on the fruit quality (Hegazi et al., 2007). Those led to improve fruit quality of cactus pear.

The results of cattle manure on improving fruit quality are confirmed by the findings of Mansour (2018) on pomegranate. The improved effect of humic acids on fruit quality may be attributed to that humic acid stimulates plant growth and consequently fruit quality through accelerating cell division

and it enhances the uptake of nutrients and water (Chen et al., 2004; Abdel Fatah et al., 2008 and Hussein and Hassan, 2011) and humic acid has similar effect like IAA on plants in this concern (Nardi et al., 2002), subsequently, it improves fruit quality. The obtained results of humic acid on improving fruit quality are in agreement with the findings of Abbas et al. (2013) on mandarin; Olyaie Torshiz et al. (2017) and Salama et al. (2020) on pomegranate. The obtained results of the interaction between manure and humic acid on fruit quality go in line with the findings of Mansour (2018) on pomegranate.

10. Economic Analysis

The final aim of any horticultural practices is to get profitable from the invested cost. The agricultural process is mainly economic if the net gain of each EGP gave the highest rate of revenue. Table (13) indicates that the calculation of fixed costs for one feddan of cactus pear plants were 12760 EGP in the first season and 12800 EGP in the second season.

Table (13). Fixed costs (EGP/feddan) for El-shamia cactus pear production (2018 and 2019 seasons).

Items	Unit	Counts	2018		2019	
			Unit cost (EGP)	Total (EGP)	Unit cost (EGP)	Total (EGP)
Calcium Super phosphate	50 kg	4	100	400	100	400
Sulfur agriculture	45 kg	3	50	150	60	180
Land prepared for add organic and humic fertilizers				1000		1000
Pesticides	Liter	1	130	130	140	140
Gasoline for Irrigation	Liter /season	80	7.25	580	7.25	580
Labor cost						
Humic fertilizers add	Worker/day	2	150	300	150	300
Seasonal labor	Worker/day	4	150	600	150	600
Pesticides	Worker/day	2	150	300	150	300
Plants pruning	Worker/day	2	150	300	150	300
Labor for irrigation and guard orchard	Salary/ season	12 months	700	8400	700	8400
Harvest	Worker/day	4	150	600	150	600
Total				12760		12800

Table (14) indicates that cattle manure rates increased total variable costs in both seasons of study. Generally, cattle manure at 40 kg/plant gave higher variable costs of 18360 and 18400 EGP, followed by cattle manure at 30 kg/plant (16960 and 17000 EGP), then cattle manure at 20 kg/plant (15560 and 15600 EGP) in both seasons, respectively. Moreover, 20 g humic acid/plant gave the highest total variable costs in both seasons. Furthermore, the interaction between cattle manure rates and humic acid rates showed that cattle manure at 40 kg/plant combined with humic acid at 20 g/plant increased total variable costs and scored 18760 and 18800 EGP against 15560 and 15600

EGP for cattle manure at 20 kg/plant combined with humic acid at zero g/plant in both seasons, respectively.

Table (14). The total variable costs and total costs (sum of fixed and variable) for all treatments of El-shamia cactus pear plants (2018 and 2019 seasons).

Treatments	Counts	Unit	Unit cost (EGP)	2018		2019	
				Total variable (EGP)	Total costs (EGP)	Total variable (EGP)	Total costs (EGP)
Specific effect of cattle manure rates							
20 kg/plant	M^3/fed	8	350	2800	15560	2800	15600
30 kg/plant	M^3/fed	12	350	4200	16960	4200	17000
40 kg/plant	M^3/fed	16	350	5600	18360	5600	18400
Specific effect of humic acid rates							
0 g/plant	kg/fed	0	-	-	12760	-	12800
10 g/plant	kg/fed	4	50	200	12960	200	13000
20 g/plant	kg/fed	8	50	400	13160	400	13200
Interaction between cattle manure and humic acid							
20 kg/plant + 0 g/plant	-	-	-	-	15560		15600
20 kg/plant + 10 g/plant	-	-	-	-	15760		15800
20 kg/plant + 20 g/plant	-	-	-	-	15960		16000
30 kg/plant + 0 g/plant	-	-	-	-	16960		17000
30 kg/plant + 10 g/plant	-	-	-	-	17160		17200
30 kg/plant + 20 g/plant	-	-	-	-	17360		17400
40 kg/plant + 0 g/plant	-	-	-	-	18360		18400
40 kg/plant + 10g/plant	-	-	-	-	18560		18600
40 kg/plant + 20 g/plant	-	-	-	-	18760		18800

Table (15) indicates that cattle manure rates increased total number of fruits packages for sale which induced high total revenue in both seasons of study. Generally, cattle manure at 40 kg/plant gave higher total number of fruits packages that increased total revenue and scored 31850 and 38093 EGP, followed by cattle manure at 30 kg/plant that scored 31267 and 37267 EGP, then cattle manure at 20 kg/plant (17745 and 23760 EGP) in both seasons, respectively. Moreover, humic acid at 20 g/plant increased total number of fruit packages sale and it gave the highest total revenue in both seasons. Furthermore, interaction between cattle manure rates and humic acid rates showed that cattle manure at 40 kg/plant combined with humic acid at 20 g/plant increased total number of fruits packages sale that increased total revenue and scored (38640 and 45813 EGP against 13860 and 18893 EGP) for cattle manure at 20 kg/plant combined with humic acid at zero g/plant in both seasons, respectively.

Table (15). Yield (ton) per feddan and the total revenue (EGP) for all treatments of El-shamia cactus pear plants (2018 and 2019 seasons).

Treatments	2018			2019		
	Yield tons/fed	Total no. of packages for yield	Total revenue (EGP)	Yield tons/fed	Total no. of packages for yield	Total revenue (EGP)
Specific effect of cattle manure rates						
20 kg/plant	6.08	507.0	17745	7.13	594.0	23760
30 kg/plant	10.72	893.3	31267	11.18	931.7	37267
40 kg/plant	10.92	910.0	31850	11.43	952.3	38093
Specific effect of humic acid rates						
0 g/plant	7.42	618.3	21642	8.06	671.3	26853
10 g/plant	9.10	758.7	26553	9.75	812.7	32507
20 g/plant	11.20	933.3	32667	11.93	994.3	39773
Interaction between cattle manure and humic acid						
20 kg/plant + 0 g/plant	4.75	396.0	13860	5.67	472.3	18893
20 kg/plant + 10 g/plant	6.15	512.7	17943	7.24	603.7	24147
20 kg/plant + 20 g/plant	7.35	612.7	21443	8.47	706.0	28240
30 kg/plant + 0 g/plant	8.69	724.3	25352	9.03	752.3	30093
30 kg/plant + 10 g/plant	10.47	872.7	30543	10.94	911.7	36467
30 kg/plant + 20 g/plant	13.00	1083.3	37917	13.57	1131.0	45240
40 kg/plant + 0 g/plant	8.82	734.7	25713	9.47	789.3	31573
40 kg/plant + 10 g/plant	10.69	891.0	31185	11.07	922.7	36907
40 kg/plant + 20 g/plant	13.25	1104.0	38640	13.74	1145.3	45813

Obtained results in table (16) illustrate that cattle manure at 30 kg/plant gave the highest value of net profit and investment ratio more than the two rates of cattle manure in both seasons. Moreover, humic acid at 20 g/plant increased net profit and investment ratio than the two rates in both seasons. The interaction between cattle manure rates and humic acid rates showed that cattle manure at 30 kg/plant combined with humic acid at 20 g/plant gave the highest value of net profit and investment ratio. Besides, in the first season, cattle manure at 20 kg/plant combined with humic acid at zero g/plant showed that the total net profit was reduced and it looser.

Table (16). Net profit and investment ratio for all treatments of El-shamia cactus pear plants (2018 and 2019 seasons).

Treatments	2018		2019	
	Net profit (EGP/ fed)	Investment ratio	Net profit (EGP/ fed)	Investment ratio
Specific effect of cattle manure rates				
20 kg/plant	2185.0	8160.0	1.140	1.523
30 kg/plant	14306.7	20266.7	1.844	2.192
40 kg/plant	13490.0	19693.3	1.735	2.070
Specific effect of humic acid rates				
0 g/plant	8881.7	14053.3	1.696	2.000
10 g/plant	13593.3	19506.7	2.049	2.501
20 g/plant	19506.7	26573.3	2.482	3.013
Interaction between cattle manure and humic acid				
20 kg/plant + 0 g/plant	-1700.0	3293.3	0.891	1.211
20 kg/plant + 10 g/plant	2183.3	8346.7	1.139	1.528
20 kg/plant + 20 g/plant	5483.3	12240.0	1.344	1.765
30 kg/plant + 0 g/plant	8391.7	13093.3	1.495	1.770
30 kg/plant + 10 g/plant	13383.3	19266.7	1.780	2.120
30 kg/plant + 20 g/plant	20556.7	27840.0	2.184	2.600
40 kg/plant + 0 g/plant	7353.3	13173.3	1.401	1.716
40 kg/plant + 10 g/plant	12625.0	18306.7	1.680	1.984
40 kg/plant + 20 g/plant	19880.0	27013.0	2.060	2.437

CONCLUSION

Shortly, cattle manure at 40 kg/plant combined with humic acid at 20 g/plant induced the highest positive effect on El-shamia cactus pear plant growth, yield and fruit quality traits as well as cladodes nutrients content. The increment in productivity is an economic important factor for farmers and the improvement of fruit quality is important to consumers. Economic study recommended that the cattle manure at 30 kg/plant combined with humic acid at 20 g/plant is the best treatment to improve the El-shamia cactus pear production and fruit quality as well as raising the net income of farmer, which reflect positively on farmers cultivated cactus pear in Egypt.

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تأثير السماد العضوي وحمض الهيوميك على إنتاج وجودة ثمار التين الشوكي

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أجريت تجربة حقلية خلال موسمي ٢٠١٨ و٢٠١٩ في بستان نباتات التين الشوكي صنف الشامية، عمرها ثماني سنوات ومزروعة في تربة رملية تحت نظام الري بالتنقيط. تروى من بئر بمنطقة أبو غالب بطريق "القاهرة - الإسكندرية الصحراوي" على بعد حوالي ٥٠ كم من القاهرة، مصر. لدراسة تأثير سماد الماشية بمعدلات ٢٠، ٣٠ و٤٠ كجم/نبات، وحمض الهيوميك بثلاث معدلات هي ٠، ١٠و٢٠ جم/نبات بالإضافة إلى تفاعلاتهما على النمو ومحتوى الكفوف من المغذيات والمحصول وجودة الثمار بالإضافة إلى نسبة الإستثمار للتين الشوكي صنف الشامية. أظهرت النتائج أن زيادة معدل إضافة سماد الماشية أدى إلى زيادة تدريجية للنمو ومحتوى الكفوف من المغذيات والمحصول وصفات جودة الثمار. علاوة على ذلك، تجاوز حمض الهيوميك بمعدل ٢٠ جم/نبات المعدلين الأخريين في تحسين الصفات المذكورة سابقًا. علاوة على ذلك، كان لسماد الماشية وحمض الهيوميك بالإضافة إلى تفاعلاتهما تأثير إيجابي على صافي الربح ونسبة الإستثمار. أخيرًا، يفضل إستخدام سماد الماشية بمعدل ٤٠ كجم/نبات مع حمض الهيوميك بمعدل ٢٠ جم/نبات لزيادة النمو والمحصول وجودة الثمار بالإضافة إلى محتوى الكفوف من المغذيات في التين الشوكي صنف الشامية. إلى جانب ذلك، حقق سماد الماشية بمعدل ٣٠ كجم/نبات مع حمض الهيوميك بمعدل ٢٠ جم/نبات أعلى قيمة لإجمالي الإيرادات للفدان وصافي الربح للفدان ونسبة الاستثمار. وكان تأثير سماد الماشية وحمض الهيوميك وتفاعلاتهما أثر تراكمي وكان الموسم الثاني أفضل من الموسم الأول في الإنتاجية وصافي الربح وكذلك نسبة الإستثمار.