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Growth and Ultimate Size of cactus pear *Opuntia ficus-indica* Fruit following Fruit Thinning in a semi-arid area

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Abstract

The aim of this work was to study the effect of fruit thinning on fruit yield and quality of cactus pear. To meet this objective, trials on fruit thinning were conducted on an adult plantation of cactus pear *Opuntia ficus-indica*. cv 'Cristalina' 10 years old at the research farm at Sohag University in Kawthar area, where semi-arid climatic condition is conducted. The fruit thinning consisted of reducing the fruit load of overcharged cladodes by reducing the number of fruits to 4, 8 and 12 per cladode. We established a cladode load and thinning time that maximized fruit and flesh size in cactus pear. It was practiced in mid-March month by removing some floral buds at the flowering stage. The control cladodes had an average number of 18 fruits per cladode. Obtained results showed that the reduction in the load of cladodes improved fruit size and quality. Fruit and flesh weight increased with thinning. Heavier thinning (4 per cladode) causes increase of fruit or flesh weight but it is less economically feasible due to the small number of total fruits per feddan. Percent flesh affected by thinning. Fruit characteristics, such as total soluble solids concentration and seed content change with thinning. But the best economic return was with 8 fruit because of the high price of selling per fruit and the yield per acre compared to the rest of the treatments and control. In 8 fruits per cladode thinned plants as the best obtained seasons' results, an average fruit weight was 189.74 g and average fruit length and diameter was 9.81 and 7.34 cm, respectively. Regarding to untreated plants (control), an average of the fruit weight was only 105.28 g and average fruit length and diameter was 7.88 and 6.16 cm, respectively as the best obtained seasons' results. Thinning treatment affected the total sugar significantly. The number of seeds was affected by thinning treatments whereas in T3 (4 fruits), T2 (8 fruits) T1 (12 fruits) and Control, respectively, while depending on the distribution of seeds through the fruit pulp is favorable in T3 (4 fruits) than other thinning. Fruit thinning also improved the economic income of the yield.

Keywords: Cactus Pear, Fruit Thinning, Fruit Quality, Fruit Yield.

INTRODUCTION

Opuntias are typical species that are perfectly suited to the development of arid and semi-arid regions thanks to their adaptation to drought and their use in human and animal nutrition. Their culture is not very demanding in water and investments and the income they can generate is important. Cactus pear is considered one of the pillars of the local economy of the arid and semi-arid regions. In the southern Mediterranean countries, as in Egypt, the most plantations of cactus pear are traditional and don't benefit from cultivation practices. The yield is low and the fruits are often of small size and low quality (not very juicy and tasty). However, cultivation techniques which can improve fruit quality, mainly fruit thinning by reducing the fruit load of cladodes, are the practices which are decisive in the marketing of the crop yield. What will improve the market value of the crop and the economic income of the farmers and rural populations of the arid and semi-arid regions. The aim of this work was to study the effect of fruit thinning on the improvement of fruit yield and quality of cactus pear and to evaluate the economic income of this thinning operation for the farmers.

Several authors reported that the improvement of fruit yield and quality of cactus pear requires appropriate technical management of the orchard, especially the fruit load of cladodes and parameters related to the fruit, such as fruit size, the edible fresh matter content and the organoleptic components of the fruit (Sulé et al. 2002; Ochoa, 2003; Barbara, 2007; Mora et al. 2011; Migliore, 2015). A fruit size of 120 g weight is a positive attribute for the marketing of cactus pear fruits. The seed content in the fruit and the fruit peel thickness also has an impact on the marketing of fruits (Mokoboki et al. 2009; FIA, 2010). Cactus pear fruits can be of good quality when they have criteria which are requested by the producer and the consumer, such as fruit size, taste (flavor and sugar content or °Brix > 15) and edible fresh matter (De, et al. 2010). The selling price of the fruits on the local market could be interesting by improving fruit quality using cultivation practices, mainly fruit thinning (Migliore, 2015; Timpanaro et al. 2017). Several authors also reported that fruit size of cactus pear depends on the cultivar, water availability, plant mineral nutrition and fruit load of the cladodes (Barbera et al. 1992; Inglese et al. 1995; Ochoa et al. 2002; Potgieter, 2007; Zegbe and Mena 2010).

Most of emitted flowers by cactus pear are transformed into fruits, and in a year of high production, the cladodes are too heavy and if this load is not reduced by thinning, the fruits are of small size and the cladodes can be damaged (FAO, 2018). In cactus pear, the emission of floral buds is often done on one year old cladodes, on the upper half part of the cladodes. Terminal and peripheral cladodes on the plant are the most fertile because they are well exposed to the sun (Inglese et al. 1995; FAO, 2013; Inglese et al. 1994; Nerd and Mizrahi 1997; Inglese, 2010). In a year of high production, a cladode can produce 25 to 40 fruits (Arba, 2017), what leads to the reduction in fruit growth and low fruit quality, and a late and irregular fruit ripening (Inglese et al. 1995; Inglese et al. 1994). In order to produce homogeneous good fruit size, it is necessary to reduce the fruit load of cladodes (FAO, 2013). However, a severe thinning of 4 fruits per cladode can greatly reduce the yield up to 58% and can even lead to a second flowering or reflowering (Zegbe and Mena 2010). Fruit thinning can be practiced manually using gloves that protect against spines and glochids and the appropriate period for thinning is located between two weeks before flowering until three weeks after flowering or two weeks after fruit set. Early bud thinning is difficult to achieve and late thinning does not improve fruit size (Inglese et al. 1995; De and Nobel 2004). Gugliuzza et al., (2002) reported that determining the optimal number of fruits to be removed per cladode depends on the surface of the cladode and its fruit load. On an adult plantation of 335 plants per hectare, a thinning of 6 fruits per cladode yielded 20 tons per hectare and yielded fruits have an average size of 100-120 g (Blanco-Macías et al. 2006). Several studies have shown that leaving a load of 6, 9 or 15 fruits per cladode, the fruit and pulp fresh weight increases as the number of removed fruits per cladode increases (Inglese et al. 1995; Inglese et al. 2002).

MATERIALS AND METHODS

The study area and an experimental design

Trials were carried out on an adult plantation of cactus pear *Opuntia ficus-indica*. cv 'Cristalina' 10 years old at the research farm at Sohag University in Kawthar area. The location map of the study area is demonstrated in the figure (1). Plants have an average length of 2 m and average width of 1.5 m. The planting density is 4 m between rows and 3 m between plants in the rows 350 plants/fd. The climate of this area is characterized as dry climate along the year. The temperature varies from 8°C to 39°C and is rarely below 5°C or above 43°C. Non-significant seasonal variation in the frequency of rainfall is recorded. The average wind speeds are about 8.5 knots with maximum records for 10.0 k knots. Table (2) and Figure (2) demonstrated the climatic condition of 2021 year of the study area. The soils of the study area are calcareous (between 8 and 17%), coarse textured (Sandy and loamy sand), slightly alkaline (between 7.7 and 8.6) and slightly saline (ranged from 0.23 to 2.95 dS/m). The available macro and micro nutrients are low in their contents in the soils. The soil organic matter content is low which not exceeded 0.2%. Soil characterization of the study area is demonstrated in the table (1).

Table (1) soil characterization of the study area.

Soil characteristics	Range
pH	7.7 – 8.6
EC (dS/m)	0.23 – 2.95
Texture class	Sandy – loamy sand
O.M (%)	0.09 – 0.19
$CaCO_3$ (%)	8 - 17
N (%)	0.01 – 0.017
P (mg/kg)	1.4 – 4.5
K (mg/kg)	56 - 118
Fe (mg/kg)	0.3 – 1.1
Mn (mg/kg)	0.1 – 1.6
Cu (mg/kg)	0.02 – 0.1
Zn (mg/kg)	0.01 – 0.06

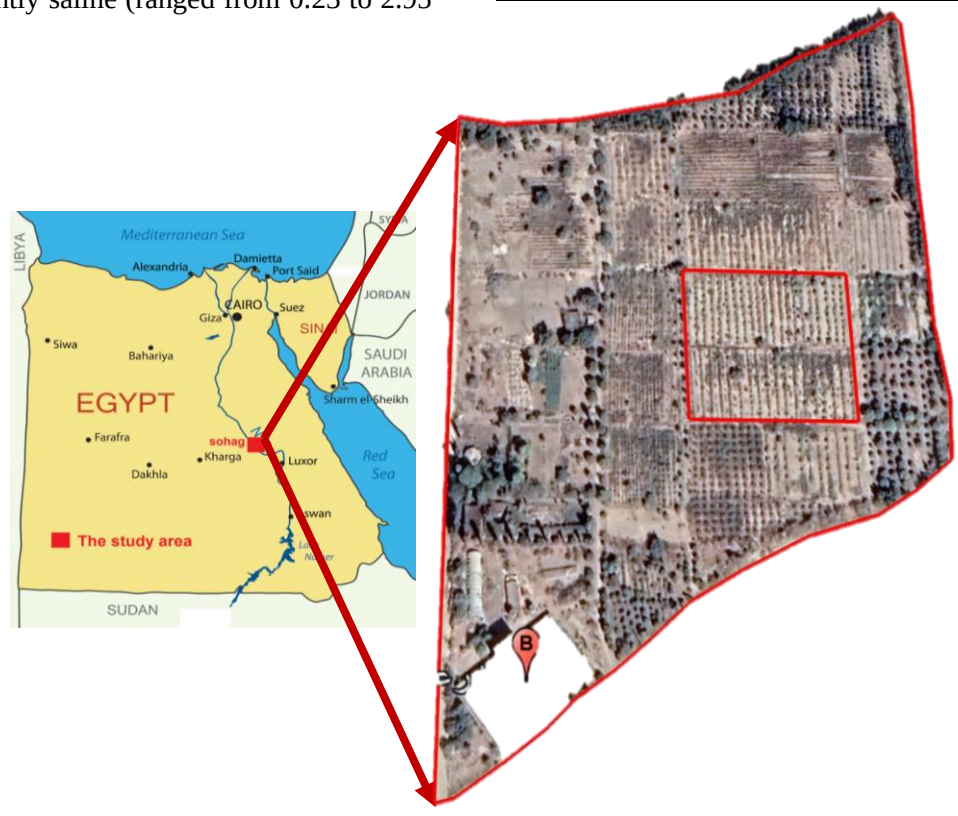

Figure (1): The study area.

Table (2): The average of climatic condition of the study area (https://weatherspark.com/).

Average	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Temperature	14	16	20	25	30	32	33	32	30	26	20	16
Wind Speed	7	7.4	8	8.4	9.1	10	9.5	9.4	9.3	8	7.2	7
Precipitation	0.1	0	0	0	0	0	0	0	0	0.1	0.1	0

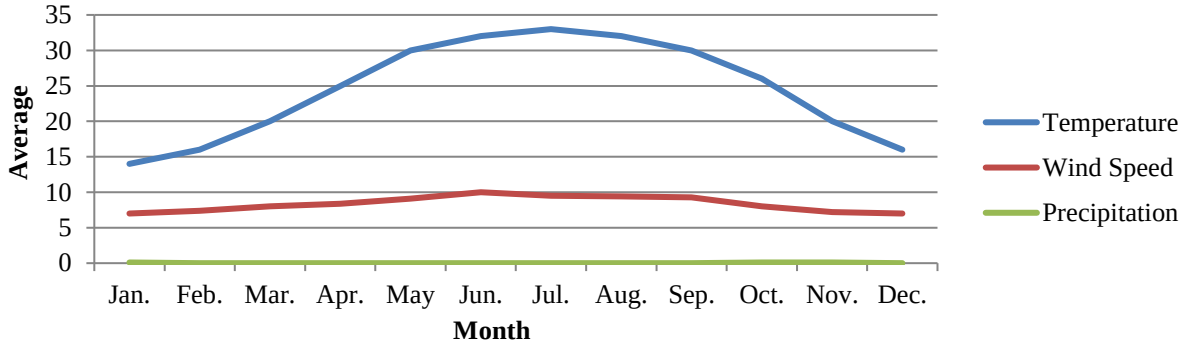

Figure (2): The average of climatic condition of the study area.

Thinning treatments

This research work consisted in studying the effect of fruit thinning on fruit yield and quality of an adult plantation under the natural conditions of the environment of the site of trials. Three types of fruit thinning were used: light thinning with 12, 8 fruits per cladode and severe thinning with 4 fruits per cladode. The not thinned plants (control) had an average load of 18 fruits per cladode. Fruit thinning was carried out on March 15, (2019-2020; 2020-2021 and 2021-2022). Fruit thinning treatments used were: T: not thinned plants (the control); T1: thinned plants to 12 fruits per cladode; T2: thinned plants to 8 fruits per cladode and T3: thinned plants to 4 fruits per cladode

The fruit quality

Fruit size (fruit weight and dimensions: fruit length and diameter) and the organoleptic compounds in the fruits (sugar content and titratable acidity and the pH of juice). Fruit quality parameters were carried out on a sample of 5 mature fruits per experimental unit. Fruit length and diameter and fruit peel thickness were measured with a caliper. Fruit and pulp weight was measured using an electronic balance with an accuracy of 0.01 g.

The content of sugars in the fruits or degree Brix was measured with a refractometer. The pH of juice was determined with a pH meter and the titratable acidity was carried out by the titration of the juice using NaOH 0,1 N and phenolphthalein as indicator of color change. It is calculated according to IFU (2017) as expressed in the following equation.

$$QAC = 0.67 \times VNaOH$$

Where QAC is the titratable acidity expressed in g of malic acid per liter of juice; VNaOH is the volume of NaOH used in the titration (in ml).

For each studied organoleptic parameter, measures were repeated 3 times and the mean value of the three measures was taken into account.

Fruit yield

It was measured on the two plants of each experimental unit and fruit yield per hectare was calculated on the basis of the density of plantation and average yield per plant.

The seed content in the fruit: on the samples of fruits used in the study of the fruit quality, 10 g of pulp per fruit were used for the separation of the seeds from the pulp and their subsequent counting.

The fruit peel thickness

It is measured on the fruit peel using a caliper after peeling the mature fruits.

The economic income of the thinning operation

It was determined by calculating the gain of the economic income of the yield of thinned plants compared to the yield of not thinned plants, based on the yield, the quality of the fruits and the selling prices of the fruits in the local market.

RESULTS AND DISCUSSIONS

Fruit growth potential of cactus pears depends on seed content (Barbera et al., 1994). Actual fruit weight is affected by competition at the cladode level, and fruit with the same seed count vary greatly in the weight and seed: flesh ratio, according to the number of fruits per cladode. Our results indicate that optimal fruit weight and quality can be attained with 8 fruit per fruiting cladode. A lower fruit load does result in further increase of fruit weight, but it strongly reduces yields (Inglese et al. 1994b).

Variation in the growth and diameter every 15 days during the three seasons

Variation in the growth of the length (cm) of the fruits every 15 days

The thinning treatment T1.T2 and T3 (thinned plants to 12, 8 and 4 fruits per cladode) gave the highest fruit length for the three seasons compared with control. Figure (3) demonstrated the fruits' morphological shape variability of the thinning treatments. Through the figure (4) and the table (3) shown, we notice that treatment T3 (4 fruits per cladode) gave the highest values during the three seasons, followed by treatment T2 (8 fruits per cladode), then, treatment T1(12 fruits per cladode), but in the second season we find a convergence in the values of the length of the fruit in treatments 8 and 12 starting from the month of mid-May with the values of (7.34, 7.74, 8.16, 8.68 and 6.71, 7.41, 7.89, 8.34) respectively, where there is no significant between them.

Thinning treatment	1st season	2nd season	3rd season
Control			
12			
8			
4			

Figure (3): The fruits' morphological shape of the thinning treatments.

Table (3): Variation in the growth of the length of the fruits.

Season 1	control	12 fruit	8 fruit	4 fruit
mid-march	2.46^{d}	2.97^{c}	4.78^{b}	6.68^{a}
first April	.290^{d}	3.74^{c}	6.19^{b}	7.41^{a}
mid-April	3.28^{d}	4.60^{c}	6.93^{b}	7.97^{a}
first may	3.94^{d}	5.54^{c}	7.52^{b}	8.37^{a}
mid-may	4.60^{d}	6.47^{c}	8.03^{b}	8.88^{a}
first June	5.36^{d}	7.03^{c}	8.51^{b}	9.25^{a}
mid-June	6.18^{c}	7.41^{b}	8.99^{a}	9.56^{a}
first July	6.93^{d}	7.77^{c}	9.34^{b}	10.09^{a}
Season 2	control	12 fruit	8 fruit	4 fruit
mid-march	2.60^{d}	3.46^{c}	5.15^{b}	6.37^{a}
first April	3.08^{d}	4.32^{c}	5.72^{b}	7.00^{a}
mid-April	3.64^{d}	5.22^{c}	6.32^{b}	7.52^{a}
first may	4.41^{d}	5.99^{c}	6.87^{b}	8.13^{a}
mid-may	5.10^{d}	6.71^{b}	7.34^{b}	8.48^{a}
first June	5.95^{c}	7.41^{b}	74.7^{b}	8.81^{a}
mid-June	6.74^{c}	7.89^{b}	8.16^{b}	9.14^{a}
first July	7.40^{c}	8.34^{b}	8.68^{b}	9.44^{a}
Season 3	control	12 fruit	8 fruit	4 fruit
mid-march	2.19^{c}	2.87^{c}	4.79^{b}	6.70^{a}
first April	2.58^{d}	3.54^{c}	5.81^{b}	7.38^{a}
mid-April	3.12^{d}	4.74^{c}	6.69^{b}	7.88^{a}
first may	3.97^{d}	6.00^{c}	7.34^{b}	.830^{a}
mid-may	4.87^{d}	04.7^{c}	7.91^{b}	8.85^{a}
first June	6.15^{d}	7.74^{c}	8.54^{b}	9.19^{a}
mid-June	6.95^{d}	8.12^{c}	8.93^{b}	9.48^{a}
first July	.697^{d}	8.42^{c}	9.31^{b}	10.05^{a}

The different letters (in the same column) represent statistically significant differences between treatments ($p<0.05$).

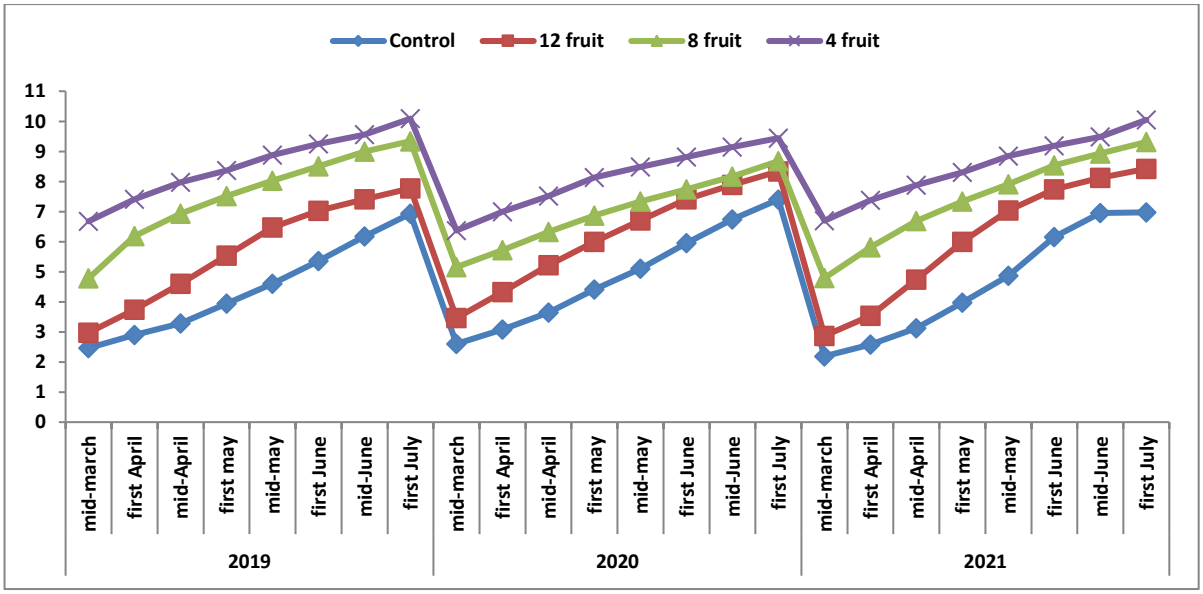

Figure (4): Variation in the growth of the length of the fruits.

Variation in the growth of the diameter (cm) of the fruits every 15 days

The thinning treatment T1.T2 and T3 (thinned plants to 12, 8 and 4 fruits per cladode) gave the highest fruit diameter for the three seasons compared with control. Through the figure (5) and the table (4) shown, we notice that treatment T3 (4 fruits per cladode) gave the highest values during the three seasons, followed by treatment T2 (8 fruits per cladode), then, treatment T1 (12 fruits per cladode).

Table (4): Variation in the growth of the diameter of the fruits.

Season 1	**control**	**12 fruit**	**8 fruit**	**4 fruit**
mid-march	1.60^{d}	2.06^{c}	2.44^{b}	3.48^{a}
first April	1.89^{d}	2.61^{c}	3.22^{b}	3.98^{a}
mid-April	2.16^{d}	$.320^{c}$	3.99^{b}	4.46^{a}
first may	2.54^{d}	3.86^{c}	4.47^{b}	4.94^{a}
mid-may	2.89^{d}	2.48^{c}	4.93^{b}	5.33^{a}
first June	3.28^{c}	4.95^{b}	5.46^{a}	5.83^{a}
mid-June	3.85^{c}	5.40^{b}	6.12^{a}	6.29^{a}
first July	4.59^{b}	5.98^{a}	6.70^{a}	6.61^{a}
Season 2	**control**	**12 fruit**	**8 fruit**	**4 fruit**
mid-march	1.81^{c}	2.21^{b}	2.51^{b}	3.23^{a}
first April	2.16^{c}	2.81^{b}	2.96^{b}	3.63^{a}
mid-April	2.62^{c}	3.38^{b}	3.37^{b}	4.03^{a}
first may	3.12^{c}	$.390^{b}$	3.86^{b}	4.46^{a}
mid-may	$.380^{b}$	4.42^{a}	4.23^{ab}	4.72^{a}
first June	4.47^{c}	5.02^{ab}	4.63^{bc}	5.17^{a}
mid-June	5.01^{b}	5.53^{ab}	5.15^{b}	5.70^{a}
first July	5.66^{a}	5.95^{a}	5.78^{a}	6.10^{a}
Season 3	**control**	**12 fruit**	**8 fruit**	**4 fruit**
mid-march	1.37^{c}	2.11^{b}	2.48^{b}	3.49^{a}
first April	1.79^{c}	2.71^{b}	3.13^{b}	3.91^{a}
mid-April	2.32^{c}	3.38^{b}	4.01^{a}	4.38^{a}
first may	2.86^{c}	3.82^{b}	4.48^{a}	4.85^{a}
mid-may	3.83^{c}	4.33^{b}	4.96^{a}	5.36^{a}
first June	4.51^{b}	4.94^{b}	5.56^{a}	5.71^{a}
mid-June	5.03^{b}	5.41^{b}	6.22^{a}	6.26^{a}
first July	5.33^{b}	6.00^{ab}	6.71^{a}	6.53^{a}

The different letters (in the same column) represent statistically significant differences between treatments ($p<0.05$).

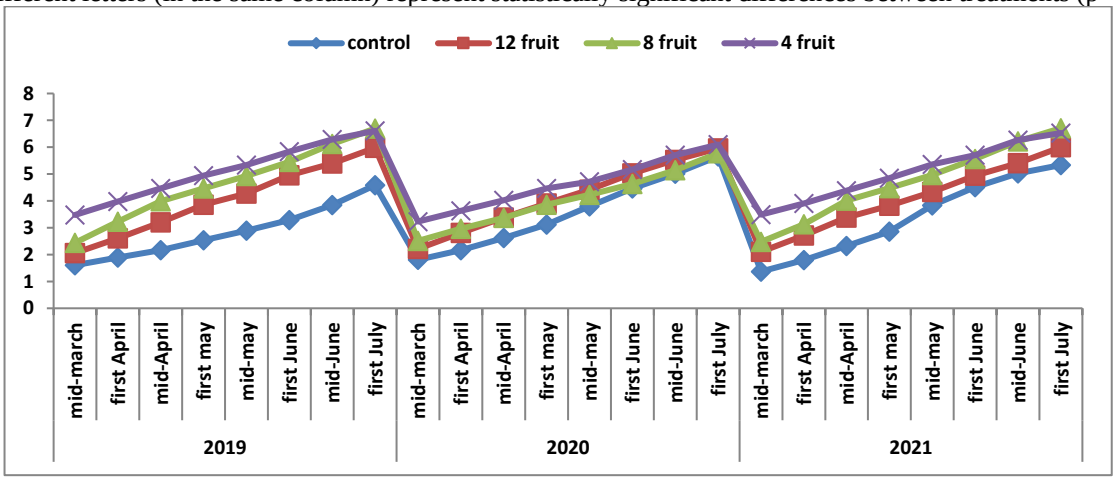

Figure (5): Variation in the growth of the diameter of the fruits.

Effect of fruit thinning on fruit quality (fruit length and diameter on harvest).

Table (5): Effect of fruit thinning on fruit quality (fruit length and diameter on harvest).

Number of fruits	Harvest Length			Harvest Diameter		
	Season1	Season2	Season3	Season1	Season2	Season3
Control	.780^{c}	7.88^{c}	7.68^{d}	5.24^{b}	6.16^{c}	5.64^{b}
12	8.24^{c}	8.79^{b}	8.69^{c}	6.69^{a}	6.38^{bc}	6.51^{a}
8	9.77^{b}	9.81^{a}	9.61^{b}	7.15^{a}	7.34^{a}	7.21^{a}
4	10.63^{a}	9.89^{a}	10.45^{a}	7.14^{a}	6.71^{b}	7.12^{a}

The different letters (in the same column) represent statistically significant differences between treatments ($p<0.05$).

Obtained results (table 5 and figure 6) showed that for fruit size (fruit length and diameter) there was a significant difference ($p \leq 0.001$) between fruit thinning treatments .The thinning treatment T1 (thinned plants to 4 fruits per cladode) gave the highest fruit length and diameter with an average fruit length and diameter of 10.63 and 7.14 cm respectively. While in not thinned plants, average fruit length and diameter was only 7.88 and 6.16 cm respectively.

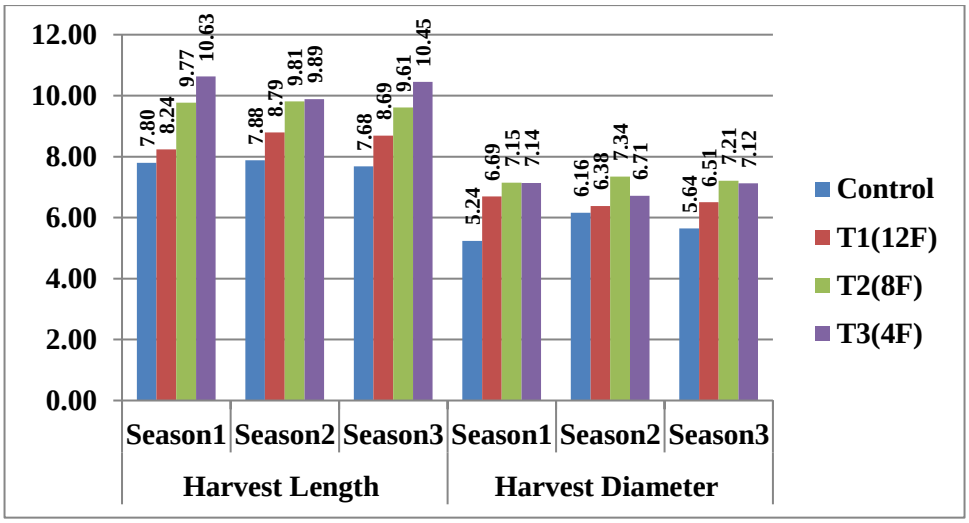

Figure (6): Effect of fruit thinning on fruit quality (fruit length and diameter on harvest).

Effect of fruit thinning on fruit quality (fruit weight and pulp weight).

Table (6): Effect of fruit thinning on fruit quality (fruit weight and pulp weight).

Number of fruits	Fruit weight			Pulp weight		
	Season1	Season2	Season3	Season1	Season2	Season3
Control	96.83^{d}	105.28^{d}	98.34^{d}	57.14^{d}	61.51^{c}	58.66^{d}
12	146.80^{c}	151.98^{c}	149.06^{c}	102.24^{c}	103.09^{b}	103.94^{c}
8	185.50^{b}	189.74^{b}	180.36^{b}	126.75^{b}	135.05^{a}	124.15^{b}
4	213.72^{a}	201.01^{a}	210.98^{a}	146.95^{a}	138.03^{a}	145.89^{a}

The different letters (in the same column) represent statistically significant differences between treatments ($p<0.05$).

Obtained results in table (6) and figure (7) showed that for fruit weight and fruit pulp weight there was a significant difference ($p \leq 0.001$) between fruit thinning treatments, The thinning treatment T3 (thinned plants to 4 fruits per cladode) gave the highest fruit weight and fruit pulp weight with an average fruit weight and pulp weight of 213.72 and 146.95g respectively. While in not thinned plants, average fruit weight and pulp weight was only 105.28 and 61.51 g respectively. This has shown

that the large severe thinned cladodes have yielded fruits with the largest size due to the low fruit load of the cladodes and large photosynthetic surface of the cladodes. Our results are similar to those of several authors who reported that fruit and pulp weight increase with the increase of the number of removed fruits per cladode (Inglese et al., 1995; Zegbe Dominguez et al., 2009) and a thinning of 6 fruits per cladode yielded good size fruits with 100-120 g in fruit weight (Inglese et al., 2002).

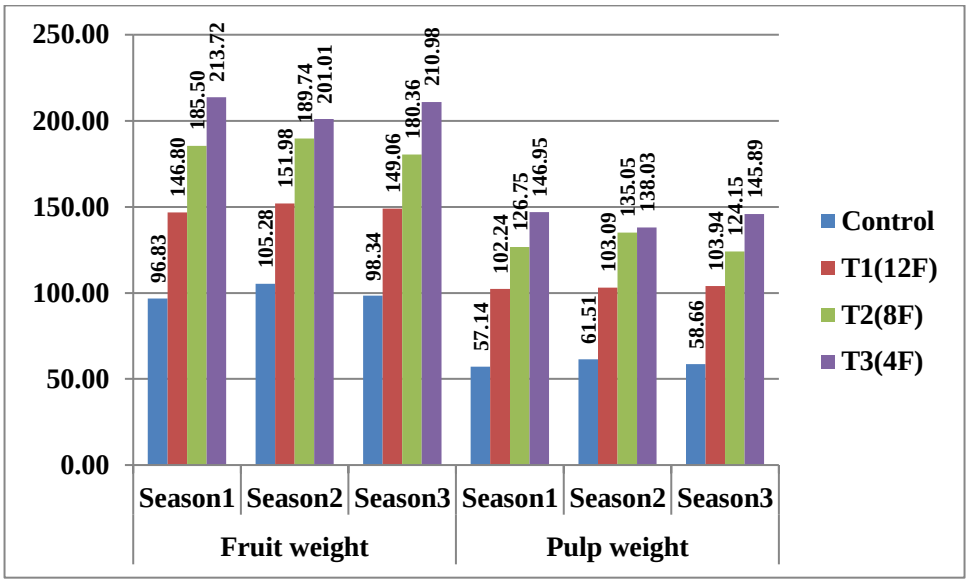

Figure (7): Effect of fruit thinning on fruit quality (fruit weight and pulp weight).

Effect of fruit thinning on fruit quality (peel thickness and peel weight).

Table (7): Effect of fruit thinning on fruit quality (peel thickness and peel weight).

Number of fruits	Peel thickness			Peel weight		
	Season1	Season2	Season3	Season1	Season2	Season3
Control	0.39^{c}	0.41^{d}	0.40^{b}	39.69^{d}	43.77^{d}	39.68^{d}
12	0.39^{c}	0.42^{c}	0.39^{b}	44.56^{c}	48.89^{c}	45.12^{c}
8	0.53^{b}	0.48^{b}	0.41^{b}	58.76^{b}	54.69^{b}	56.22^{b}
4	0.54^{a}	0.51^{a}	0.51^{a}	66.78^{a}	62.98^{a}	65.10^{a}

The different letters (in the same column) represent statistically significant differences between treatments ($p<0.05$).

Table (7) and figure (8) showed the effect of fruit thinning on fruit quality (peel thickness and peel weight). The thinning treatment T3 (thinned plants to 4 fruits per cladode) gave the highest fruit peel thickness and fruit peel weight with an average fruit peel thickness and fruit peel weight 0.54mm and 66.78 g respectively. While in not thinned plants gave the lowest, average fruit peel thickness and fruit peel weight was 0.39 mm and 39.68 g respectively.

Effect of fruit thinning on fruit quality (pulp peel ratio and Tss).

Table (8) and figure (9) showed the effect of fruit thinning on fruit quality (pulp peel ratio and Tss). The thinning treatment T0 (thinned plants to 8 fruits per cladode) gave the highest fruit pulp peel ratio with an average fruit pulp peel ratio 2.47 in the whole season. While in not thinned plants, average fruit pulp peel ratio was 1.40. No significant difference in fruit pulp peel ratio was found between (12,8 and 4 fruit per cladode) (2.34, 2.21and2.24 respectively) on 3rd season, While there are clear significant differences between the control and all thinning treatments with regard to (%TSS) The highest mean value (%TSS) was found in treatment (thinned plants to 4 fruits per cladode) (13.77).

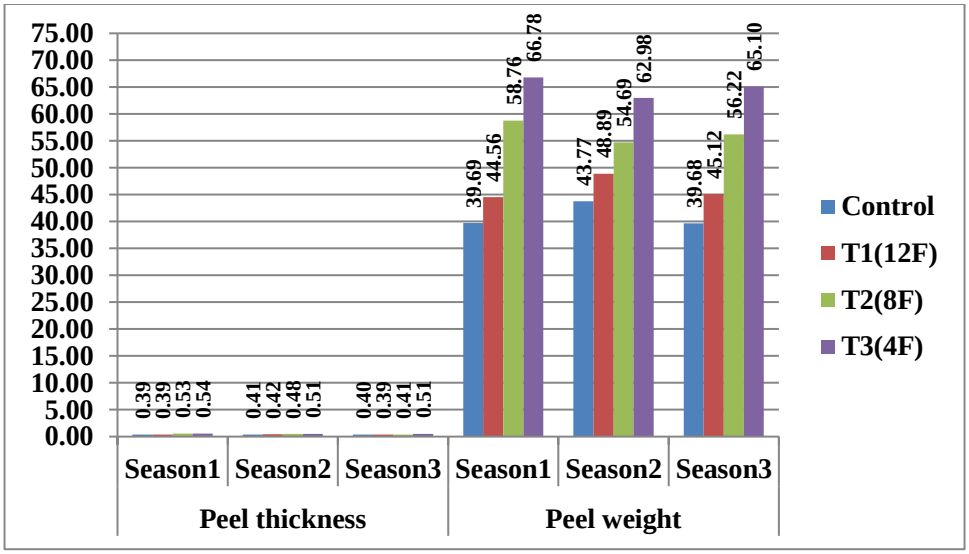

Figure (8): Effect of fruit thinning on fruit quality (peel thickness and peel weight).

Effect of fruit thinning on fruit quality (pulp peel ratio and Tss).

Table (8): Effect of fruit thinning on fruit quality (pulp peel ratio and Tss).

Number of fruits	Pulp peel ratio			Tss		
	Season1	Season2	Season3	Season1	Season2	Season3
Control	1.44^{c}	1.40^{c}	1.47^{b}	10.84^{c}	11.45^{c}	10.29^{d}
12	2.30^{a}	2.12^{b}	2.34^{a}	11.61^{b}	11.93^{b}	11.92^{c}
8	2.16^{b}	2.47^{a}	2.21^{a}	11.93^{b}	12.35^{b}	12.61^{b}
4	2.20^{ab}	2.19^{b}	2.24^{a}	13.17^{a}	13.77^{a}	13.60^{a}

The different letters (in the same column) represent statistically significant differences between treatments ($p<0.05$).

Table (9) and figure (10) showed the effect of fruit thinning on fruit quality (Acidity and Reducing sugar). Not thinned plants, have the highest fruit acidity with an average 0.28 in among all season. The lowest value of acidity was (thinned plants to 4 fruits per cladode) with value (0.12). While (thinned plants to 4 fruits per cladode) data preformed the highest percentage observed reducing sugar (7.70) on 1st season. The lowest value of reducing sugar was in not thinned plants with percentage (4.08).

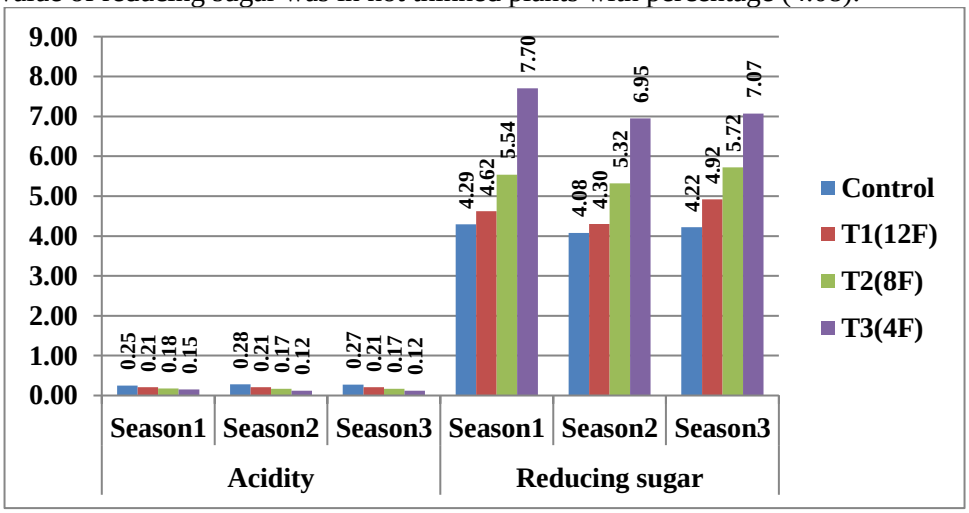

Figure (10): Effect of fruit thinning on fruit quality (Acidity and Reducing sugar).

Effect of fruit thinning on fruit quality (Total sugar and non reducing sugar).

Table (10): Effect of fruit thinning on fruit quality (Total sugar and non reducing sugar).

Number of fruits	Total sugar			Non reducing sugar		
	Season1	Season2	Season3	Season1	Season2	Season3
Control	6.02^{c}	6.24^{b}	6.03^{c}	1.79^{a}	2.16^{bc}	1.81^{b}
12	6.56^{bc}	6.59^{b}	6.67^{bc}	1.94^{a}	2.29^{b}	1.74^{b}
8	7.38^{b}	7.05^{b}	7.55^{b}	1.84^{a}	1.73^{c}	1.83^{ab}
4	9.86^{a}	10.05^{a}	9.24^{a}	2.15^{a}	3.10^{a}	2.18^{a}

The different letters (in the same column) represent statistically significant differences between treatments ($p<0.05$).

Table (10) and figure (11) showed the effect of fruit thinning on fruit quality (Total sugar and non-reducing sugar). In particular, the highest percentages of Total sugar were found in the value 10.05 in (thinned plants to 4 fruits per cladode) on 2nd season. The lowest proportion for Total sugar not thinned plants with value (6.02) While non-reducing sugar preformed the highest percentage observed on (thinned plants to 4 fruits per cladode) with value (3.10on 2nd season). However, it is noted that there is no significant difference between all thinning treatments and control (not thinned plants) represented in 1st season.

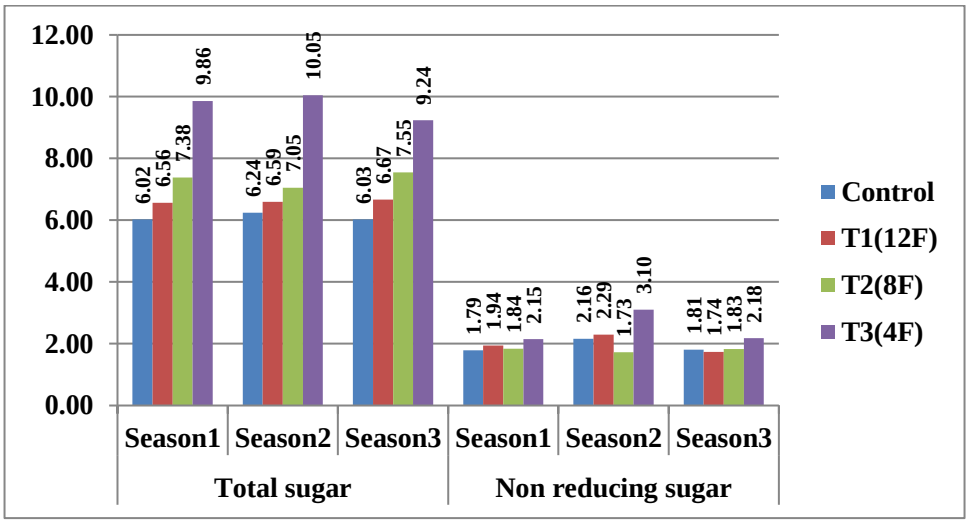

Figure (11): Effect of fruit thinning on fruit quality (Total sugar and non-reducing sugar).

Effect of fruit thinning on fruit seed number

Table (11): Effect of fruit thinning on fruit seed number.

Number of fruits	Seed number		
	Season1	Season2	Season3
Control	265.39^{c}	295.67^{c}	268.47^{c}
12	321.61^{b}	343.00^{b}	322.25^{b}
8	365.38^{a}	378.75^{a}	360.96^{a}
4	368.08^{a}	387.58^{a}	365.42^{a}

The different letters (in the same column) represent statistically significant differences between treatments ($p<0.05$).

Table (11) and figure (12) showed the effect of fruit thinning on fruit seed number. On the seed content in the fruits. The average number of seeds in the fruits of not thinned plants was (265.39 to 295.67), while average number of seeds in the fruits of thinned plants was (321.61 to 343.00) for thinned cladodes to 12 fruits compared to thinned plants 8 fruits per cladode (360.96 to 378.75) and thinned plants 4 fruits per cladode (365.42 to 387.58).

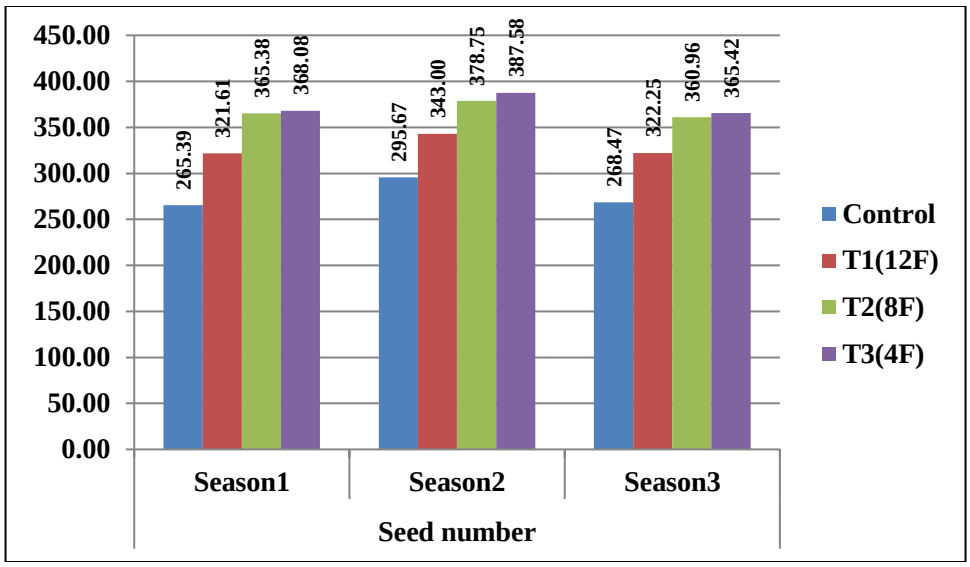

Figure (12): Effect of fruit thinning on fruit seed number.

CONCLUSION

Fruit thinning has improved the quality of the fruits, mainly fruit size and the sugar content in the fruits. What improves the selling price of the fruit production on the market, despite the negative effect of the thinning operation on fruit yield. Fruit thinning also made it possible to obtain an earlier and more regular ripening of the fruits in time, mainly on large cladodes, and to avoid the alternation of the production by reducing the number of fruits on loaded cladodes. The best results in terms of fruit size and quality were obtained in thinned plants to 8 and 4 fruits per cladode. And this has increased the gain of the fruit production of thinned plants by increasing its economic income compared to the production of not thinned plants thanks to attractive selling prices of the good size fruits of thinned plants on the market.

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الملخص العربي

النمو والحجم النهائي لفاكهة التين الشوكي *Opuntia ficus-indica* بعد خف الثمار بالمناطق شبه القاحلة

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الهدف من هذا العمل هو دراسة تأثير خف الثمار على المحصول وجودة الثمار في التين الشوكى. لتحقيق هذا الهدف ، أجريت تجارب خف الثمار في مزرعة للتين الشوكى *Opuntia ficus-indica.* صنف "Cristalina" عمرها 10 سنوات في مزرعة البحوث بجامعة سوهاج بمنطقة الكوثر ، وهي منطقة شبه قاحلة في جنوب مصر. يتشكل خف الثمار فى تقليل حمل الثمار للالواح ذات الحمولة الزائدةعن طريق تقليل عدد الثمار إلى (12,8) و4 لكل لوح . لقد أنشأنا حمولة للالواح ووقت للخف مما أدى إلى زيادة حجم الثمار واللحم في التين الشوكى. تمت تطبيق ذلك في منتصف شهر مارس عن طريق إزالة بعض البراعم الزهرية في مرحلة التزهير. كان لدى الالواح الغير معاملة (الكنترول) متوسط عدد 18 ثمرة لكل لوح. أظهرت النتائج المتحصل عليها أن تقليل حمل الالواح أدى إلى تحسين حجم الثمار وجودتها. يزداد وزن الثمار واللحم مع التخفيف. يؤدي التخفيف الثقيل (4 في اللوح) إلى زيادة وزن الثمار و اللحم ولكنه أقل جدوى من الناحية الاقتصادية بسبب قلة عدد الثمار الكلية للفدان. تأثرت نسبة اللحم بالتخفيف. تتغير خصائص الفاكهة ، مثل تركيز المواد الصلبة الذائبة الكلية ومحتوى البذور مع التخفيف. لكن أفضل عائد اقتصادي كان بثمانية ثمار وذلك لارتفاع سعر بيع الثمرة ومحصول الفدان مقارنة بباقي المعاملات والكنترول. في النباتات المخففةالى 8 ثمار ، بلغ متوسط وزن الثمرة 189.74 جم ، ومتوسط طول وقطر الثمار 9.81 و 7.34 سم على التوالي. بينما كان متوسط وزن الثمرة 105.28 جم فقط وكان متوسط طول الثمار وقطرها 7.88 و 6.16 سم على التوالي في الكنترول. أدى خف الثمار إلى زيادة محتوى السكر في الفاكهة وخفض عدد البذور في الفاكهة مقارنة بالوزن ، كما أدى إلى تحسين حموضة العصير القابلة للمعايرة. كما أدى ترقق الفاكهة إلى تحسين الدخل الاقتصادي للعائد.