Effect of shoot Pruning on Growth, Yield and Fruit Quality of Husk Tomato *(Physalispubescens*L.)

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Abstract: This investigation was carried out within the two successive seasons of 2012 and 2013 on husk tomato (Local variety) planted in a private farm located at Shebeen El-Qanatir city, El-Qaliubiya governorate, Egypt to study the response of husk tomato to some pruning treatments on growth, yield and fruit quality. Seeds were sown in seedbed on July 5th in both seasons of 2012 and 2013. Seedlings were transplanted forty days after sowing into open field transplanting carried outin 60 cm apart on the row among plants. Plants were trained on thread and pruned as follows: plants were left to grow without pruning ($Pr._0$)as acontrol, plants were pruned to three shoots on the main stem($Pr._3$), plants were pruned to six shoots on the main stem($Pr._6$) and plants were pruned to nine shoots on the main stem($Pr._9$). Results showed that all pruning treatments improved vegetative growth. Data showed that no differences were detected in total chlorophyll in leaves. Data also recorded that the pruning treatments have a positive effect in average fruit weight, size and diameter while fruit firmness decreased during the two seasons compared with the control ($Pr._0$).The results also recorded that chemical character of husk tomato fruits were significant differences among treatments. No significant was recorded in the parameters of total titratable acidity. On the other side the parameters of total soluble solids (T.S.S. %), vitamin C (ascorbic acid), total sugar, total carotenoidsand dry matter increased due to pruning treatments. Fruityield were differ according to treatments.
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Introduction

Husk tomato (*Physalispubescens* L.) is one of themost important vegetable crops in Egypt. The husk tomato belongs to the nightshade family (solanaceae). The genus *Physalis*, established by Linnaeus in 1753, contains about 463 species but 100 species are well known and have more fanciful names such as husk tomato, golden berry, ground cherry, strawberry tomato, Cape gooseberry and pubescent ground cherry **(El Sheikha, 2004)**. *Physalis* has been known in Egypt since the sixteen century under the name of its varieties 'Harankish', 'Halawyat' and 'El-Set El-Mestihya'. Becausethe fruit is covered in papery husk; giving it its name **(El Sheikha et al., 2010)**. Husk tomato plants produce small orange fruits similar in size and shape to a cherry tomato. It is a highly nutrition fruit; low in fat and contains no cholesterol or sodium. Husk tomato fruits provide an excellent source of the vitamin A and C, minerals (phosphorus and iron), protein, carotene, sugars and organic acids because of this they are a good choice for making health **(Mustafa, 2009)**.

Although, pruningincreasescostsinplants production, itimproves lightpenetrationinsidetheplantcanopy andincreases photosynthesisefficiency and sofruit yield **(Rajewar&Patil, 1979; Mbinga,1983 and Ambroszczyketal.,2008)**. Since vegetative growth, as a powerful sink, consumesproducedassimilates,limitationofvegetative growth enhancesassimilatetransporttorootsorfruits. Thus, proper balance between vegetative and reproductive growth could improve fruit quantity and quality **(Arzani et al., 2009)**. Many researches done on the effect of pruning on quantitative and qualitative characteristics of tomato show that pruninglimitsvegetativegrowthandallows morelight penetration andsoimproves qualitative and quantitative characteristics oftomatofruits **(Preece and Read, 2005)**.Vegetative growth has direct relation with leaf area, dry matter and stem diameter; however, it has negative correlation with fruit yield **(Hall, 1983; Hartmann, 1977; Navarrete et al., 1997)**.

The aim of this experiment was evaluation of shoot pruningin husk tomato togain high yield along with desirable quality.

Materials and methods

This investigation was carried out during two successive seasons of 2011-2012 and 2012-2013 on husk tomato plant (*Physalispubescens* L.) cv. (local variety). Plants were grown in a private farm located at Shebeen El-Qanatir city, El-Qaliubiya governorate, Egypt to study the response of some pruning treatments on growth, yield and fruit quality. The soil type is clay loam. Soil samples were taken before planting for physical and chemical analysis according

to **Jackson (1973)**. Its physical and chemical analysis isshown in Table (1).

Seeds were sown in seedbeds on July 5th in both seasons of 2011-2012 and 2012-2013.

Table (1):Physical and chemical analysis of the experimental soil during 2011/2012 and 2012/2013 seasons.

Seasons	Physical properties				Chemical properties								
	Sand %	Silt %	Clay %	Texture	EC ds/m	PH	Soluble cation (meq l-1)				Soluble anion (meq l-1)		
							Na^+	Ca^{++}	Mg^+	K^+	Hco_3^-	Cl^-	SO_4
2011/2012	41.80	28.70	29.50	Clay loam	0.25	7.99	0.72	1.00	0.50	0.09	1.00	1.00	0.31
2012/2013	43.80	27.60	28.60	Clay loam	0.24	7.97	0.69	1.00	0.50	0.08	1.00	1.00	0.27

Seedlings were transplanted after 40 days from sowing in the open field. Surface irrigation by furrows was applied and the others agricultural practices took place according to the recommendation of the Ministry of Agricultural.Plants were trained on thread andpruned as follows:Plants were left to grow without pruning as a control ($Pr._0$).Plants were pruned to three shoots on the main stem($Pr._3$). Plants were pruned to six shoots on the main stem($Pr._6$). Plants were pruned to nine shoots on the main stem($Pr._9$).The area unit of each replicate was 15 m^2 and consisted of three rows. Each row was five meters long and one meter width. The seedlings were transplanted80 cm apart. The pruning process started two months after transplanting and was carried out continuously every two weeks to keep the required number of stem for the different treatments.

Data were recorded from each plot as follow:

A. Vegetative growth characteristics and total chlorophyll content in leaves:

Data were taken after five months from transplanting on:Plant height (cm), Stem diameter (cm) and leaf area (cm^2)which measured by Li-300 leaf area meter produced by Li-Cor, Pinclivania).Total leaf chlorophyll content was determined by the spectrophotometric method described by **Hipkins and Baker (1986).**

B. Physical and chemical Fruit characteristics:

A random sample of 20 fruits from each plot was randomly chosen to determination of: averagefruit weight (g),fruit size (cm^3), fruit diameter (cm), and fruit firmness (kg/cm^2) using a pressure tester (Digital force-Gouge Model FGV-0.5A to FGV-100A. shimpo instruments.

Chemical parameters were determined in:Total carotenoids (mg/100 g.f.w.) using spectrophotometer and calculated by using watt stein formula as described in **Hipkins and Baker (1986)**, vitamin C (Ascorbic acid) (mg/100 g f.w.) were measuredaccording to **A.O.A.C (2000)**, total sugars contentwas measured as (g /100g dry weight) according to **Smith et al., (1956),** total titratable acidity (g citric/100 g f.w.) was determined according to **A.O.A.C (2000)**,total soluble solids (T.S.S. %) was determined by hand Refract-meter and fruit dry matter (%).

C. Yield characteristics:

Number of fruits per plant, early yield per plot, total yield per plant and plotwere measuredduring the whole period of harvesting.

Statistical analysis: All experiments were statistically analyzed in a complete randomized design withthree replicates. Each replicate consisted of six plants. Obtained data were subjected to the analysis of variance procedure and means were compared by L.S.D. method at 5% level of significant according to**Snedecor and Cochran (1982)**.

Results and Discussions

A. Vegetative growth characteristics and total chlorophyll content in leaves:

The results about the physical parameters of vegetative growth of husk tomato according topruning treatments are obvious in Table (2 and 3). It could be noticed from the data that all pruning treatments significant encouraged the vegetative growth of pruned husk tomato plants expressed as plant height, stem diameter and leaf area as compare to those plants trained without pruning. Data also clear that this character significantly increased with decreasing the number of shoots per plant in both seasons from $Pr._0$ to $Pr._3$. So the plant trained without pruning ($Pr._0$) gave the lowest results while, those plants trained with tree shoots in the main stem ($pr._3$) obtained the highest values of the previous parameters. Many researchers studied the effect of pruning on vegetative parameters of plants and show that pruning limits vegetative growth and allows more light penetration and increases photosynthesis efficiency and so improve vegetative growth of plants **(Preece and Read, 2005)**. Moreover, the increment in growth of husk tomato plants as a result of pruning treatments also may be

attributed to the more availability of nutrients, water and light to plants as reported by **Paksoy&Akella, (1993)** on eggplant; **Ara et al., (2007)**; **Maboko& Du Plooy,(2009);.Maboko et al., (2011)**and**Hesamil et al., (2012)**on tomato.On the other hand the increment results of physical vegetative parameters of the husk tomato plants due to pruning the plants to three shoots than the other treatments of pruning might be due to the fact that competition between plants for available water, nutrients and light is less in less branch system than in much branches systems as reported by **Alsadon et al., (2013)**.

Concerning the effect of pruning treatments on leaf total chlorophyll content, results cleared that no significant differences were obtained between pruning and the control treatments on chlorophyll content in leaves. This result is in agreement with those obtained by **Hesami et al., (2012)** who found that shoot pruning had no effect on chlorophyll content oftomato leaves.

Table (2): Effect of shoot pruning on plant height, stem diameter and leaf area of husk tomato plants during 2011-2012 and 2012-2013 seasons.

Parameters	Plant height (cm)		Stem diameter (cm)		Leaf area (cm^2)	
Seasons / Treatment	2012	2013	2012	2013	2012	2013
Control ($Pr._0$)	115.00	123.00	2.06	2.01	8.09	7.98
Three shoots ($Pr._3$)	158.00	163.33	2.30	2.33	9.74	9.52
Six shoots ($Pr._6$)	144.93	148.00	2.23	2.21	9.27	8.91
Nine shoots ($Pr._9$)	140.67	143.00	2.16	2.10	8.76	8.32
L.S.D at 5%	**3.95**	**2.77**	**0.06**	**0.08**	**0.19**	**0.22**

Table (3): Effect of shoot pruning treatments on total chlorophyll of husk tomato plants during2011-2012 and 2012-2013 seasons.

Characters	Total chlorophyll (m/100g F.W.)	
Seasons / Treatment	2012	2013
Control ($Pr._0$)	4.21	4.19
Three shoots ($Pr._3$)	4.65	4.68
Six shoots ($Pr._6$)	4.47	4.53
Nine shoots ($Pr._9$)	4.35	4.31
L.S.D at 5%	**N.S**	**N.S**

B. Physical and chemical fruit characteristics:

The results about the effect of pruning treatments on physical fruit characteristics expressed by average fruit weight, size, diameter and firmness are shown in Table (4, 5 and 6) for the two growing seasons 0f 2011-2012 and 2012-2013. The results indicated that, the pruning treatments have a positive effect in average fruit weight, size and diameter during the two seasons compared with the control ($Pr._0$). The best results were obtained when the plants trained to the lowest shoots ($Pr._3$), while the plants grown without pruning ($Pr._0$) gave the lowest results. On the other side fruit firmness of the husk tomato plants decreased according to pruning treatments, thus the plants grown without pruning ($Pr._0$) gave the hardest fruits. The increment of average fruit weight, size, and diameter according to pruning treatments than the control may be due to that the control treatment produced much number of shoots as it utilizes nutrients absorption from the plants, and slow down nutrient uptake by shoot growth causing less in fruit weight, diameter and size. On the other side, since vegetative growth, as a powerful sink, consumes produced assimilates, limitation of vegetative growth enhances assimilate transport to roots or fruits. Thus, proper balance between vegetative and reproductive growth could improve fruit quantity and quality as shown in the results of pruning treatments in the two seasons under study **(Arzani et al., 2009)**. Our results are in agreement with those of obtained by **Fahimahelal, (2011)** on cucumber and **Maboko et al., (2011)** on tomato.

Regarding to the decrease of husk tomato fruit firmness in our investigation by pruning treatment may be due to increase the availability of

water to plants. Same results were obtained by **Ara et.al. (2007)** on tomato plants.

Table 4: Effect of pruning on fruit weight, size, diameter and firmness of husk tomato fruits during 2011-2012 and 2012-2013 seasons.

Characters	Average fruit weight (g)		Fruit size (cm^3)		Fruit diameter (cm)		Fruit firmness (Kg/cm^2)	
Seasons / Treatment	2012	2013	2012	2013	2012	2013	2012	2013
Control ($Pr._0$)	4.17	4.43	3.82	3.91	1.57	1.44	1.75	1.95
Three shoots ($Pr._3$)	5.24	5.79	4.77	5.33	2.06	1.98	1.59	1.82
Six shoots ($Pr._6$)	4.91	5.26	4.43	4.92	1.91	1.79	1.64	1.87
Nine shoots ($Pr._9$)	4.65	4.97	4.11	4.64	1.78	1.64	1.70	1.91
L.S.D at 5%	**0.24**	**0.19**	**0.18**	**0.21**	**0.09**	**0.13**	**0.03**	**0.02**

Table 5: Effect of pruning on Total soluble solids (TSS), total acidity and vitamin C (ascorbic acid) of husk tomato fruits during 2011-2012 and 2012-2013 seasons.

Characters	TSS (%)		Total titratable acidity (g /100 g /f. w.)		Vitamin C (m/100g F.W.)	
Seasons / Treatment	2012	2013	2012	2013	2012	2013
Control	14.6	15.0	1.28	1.12	17.0	17.9
Three shoots	13.4	13.4	0.95	0.98	23.1	22.7
Six shoots	13.7	13.9	1.08	1.01	22.0	20.8
Nine shoots	14.0	14.5	1.16	1.05	19.3	19.5
L.S.D at 5%	**0.23**	**0.37**	**N.S**	**N.S**	**1.13**	**1.21**

Table 6: Effect of pruning on total carotenoids, total sugars and dry matter (%) of husk tomato fruits during 2011-2012 and 2012-2013 seasons.

Characters	Total sugars (g /100 g d. w.)		Total carotenoids (m/ 100 g F. W.)		Dry matter (%)	
Seasons / Treatment	2012	2013	2012	2013	2012	2013
Control ($Pr._0$)	8.25	8.68	2.50	2.80	16.7	16.8
Three shoots ($Pr._3$)	9.92	10.25	3.65	3.93	18.1	17.9
Six shoots ($Pr._6$)	9.48	9.61	3.32	3.54	17.5	17.5
Nine shoots ($Pr._9$)	8.77	9.18	2.88	3.29	17.1	17.1
L.S.D at 5%	**0.34**	**0.29**	**0.29**	**0.22**	**0.22**	**0.19**

Concerning the effect of the various pruning treatmentson chemical characteristics of husk tomato fruits expressed as total soluble solids (T.S.S. %), total acidity, vitamin C (ascorbic acid), total sugar, total carotenoids, and drymatter recorded in Table (5 and 6).Data showed that this characters were different significant among treatments. Whereas no significant was recorded in the parameters of total titratable acidity, while, the parameters of total soluble solids (T.S.S. %), vitamin C (ascorbic acid), total sugar, total carotenoids and dry matter increased due to pruning treatments. The positive effect of pruning treatments on total soluble solids (T.S.S. %), vitamin C, total sugar, total carotenoids and dry matter may be attributed the effect of pruning in limits vegetative growth and allows more light penetration and increases photosynthesis efficiency and so increase vitamin C as it is well known that light is the major factor effecting vitamin C content **Kassem (1998)** on tomato.

C. Yield characteristics:

The results about yield characteristics (Table 7) which including number of fruit per plant, early yieldper plot and total yield per plant and plot, it is obvious that, different results were detected among pruning treatments. However plants un-pruned (Pr.0) obtained the highest value of number of fruits per plant followed by pruned plants to nine shoots ($Pr._9$), while the lowest value was obtained with those plants pruned to three shoots ($Pr._3$). Meanwhile the highest total yield was produced with the plants pruned to nine shoots ($Pr._9$) compared to the control treatment ($Pr._0$). On the other side, plants pruned with three shoots ($Pr._3$) significantly gave the lowest total yield compared to un-pruned plants and other treatments. The increasing of total yield per plant and plot due to the nine shoots ($Pr._9$) than the others pruning and control treatment ($Pr._0$) may be attributed to the increase of branch number which produced much number of fruits than the other pruning treatments.And at the same time this treatment ($Pr._9$) gave heaviest fruits than the control thus, produced the best result of total yield. Our results in both years are in agreement with the findings by **Ara et al. (2007)** and **Maboko& Du Plooy (2009),** who found that yield of tomato was found to increase with an increase in branch number. Conversely the early yield per plot increased due to the pruning treatments especially with the treatment of pruning plants to three shoots. These results may be attributed to the effect of pruning on vegetative characteristics of plants and shows that vegetative growth has direct relation with leaf area, dry matter and stem diameter; however, pruning limits vegetative growth and allows more light penetration and increases photosynthesis efficiency and so improve vegetative growth of plants hence average fruit weight increased and early fruit yield increased **(Preece and Read, 2005)**.

Table (7): Effect of pruning on number of fruits per plant, total yield per plant &plot early yield per plot of husk tomato during 2011-2012 and 2012-2013 seasons

Characters	Number of fruits/plant		Total yield per plant		Total yield per plot		Early yield per plot	
Seasons / Treatment	2012	2013	2012	2013	2012	2013	2012	2013
Control ($Pr._0$)	607.47	573.33	2.53	2.34	45.59	45.72	4.20	3.81
Three shoots ($Pr._3$)	398.64	357.66	1.88	1.78	33.83	32.06	8.02	8.21
Six shoots ($Pr._6$)	515.38	493.73	2.63	2.59	46.55	46.75	7.30	7.52
Nine shoots ($Pr._9$)	579.45	545.64	2.90	3.02	49.13	49.92	5.35	5.06
L.S.D at 5%	**27.86**	**26.58**	**0.19**	**0.21**	**1.54**	**1.13**	**1.08**	**1.27**

Conclusion:

All pruning treatments improved vegetative growth parameters (i.e. plant high, stem diameter and leaf area) and physical and chemical characteristics of fruits (i.e. fruit weight, size, diameter, TSS, vitamin C and total carotene) and increased of fruit yield (number of fruit per plant, weight of fruit per plant and total yield per plot). Nine shoots treatment is the best recommended treatment, which it increased total yield per plant as compared to the other treatments of pruning and the control treatment in both seasons of study.

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