

## Effect of Pruning and Spraying of Ascorbic Acid on Growth, Fruits Yield and Quality and Some Physiological Attributes of Cucumber

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**Abstract:** This study was carried out during the two winter seasons of 2012-2013 and 2013-2014 to evaluate the effect of pruning and foliar application of ascorbic acid (AsA) on the growth, fruit quality and yield of cucumber cv. Fahd. The experiment included 4 treatments arranged in a split-plot design and replicated three times, where pruning treatments (pruning in the main stem and no pruning) were distributed randomly in the main plots, while the foliar application of AsA (using or without using AsA) were arranged in sub plots. The results indicated that plant height, leaf area, chlorophyll readings and fruit length were significantly increased in pruned cucumber plants than non-pruned plants. Otherwise, total yield was not affected significantly with pruning. Moreover, Spraying AsA on cucumber led to a positive significant influence on the plant height, early and total yield, fruit length and photosynthesis.

**Key words:** Cucumber • Pruning • Ascorbic acid • Fruit quality • Yield • Photosynthesis

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### INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important and popular vegetable crops grown widely throughout the tropical and subtropical regions of the world. It belongs family Cucurbitaceae and is native to Southern Asia [1]. Cucumber is one of the most cultivated vegetables under the protected cultivation in the world. It consumes along the year because of its popular use. Cultivating cucumber commercially in the naturally ventilated greenhouse improves productivity and makes a good income to the growers [2].

Improving cucumber plants performance requires appropriate cultivation practices. One possible action taken to increase the cucumber yield is by improving the cultivation techniques through organizing vegetative growth and fruiting via proper pruning. After transplanting, cucumber plants of age about 21 days usually produce very dense branches and leaves which lead to producing a strong vegetative growth but attenuating fruiting resulted in decreasing flowers and fruits forming [3].

The fast-growing of cucumber needs organizing its growth through pruning and training for getting maximum yield with higher quality. Pruning of leaves, lateral branches and flower buds contribute to the ultimate yield

in many ways. A dense canopy of leaves shades the fruits causing them to pale. Excess pruning may sometimes cause the plants to cease flowering. Therefore, it is important to let sufficient foliage on the plant for adequate rates of photosynthesis that reflected on plant growth and yielding [4, 5]. On the other hand, some cucumber growers do not prefer the intensive agronomic practices such as pruning which can affect plants growth and yielding. According to Beadle *et al.* [6], pruning can decrease the total number of branches and improve stem straightness. Fewer branches provide an optimized light rate so affect plant developmental processes [7]. The application of pruning practice is still difficult because of poor information available to the farmers and less experience performance.

Although pruning is difficult in cucumber plants, leaving plants without pruning greatly affects the quality of cucumber fruits. Therefore, many farmers are trying to use some amendments to improve fruit quality, especially when the pruning process is not performed. AsA is a familiar molecule because of its dietary significance, most aspects of its metabolism and some aspects of its function in plants are very poorly understood [8]. AsA has a role in photosynthesis and photoprotection, in defense against ozone and other oxidative stresses and speculations about its role in cell expansion and cell

division will be emphasized. Improved understanding of ascorbate in plants will lead to the possibility of increasing ascorbate concentration in plants by genetic manipulation. This will have benefits for human nutrition and possibly for tolerance of plants to photooxidative stresses [9, 10].

(AsA) is generally distributed in the cytosol of the plant and it acts as an antioxidant. Moreover, the plants with low ascorbate synthesis are quite sensitive to different environmental stresses which can adversely affect their growth and development [11, 12]. Exogenous application of AsA has been very effective in improving plant growth and development by altering oxidative defense system, phytohormone signaling, cell expansion, ion transports and other related processes under stress or non-stress conditions [13-15]. Due to the differences in response of cucumber cultivars to pruning process and also with lack of available information to farmers about pruning implementation, using AsA can enhance cucumber growth and fruit quality especially with the difficulty of performing pruning. So, the purpose of the present study was to evaluate the efficiency of foliar AsA application with pruning technique on improvement of cucumber growth, fruit quality, yield and some physiological characteristics under protected cultivation conditions.

## MATERIALS AND METHODS

The present study was carried out at the greenhouses of increasing export competition for some vegetable crops project in the Faculty of Agriculture, Cairo University during the two winter growing seasons of 2012-2013 and 2013-2014 to evaluate the impact of combination of two pruning treatments (pruning and non-pruning) and ascorbic acid (AsA) foliar spraying (spraying and non-spraying) on the growth, fruit quality and yield of cucumber. The present study included 4 treatments that were arranged in a split-plot design with three replicates. The main plot included the comparison between the pruning on the main stem (all branches on the main stem were removed) versus without pruning, while spraying AsA treatments were distributed in the subplot. The foliar application of AsA repeated 3 times per 10 days at flowering stage of cucumber using the trade compound, namely Seter2 (produced by UAD CO.) at the rate of 2.5 ml/l. The experimental plot area was 10 m<sup>2</sup> (10 m length X 1m width). Cucumber seedlings of F1 cv. Fahd were transplanted about a distance of 50 cm between plants, on the two sides of each row on 22<sup>nd</sup>

October 2012 and on 24<sup>th</sup> of October 2013 in the greenhouse. The normal cultural practices needed for grown cucumber plants, i.e. N, P and K fertilization (100 kg N, 75 kg P<sub>2</sub>O<sub>5</sub> and 100 kg K<sub>2</sub>O/fed) and pest control were implemented as commonly followed in the district. Three plants from each plot were randomly chosen after 45 days from transplanting to measure plant height, leaf area of the fifth leaf from apex (measured by leaf area meter), chlorophyll reading in fresh leaves (measured by SPAD 502 chlorophyll meter) and both of photosynthesis and transpiration were measured by Promoter instrument (Portable Photosynthesis System, model LI 6200, JICA Project, Japan). Samples of 3 fruits were picked from each experimental plot at 60 days after transplanting to measure the fruit physical characters (fruit weight, fruit length and fruit diameter) and chemical contents of the fruits (TSS%, using Zeiss laboratory refractometer and total sugar content according to the method described in AOAC [16]. In each plot, fruits were collected and weighed. Thereafter, early (1<sup>st</sup> and 2<sup>nd</sup> harvest) and total yield/m<sup>2</sup> were calculated. All data concerning growth, yield, fruit characters and physiological parameters of cucumber plants were analyzed as split-plot design. Data were treated by analysis of variance with using MSTAT-C v. 2.1 and means were compared by the least significant difference test (LSD) at 5 % level of probability [17].

## RESULTS AND DISCUSSION

**Plant Height and Leaf Area:** Table 1 shows the impact of pruning and ascorbic acid (AsA) spraying on plant height and leaf area of cucumber. Pruning had a significant effect on plant height and leaf area in both seasons. Data referred that plant height and leaf area was significantly higher with applying pruning on the main stem than without applying pruning in both seasons. These results may be attributed to nutrients diversion to the main shoot because of the rearrangement of vegetative growth that caused by pruning. Also, pruning led to expose plant to light conditions that enhanced photosynthetic activities. These results were in accordance with that of Shivaraj *et al.* [5].

Spraying AsA on cucumber plants increased the plant height significantly in both seasons as compared with non-sprayed one. On the other hand, there were no significant differences in leaf area between the plants treated or not-treated with the AsA over both seasons. The positive effect of the AsA on plant height may be due to its role in enhancing the efficiency of

Table 1: Effect of pruning, spraying ascorbic acid (AsA) and their interaction on plant height, leaf area, early and total yield of cucumber during 2012-2013 and 2013-2014 seasons.

Treatment		Season of 2012-2013				Season of 2013-2014			
		Plant height (cm)	Leaf area (cm <sup>2</sup> )	Early yield (kg/m <sup>2</sup> )	Total yield (kg/m <sup>2</sup> )	Plant height (cm)	Leaf area (cm <sup>2</sup> )	Early yield (kg/m <sup>2</sup> )	Total yield (kg/m <sup>2</sup> )
Pruning	AsA								
With pruning	With AsA	146.70	15.67	6.167	13.270	142.70	15.00	6.667	13.170
	Without AsA	125.00	15.33	5.167	10.870	123.30	14.67	5.733	11.500
Mean		135.80	15.50	5.667	12.070	133.00	14.83	6.200	12.330
Without pruning	With AsA	105.00	13.33	7.767	13.430	108.30	14.00	7.633	13.500
	Without AsA	98.33	13.00	5.667	11.000	101.70	12.33	6.333	11.170
Mean		101.70	13.17	6.717	12.220	105.00	13.17	6.983	12.330
AsA									
With AsA		125.80	14.50	6.967	13.350	125.50	14.50	7.150	13.330
Without AsA		111.70	14.17	5.417	10.930	112.50	13.50	6.033	11.330
LSD at 0.05%									
Pruning		3.58	1.90	0.111	NS	15.11	0.72	0.749	NS
AsA		7.67	NS	0.453	0.830	6.93	NS	0.502	0.866
Pruning X AsA		10.85	NS	0.641	1.174	9.79	NS	0.710	1.225

photosynthesis, cell expansion and cell division. These results are in agreement with those found by Naz, *et al.* [15] who reported that exogenous application of the AsA has been very effective in improving plant growth.

The interaction effect of pruning method and spraying the AsA was significant only in plant height case, while not significant in leaf area. These results were true in both seasons. Generally, spraying the AsA improved plant height significantly under pruning the plants on the main stem, whereas there no significant differences between spraying or without spraying AsA in the case of plants remained without pruning. These results may back to the intensive growth of branches that affected by AsA in growth improvement.

**Early and Total Yield:** Data in Table 1 indicated that there were significant differences among pruned-plants and non-pruned ones only in early yield of cucumber in both seasons. In this regard, pruning cucumber plants on the main stem caused a significant reduction in early yield as compared with non-pruned plants in both seasons. In contrast, total yield did not affect significantly by pruning in both seasons. The reduction in early yield under pruning may be reflect the effect of removing branches with all flowers on the number of formed fruits that resulted in the shortage in yield in the first stage of growth, while total yield increased in the pruned cucumber as result of maximization of leaf area, increasing fruit length and diameter as compared to non-pruned cucumber plants. These results were confirmed by those of Beadle *et al.* [6] and Mardhiana *et al.* [3]. However, these results are in contradiction with those reported by Premalatha *et al.* [4].

Concerning the effect of spraying AsA on early and total cucumber yield, foliar spraying of AsA gave a significant increment in early and total yield in both seasons, as compared with non-sprayed plants. Also, data in the same Table indicated that the interaction between pruning and spraying AsA was significant. Generally, spraying AsA gave a significant excess in both early and total yield compared to non-treated plants, whether in the case of pruned plants on the main stem or not- pruned one in both seasons. These results may be due to the positive role of AsA in photosynthesis and photoprotection [10].

**Fruits Quality Characteristics:** Data concerning effects of pruning, AsA spraying and their interactions on physical and chemical cucumber fruits quality characteristics (fruit weight, fruit length, fruit diameter, TSS% and total sugar content) are presented in Table 2. Fruit weight was significantly lower in pruned plants on the main stem than in non-pruned plants in both seasons. However, fruit length was significantly higher in pruned plants on the main stem than in non-pruned plants in both seasons. On the contrary, there were no significant differences between pruned and non-pruned plants in fruit diameter, TSS% and total sugar content in both seasons. These results disagree with Shivaraj *et al.* [5] who reported that significant variation in fruit weight, fruit length and diameter were due to pruning treatment as compared with non-pruned treatment. This might be due to an increase in the leaf area of this treatment which led to enhanced photosynthetic activities and their accumulation.

Table 2: Effect of pruning, ascorbic acid (AsA) and their interaction on fruit characteristics of cucumber during 2012-2013 and 2013-2014 seasons

		Season of 2012-2013					Season of 2013-2014				
Treatment		Fruit weight (cm)	Fruit length (cm)	Fruit diameter (cm)	TSS %	Total sugar mg/g DW	Fruit weight (cm)	Fruit length (cm)	Fruit diameter (cm)	TSS %	Total sugar mg/g DW
Pruning	AsA										
With pruning	With AsA	81.50	14.73	2.70	3.87	2.32	94.55	15.67	2.87	3.90	2.57
	Without AsA	58.84	14.17	2.60	4.03	2.72	71.30	14.00	2.73	3.93	2.35
Mean		70.17	14.45	2.65	3.95	2.52	82.92	14.83	2.80	3.92	2.46
Without pruning	With AsA	82.90	14.00	2.73	4.03	2.34	83.37	14.17	2.83	4.10	2.35
	Without AsA	68.48	12.83	2.87	4.07	2.20	66.57	13.50	2.77	4.00	2.44
Mean		75.69	13.42	2.80	4.05	2.27	74.97	13.83	2.80	4.05	2.39
AsA											
With AsA		82.20	14.37	2.72	3.95	2.33	88.96	14.92	2.85	4.00	2.46
Without AsA		63.66	13.50	2.73	4.05	2.46	68.93	13.75	2.75	3.97	2.39
LSD at 0.05%											
Pruning		3.12	0.14	NS	NS	NS	3.99	0.08	NS	NS	NS
AsA		5.97	NS	NS	NS	NS	3.27	1.03	NS	NS	NS
Pruning X AsA		8.45	NS	0.20	0.19	0.30	4.63	1.47	NS	0.12	NS

Table 3: Effect of pruning, ascorbic acid (AsA) and their interaction on photosynthesis, transpiration and chlorophyll readings of cucumber leaves during 2012-2013 and 2013-2014 seasons

		Season of 2012-2013			Season of 2013-2014		
Treatment		Photosynthesis $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ S}^{-1}$	Transpiration $\text{mmol H}_2\text{O m}^{-2} \text{ S}^{-1}$	Chlorophyll readings	Photosynthesis $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ S}^{-1}$	Transpiration $\text{mmol H}_2\text{O m}^{-2} \text{ S}^{-1}$	Chlorophyll readings
Pruning	AsA						
With pruning	With AsA	203.20	68.89	55.50	196.80	72.98	56.30
	Without AsA	205.20	69.37	55.00	212.10	71.99	55.47
Mean		204.20	69.13	55.25	204.50	72.48	55.88
Without pruning	With AsA	206.70	70.97	49.93	203.00	77.97	51.07
	Without AsA	136.30	80.68	47.83	153.00	80.95	52.60
Mean		171.50	75.83	48.88	178.00	79.46	51.83
AsA							
With AsA		205.00	69.93	52.72	199.90	75.47	53.68
Without AsA		170.70	75.02	51.42	182.50	76.47	54.03
LSD at 0.05%							
Pruning		NS	4.20	1.94	NS	NS	3.67
AsA		17.11	NS	NS	NS	NS	NS
Pruning X AsA		24.20	7.70	3.68	47.83	NS	2.78

Fruit weight in both seasons and fruit length in the second season were significantly higher when spraying AsA on the cucumber plants compared to non-sprayed one. Otherwise, fruit length in the first season as well as fruit diameter, TSS% and total sugar content in both seasons, did not affect by AsA spraying as compared with non-treated plants. The interaction between pruning and foliar treatment with AsA revealed that using AsA significantly improved fruit weight in both seasons, whether plants were pruned or not, as well as fruit length in pruned plants on the main stem only in the second season. On the other hand, fruit length did not show any significant differences between sprayed and non-sprayed

cucumber plants with AsA in non-pruned plants in the second season.

Moreover, there were no significant effects between sprayed and non-sprayed plants with AsA on fruit diameter, TSS% and total sugar content under each of pruned or non-pruned cucumber plants. These results were true in both seasons. These results confirmed the role of AsA in increasing photosynthetic activities and their products accumulation in cucumber plants leaves that resulted in fruit quality improvement, especially in non-pruned cucumber. The previous results support the results of Pignocchi and Foyer [13] and Darvishan *et al.* [14].

**Photosynthesis, Transpiration and Chlorophyll:** Data presented in Table 3 indicated that cucumber plant leaf photosynthesis in both seasons and transpiration in the second season were not affected significantly by pruning, while in the first season transpiration was significantly lower in pruned cucumber plants than non-pruned one. On the other hand, chlorophyll readings were significantly higher with pruning the plants on the main stem than non-pruned plants in both seasons. These results may be due to the positive effects of few branches on optimizing light availability to plant leaves that important for chlorophyll synthesis. In this regard, Feng *et al.* [7] confirmed that light gives positive effect for plant developmental processes.

With regard to the impact of spraying AsA on photosynthesis, transpiration and chlorophyll synthesis, the data revealed that foliar application of AsA had did not show any significant effect on photosynthesis, transpiration and chlorophyll synthesis in both seasons, except on photosynthesis in the first season that was increased significantly in sprayed plants as compared to non-sprayed ones. These results were similar to that found by Naz *et al.* [15] who reported that exogenous application of AsA has been very effective in improving photosynthesis in the plant.

The interaction between pruning method on the main stem and AsA foliar spraying had no significant impact on photosynthesis, transpiration and chlorophyll synthesis in both seasons. In contrast, photosynthesis was significantly higher with using AsA in non-pruned plants in both seasons. Moreover, the same treatment gave a significant reduction in transpiration only in the first season. Conversely, there were no significant differences observed on transpiration in the second season or chlorophyll synthesis in both seasons in non-pruned cucumber that sprayed with ascorbic acid.

## CONCLUSION

Spraying AsA increased growth parameter, fruit quality and both of early and total yields, whether in the case of pruned plants on the main stem or not- pruned one.

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