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Response of some Cucumber Cultivars Grown under High Plastic Tunnels to Grafting and some Foliar Application Treatments

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ABSTRACT

Under high plastic tunnels in a private farm at Behbate El-hegara village, Samannoud District, El-Gharbia Governorate, Egypt, two field experiments were conducted during 2017/2018 and 2018/2019 seasons, respectively. These experiments were conducted to study the effects of grafting, some foliar applications (ascorbic acid, chitosan and salicylic acid) and their interactions on vegetative growth, leaf pigments, fruits yield and quality of two cucumber cultivars (King-53 and Sultan). Comparing the cultivars, Sultan cultivar was superior to King-53 cultivar in all studied parameters in both growing seasons. Grafted plants perform better than non-grafted ones. The obtained results indicated that the maximum values of all studies characteristics were recorded by grafted plants. Concerning the applied foliar substances, plants sprayed with salicylic acid at 200 ppm recorded the best values of all studied vegetative growth, leaf pigments, fruits yield and quality followed by spraying chitosan at 250 ppm. From the obtained results, it can be concluded that grafting Sultan cucumber cultivar and spraying salicylic acid at 200 ppm is the best combination to obtain the highest vegetative growth, leaf pigments, fruits yield as well as quality under high plastic tunnels and the environmental conditions of the experiment.

Keywords: Cucumber cultivars, grafting, foliar applications, plastic tunnels.

INTRODUCTION

Cucumber *(Cucumis sativus* L.) is one of the most cultivated vegetable crops in the world, is a popular vegetable crop in Egypt. The cultivated area is around 64.861 fed. with production around 613.031 tons (FAO, 2020). It is commonly harvested when fruits are physiologically immature, eaten as raw and generally used for salad. Fresh fruits are a source of vitamins A, C, K, B6, thiamin as well as potassium. Cucumber is generally cultivated during summer season in open fields, however it is one of the major vegetables grown in greenhouses worldwide. Nevertheless, in temperate countries and in winter of tropical and subtropical, it is mainly grown under either glass or plastic houses. Under protected vegetable crops production, cucumber is considered the main crop due to its short life cycle and it has high economic value in off-season harvest. Many varieties of cucumber exist with variations in shapes, skin color and chemical contents. The variation in cucumber varieties performance widely documented by many scholars which may be as a result of either environmental factors or genetic composition.

Plant grafting is a propagation technique combines two plants to generate a single plant, where the part responsible for water and nutrients uptake is known as rootstock and the part responsible for photosynthesis is known as scion (Yuan *et al.*, 2019). Grafting commercial cultivars on suitable rootstocks is a specific method of modifying plants resistance to environmental stresses (Lee and Oda, 2003). Hence, the production of grafted seedlings continuously increased to overcome several problems caused by successive and intensive cultivation in vegetables and stress tolerance by using proper rootstocks (Kyriacou *et al*., 2017). Recent and several studies indicated that cucumber plants responded positively to grafting. Grafted cucumber cultivars recorded significant increment in vegetative growth, chemical constituents of leaves, fruits yield as well as fruits quality (An *et al*., 2020; Bayoumi *et al*., 2021 and El-Sayed *et al*., 2021).

Foliar application with plant bio stimulants is a convenient and effective method for many crops and its effects on physiological processes of plants depends on environmental conditions, plant type, its concentration as well as stage of plant growth. The application of ascorbic acid, chitosan and salicylic acid have great roles in improving vegetable crops performance. Ascorbic acid not only acts as an antioxidant, but also the cellular levels of ascorbic acid correlated with the activation of complex biological defense mechanisms. Foliar application with ascorbic acid at 100 mg L^{-1} improved morphological traits (stem length, stem diameter, number of leaves, number of lateral stems, nodes number in main stem and leaves area) of cucumber plant under water deficit stress (Ghahremani *et al*., 2021).

Chitosan is a natural polymer derived from de-acetylation of chitin and is environmentally friendly and readily available in large quantity (Pirbalouti *et al.*, 2017), forms a semi-permeable film that regulates gas exchange, reduces both transpiration and respiration rates and slows down ripening processes (Shehata *et al.*, 2012). Chitosan stimulates plant growth and induces both biotic and abiotic stress tolerance in various horticultural crops (Malerba and Cerana, 2016). Foliar application with chitosan at 150 mg L^{-}

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[1] recorded maximum number of branches, number of fruits as well as yield under salinity stress (Ullah *et al*., 2020).

Salicylic acid (SA) is considered as a hormone like substance, acts a key role in regulating several physiological processes in plants as growth, photosynthesis, flowering, ions uptake and transportation, stomatal closure, ethylene biosynthesis inhibition, membrane permeability and transpiration (Ashraf *et al*. 2010). On cucumber, foliar application with salicylic acid at 0.30 g L^{-1} significantly improved stem length, number of leaves and branches, foliage fresh weight as well as leaves area (Nada and Abd El-Hady, 2019).

Therefore, this investigation aimed to study the effects of grafting, some foliar applications as well as their interactions on vegetative growth, leaf pigments, fruits yield and quality of two cucumber cultivars under high plastic tunnels and the environmental conditions of El-Gharbia Governorate, Egypt.

MATERIALS AND METHODS

Under high plastic tunnels in a private farm at Behbate El-hegara village, Samannoud District, El-Gharbia Governorate, Egypt, two field experiments were conducted during 2017/2018 and 2018/2019 seasons to study the effects of grafting, some foliar applications (ascorbic acid, chitosan and salicylic acid) as well as their interactions on vegetative growth, leaf pigments, fruits yield and quality of two cucumber cultivars.

The experimental layout was split-split plot design in randomized complete blocks with three replicates. The main-plots were devoted to cucumber cultivars (King-53 and Sultan) F_1 hybrids. The sub-plots were allocated to the grafting treatments (grafting and non-grafting). Grafting the two cucumber cultivars was applied onto Shintozwa (*Cucurbita maxima* x *Cucurbita moschata*) rootstock by cleft grafting method according to Kubota *et al.*, 2008. Foliar application treatments were randomly distributed in the sub-sub plots as follows:

1. Control treatment (sprayed with tap water).
2. Ascorbic acid at 200 ppm: Obtained from El-Gomhouria Company for Trading Pharmaceutical Chemical & Medical.
3. Chitosan at 250 ppm: Preparation of chitosan produced by Oxford Laboratory India. It includes chitosan 90-95% (2-Amino-2-deoxy-beta-D-glucosamine). Chitosan powder was dissolved in acetic acid 5%.
4. Salicylic acid at 200 ppm: Salicylic acid (SA) powder was dissolved in methanol.

After 10 days from transplanting, all applied foliar substances were sprayed and repeated five times every 10 days.

The experiment treatments were carried out in six high tunnels with 192 m^2 (6 m width x 32 m long). Each high tunnel contains eight experimental basic units (sub- sub plot) with 21 m^2 (4 ridges x 1.5 m width x 3.5 m long). Each plot contains 28 plant transplanted in a single row per ridge at dripper with line 0.5 distance. A distance of 0.5 m was left as a border between plots. A distance of 3 m walkers was left between the tunnels and one meter between each two tunnels, so the total consumed area of the tunnel equals 245 m^2 (7 m width x 35 m length) which lead to 17 high tunnels per fed.

On the main stem, the first four nodes were let to grow without either fruits or lateral branches, the following five nodes were let to grow only fruits, the following ten nodes were let to grow both fruits and lateral branches which were pruned only for three nodes (only fruits), finally all the above grown nodes were let to grow both fruits and lateral branches which were pruned only for two nodes (only fruits).

Soil samples were taken at random from the experimental field area at a depth of 0 - 30 cm from soil surface before soil preparation to measure the physical and chemical soil properties according to Page, 1982 as shown in Table 1.

Table 1. Some physical and chemical soil properties of the experimental field area during 2017/2018 and 2018/2019 seasons.

Soil analysis		2017/2018 Season	2018/2019 Season
A: Mechanical analysis:			
Coarse sand (%)		3.29	3.67
Fine sand (%)		26.65	25.64
Silt (%)		37.73	37.79
Clay (%)		32.33	32.9
Texture class		Clay loam (CL)	
Filed capacity (FC %)		28.5	28.6
Saturation (%)		58.9	59.6
B: Chemical analysis:			
EC ds m^{-1} (1 : 5)		1.02	1.40
pH (1 : 2.5)		7.76	7.88
Organic matter (%)		1.76	1.82
$CaCO_3$ (%)		3.95	3.05
Available (mg/kg)	N	46.9	47.7
	P	4.87	5.04
	K	217.4	189.2

Grafted and non-grafted cucumber transplants were planted in high tunnels on 30th October individually at the dripper in the two growing seasons of the study. All agricultural practices for drip irrigation, fertilization, pest and disease control were applied according to Ministry of Agriculture and Land Reclamation recommendations.

Collected data:

1. **Vegetative growth parameters:** Three plants from each sub-sub plot at 45 days after transplanting were randomly chosen for determining main stem length (cm), foliage fresh weight (g/plant), nodes number on the main stem, leaves number per plant, leaves area (cm^2), branches number per plant and leaves dry matter (%) while leaves samples were weighed as fresh weight and then oven dried at 70 °C until constant weight, then leaves dry matter percentage was calculated.
2. **Leaf pigments:** The leaves samples (the fifth leaf from the top of meristem) at 45 days from transplanting was used to determinate Chlorophylls a, b and total carotenoids according to the method of Moran and Porath, 1982.
3. **Fruits yield:** Harvesting stage started from 3rd December till 26th may (47 pickings) in each season. All fruits number and weight were calculated and recorded each picking all over season per plot (25 plants) to determine fruits number per plant (fruit/plant), fruits fresh weight per plant (kg/plant), early fruits yield measured as weight of fresh fruits of the first 15 pickings as (ton/tunnel and

ton/fed) and total fruits yield measured as (ton/tunnel and ton/fed).

4. **Fruit quality:** Samples from cucumber fruits at 65 days from transplanting were taken to determine fruits dry matter percentage, total soluble solids (TSS) and vitamin C according to the method reported in AOAC, 1990.

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split-split plot design in randomized complete blocks as published by Gomez and Gomez, 1984 by using means of "MSTAT-C" computer software package. Least significant difference (LSD) method was used to test the differences among treatment means at 5% level of probability as described by Snedecor and Cochran, 1980.

RESULTS AND DISCUSSION

1. Effects of cultivars:

As shown from the obtained results in Tables 2, 4, 6 and 8, there were significant differences between the studied cucumber cultivars (King-53 and Sultan) in vegetative growth parameters (stem length, foliage fresh weight, nodes number on the main stem, leaves number per plant, leaves area, branches number per plant and leaves dry matter percentage), leaf pigments (chlorophylls a, b and total carotenoids), fruits yield (fruits number per plant, fruits fresh weight per plant, early and total fruits yield) as well as fruits quality (fruits dry matter percentage, total soluble solids and vitamin C content) of cucumber in the two growing seasons. Sultan cultivar recorded the highest values of all the above-mentioned parameters in both seasons.

The observed differences in the studied varieties can be attributed to the genetic composition of the used varieties; Sultan cultivar may be quicker in growth or the vegetative characters may be more active than King-53 cultivar which reflected positively on the higher yield and the improved fruit quality. These resulted are in agreement with Borbora and Sapna, 2017; Daha *et al.* (2020) and Parkash *et al.* (2021) on cucumber.

2. Effects of grafting:

Significant differences were obtained in all studied parameters in response to grafting in both seasons (Tables 2, 4, 6 and 8). The grafted plants recorded the maximum values of stem length, foliage fresh weight, nodes number on the main stem, leaves number per plant, leaves area, branches number per plant, leaves dry matter percentage chlorophylls a, b, total carotenoids, fruits number per plant, fruits fresh weight per plant, early and total fruits yield, fruits dry matter percentage, total soluble solids and vitamin C content in both seasons.

These observed favorable effects of grafting on cucumber plants may be due to the fact that, the vascular tissues of both the scion and rootstock become aligned to form a continuous vascular connection and for a successful wound healing to occur. Healing at the graft junction is due to the formation of new cells from the meristematic tissue between xylem and phloem (Cui *et al.*, 2021). Vascular connection interference impairs the distribution of photo assimilates through the phloem, nutrients and water through the xylem (Souza *et al*., 2018). Additionally, rootstocks play key roles in nutrient and water uptake through the vigor root system that influences absorption and translocation of mineral nutrients and increase photosynthesis (Hu *et al.*, 2005 and Al-Harbi *et al.*, 2018). These results are in partial companionable with those stated by Dawa *et al.*, 2017; Bayoumi *et al.*, 2021 and El-Sayed *et al.*, 2021 on cucumber.

3. Effects of foliar applications:

Cucumber plants responded positively to the applied foliar substances, *i.e.*, ascorbic acid, chitosan as well as salicylic acid in both growing seasons (Tables 2, 4, 6 and 8). Plants sprayed with salicylic acid at 200 ppm are the superior in recording the best values of vegetative growth parameters leaf pigments, fruits yield and fruit quality in both seasons. Foliar application with chitosan at 250 ppm came in the second order followed by spraying ascorbic acid at 200 ppm, while the control treatment recorded the lowest values.

These positive response of cucumber plants to salicylic acid at 200 ppm may be due to that salicylic acid is considered as a hormone like substance, which acts an important role in regulating physiological processes in plants as growth, flowering, photosynthesis, stomata closure, ions uptake and transportation, inhibition of ethylene biosynthesis, membrane permeability as well as transpiration (Ashraf *et al.* 2010). In addition, chitosan has been proven to stimulate plant growth, protect the safety of edible products and induce both biotic and abiotic stress tolerance (Malerba and Cerana, 2016). Also, ascorbic acid not only acts as an antioxidant but the cellular levels of ascorbic acid are correlated with the activation of complex biological defense mechanisms (Khan *et al.*, 2010), which was reflect on increases in vine length and foliage fresh weight/plant of cucumber. These results were parallel with those reported by Ullah *et al.*, 2020 using chitosan, Ghahremani *et al.*, 2021 applying ascorbic acid and more recently Selem *et al.*, 2022 spraying ascorbic and salicylic acids on tomato, cucumber and potato, respectively.

4. Effects of the interactions:

With regard to the interactions among the studied factors, vegetative growth parameters (stem length, foliage fresh weight, nodes number on the main stem, leaves number per plant, leaves area, branches number per plant and leaves dry matter percentage), leaf pigments (chlorophylls a, b and total carotenoids), fruits yield (fruits number per plant, fruits fresh weight per plant, early and total fruits yield as well as fruits quality (fruits dry matter percentage, total soluble solids and vitamin C content) of cucumber plants were significantly affected by the interaction among cultivars, grafting and foliar application treatments in both seasons (Tables 3, 5, 7 and 9).

The highest values of all the above-mentioned parameters were resulted from grafting Sultan cultivar and spraying salicylic acid at 200 ppm in both seasons. The second best combination was grafting Sultan cultivar and spraying chitosan at 250 ppm in both seasons. In contrast, the non-grafted King-53 cultivar in the absence of foliar substances produced the lowest values the studied parameters in both seasons.

Table 2. Stem length, foliage fresh weight, nodes number on the main stem, leaves number per plant, leaves area, branches number per plant and leaves dry matter percentage of cucumber as affected by cultivars, grafting and foliar application treatments as well as their interactions during 2017/2018 and 2018/2019 seasons.

Characters	Stem length (cm)		Foliage fresh weight (g/plant)		Nodes number / main stem		Leaves number /plant		Leaves area (cm^2)		Branches number/ plant		Leaves dry matter (%)	
Treatments	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**
A- Cucumber cultivars:														
King-53	180.4	186.0	212.2	218.8	16.53	17.04	25.59	26.39	2159.4	2226.5	3.95	4.07	6.77	6.98
Sultan	198.5	204.9	233.6	241.1	17.41	17.97	26.97	27.83	2377.1	2453.3	4.16	4.29	7.13	7.36
B- Grafting treatments:														
Grafting	192.0	199.9	226.9	235.2	17.28	17.92	26.76	27.74	2309.1	2393.6	4.13	4.28	7.08	7.34
Non-grafting	186.0	190.9	218.9	224.6	16.66	17.10	25.79	26.47	2227.3	2286.1	3.98	4.08	6.82	7.00
C- Foliar application treatments:														
Control treatment	181.7	186.3	213.7	219.2	16.26	16.67	25.17	25.82	2174.8	2230.6	3.88	3.98	6.66	6.83
Ascorbic acid at 200 ppm	187.0	192.9	220.1	227.0	16.75	17.28	25.94	26.76	2239.4	2310.2	4.00	4.13	6.86	7.08
Chitosan at 250 ppm	192.8	199.2	226.8	234.4	17.27	17.85	26.75	27.64	2307.7	2385.2	4.12	4.26	7.07	7.31
Salicylic acid at 200 ppm	196.3	203.3	231.0	239.1	17.60	18.22	27.26	28.22	2350.9	2433.5	4.20	4.35	7.21	7.46
LSD at 5 %	2.5	2.6	3.0	3.2	0.28	0.24	0.36	0.37	30.5	31.4	0.05	0.06	0.09	0.10
D- Interactions (F. test):														
A × B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
A × C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B × C	*	*	*	*	*	*	NS	NS	*	NS	*	*	*	*
A × B × C	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Table 3. Stem length, foliage fresh weight, nodes number on the main stem, leaves number per plant, leaves area, branches number per plant and leaves dry matter percentage of cucumber as affected by the interaction among cultivars, grafting and foliar application treatments during 2017/2018 and 2018/2019 seasons.

Characters			Stem height (cm)		Foliage fresh weight (g/plant)		Nodes number /main stem		Leaves number / plant		Leaves area (cm^2)		Branches number /plant		Leaves dry matter (%)	
Cultivars	**Grafting**	**Foliar**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**
King-53	Grafting	Control	176.5	181.8	207.6	213.8	16.17	16.66	25.04	25.79	2112.6	2176.1	3.86	3.98	6.62	6.82
		Ascorbic acid	181.5	188.1	213.6	221.3	16.63	17.24	25.76	26.69	2173.4	2251.6	3.97	4.12	6.81	7.06
		Chitosan	186.1	193.2	219.0	227.3	17.05	17.70	26.40	27.41	2228.0	2312.6	4.07	4.23	6.98	7.25
		Salicylic acid	191.6	199.3	225.4	234.4	17.56	18.26	27.19	28.27	2293.9	2385.6	4.19	4.36	7.19	7.48
	Non-grafting	Control	168.9	172.3	198.7	202.7	15.48	15.78	23.96	24.45	2022.0	2062.5	3.70	3.77	6.34	6.47
		Ascorbic acid	174.7	179.3	205.6	210.9	16.01	16.43	24.79	25.44	2092.1	2146.4	3.82	3.92	6.56	6.73
		Chitosan	184.0	189.2	216.5	222.6	16.86	17.34	26.11	26.84	2203.2	2264.9	4.03	4.14	6.91	7.10
		Salicylic acid	179.6	184.8	211.3	217.4	16.45	16.93	25.48	26.22	2149.7	2212.0	3.93	4.04	6.74	6.93
Sultan	Grafting	Control	195.0	201.0	229.4	236.5	17.08	17.61	26.46	27.28	2333.8	2406.2	4.08	4.21	7.00	7.21
		Ascorbic acid	198.0	205.4	233.0	241.6	17.37	18.01	26.89	27.89	2370.9	2458.6	4.15	4.30	7.11	7.38
		Chitosan	204.3	212.2	240.4	249.6	17.94	18.63	27.77	28.86	2445.0	2540.4	4.29	4.45	7.36	7.63
		Salicylic acid	210.1	218.7	247.2	257.3	18.47	19.23	28.60	29.78	2515.0	2618.1	4.41	4.59	7.57	7.88
	Non-grafting	Control	186.3	190.2	219.2	223.8	16.30	16.64	25.23	25.77	2230.9	2277.7	3.89	3.97	6.67	6.81
		Ascorbic acid	193.9	199.1	228.1	234.3	16.99	17.45	26.31	27.02	2321.5	2384.2	4.06	4.17	6.96	7.15
		Chitosan	196.7	202.3	231.4	238.1	17.24	17.74	26.70	27.48	2354.4	2422.7	4.12	4.24	7.06	7.27
		Salicylic acid	204.2	210.3	240.3	247.5	17.93	18.47	27.77	28.61	2445.0	2518.4	4.28	4.41	7.34	7.57
LSD at 5 %			5.1	5.2	6.0	6.1	0.56	0.48	0.72	0.74	61.0	62.7	0.11	0.12	0.19	0.20

Table 4. Chlorophylls a, b and total carotenoids content in leaves of cucumber as affected by cultivars, grafting and foliar application treatments as well as their interactions during 2017/2018 and 2018/2019 seasons.

Characters	Chl. a (mg/100 g F.W.)		Chl. b (mg/100 g F.W.)		Total Carotenoids (mg/100 g F.W.)	
Treatments	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**
A- Cucumber cultivars:						
King-53	77.85	80.27	37.58	38.75	22.71	23.42
Sultan	82.03	84.66	39.52	40.79	23.93	24.70
B- Grafting treatments:						
Grafting	81.41	84.40	38.91	40.33	23.75	24.62
Non-grafting	78.47	80.54	38.19	39.20	22.89	23.50
C- Foliar application treatments:						
Control treatment	76.57	78.54	36.71	37.65	22.34	22.91
Ascorbic acid at 200 ppm	78.90	81.40	38.31	39.52	23.02	23.75
Chitosan at 250 ppm	81.36	84.09	39.05	40.36	23.74	24.53
Salicylic acid at 200 ppm	82.92	85.84	40.13	41.54	24.19	25.04
LSD at 5 %	1.10	1.13	0.68	0.70	0.32	0.33
D- Interactions (F. test):						
A × B	NS	NS	NS	NS	NS	NS
A × C	NS	NS	NS	NS	NS	NS
B × C	*	*	*	*	*	*
A × B × C	*	*	*	*	*	*

Table 5. Chlorophylls a, b and total carotenoids content in leaves of cucumber as affected by the interaction among cultivars, grafting and foliar application treatments during 2017/2018 and 2018/2019 seasons.

Characters / Treatments			Chl. a (mg/100 g F.W.)		Chl. b (mg/100 g F.W.)		Total Carotenoids (mg/100 g F.W.)	
Cultivars	Grafting	Foliar	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019
King-53	Grafting	Control	76.17	78.45	34.80	35.84	22.22	22.89
		Ascorbic acid	78.36	81.18	38.01	39.38	22.86	23.68
		Chitosan	80.32	83.38	39.00	40.48	23.44	24.32
		Salicylic acid	82.70	86.01	39.79	41.39	24.12	25.09
	Non-grafting	Control	72.90	74.36	35.78	36.50	21.27	21.70
		Ascorbic acid	75.42	77.39	37.02	37.98	22.01	22.58
		Chitosan	79.43	81.66	37.81	38.87	23.18	23.83
		Salicylic acid	77.51	79.75	38.41	39.52	22.61	23.27
Sultan	Grafting	Control	80.47	82.97	38.70	39.91	23.48	24.21
		Ascorbic acid	81.81	84.83	39.99	41.47	23.87	24.75
		Chitosan	84.48	87.78	41.55	42.80	24.65	25.61
		Salicylic acid	87.01	90.57	40.78	42.45	25.38	26.42
	Non-grafting	Control	76.76	78.37	37.57	38.36	22.40	22.87
		Ascorbic acid	80.03	82.19	38.21	39.24	23.35	23.98
		Chitosan	81.22	83.57	39.20	40.34	23.70	24.38
		Salicylic acid	84.48	87.02	40.19	41.76	24.65	25.39
LSD at 5 %			2.20	2.26	1.36	1.41	0.55	0.66

Table 6. Fruits number/plant, fruits fresh weight/plant, early fruits yield and total fruits yield of cucumber as affected by cultivars, grafting and foliar application treatments as well as their interactions during 2017/2018 and 2018/2019 seasons.

Characters / Treatments	Fruits number /plant		Fruits fresh weight (kg/plant)		Early fruits yield (ton/tunnel)		Early fruits yield (ton/fed)*		Total fruits yield (ton/tunnel)		Total fruits yield (ton/fed)*	
	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019
A- Cucumber cultivars:												
King-53	127.3	131.3	13.07	13.47	0.694	0.718	11.81	12.21	2.61	2.69	44.43	45.81
Sultan	140.1	144.6	13.77	14.21	0.732	0.758	12.44	12.88	2.75	2.84	46.82	48.32
B- Grafting treatments:												
Grafting	136.1	141.1	13.66	14.16	0.726	0.755	12.35	12.84	2.73	2.83	46.47	48.17
Non-grafting	131.3	134.8	13.17	13.52	0.700	0.721	11.90	12.25	2.63	2.70	44.79	45.97
C- Foliar application treatments:												
Control treatment	128.2	131.5	12.85	13.18	0.683	0.703	11.62	11.95	2.57	2.63	43.71	44.83
Ascorbic acid at 200 ppm	132.0	136.2	13.24	13.66	0.704	0.728	11.97	12.39	2.64	2.73	45.03	46.46
Chitosan at 250 ppm	136.0	140.6	13.66	14.11	0.726	0.753	12.34	12.80	2.73	2.82	46.44	48.00
Salicylic acid at 200 ppm	138.6	143.5	13.92	14.41	0.740	0.768	12.58	13.06	2.78	2.88	47.33	48.99
LSD at 5 %	1.8	1.9	0.18	0.19	0.009	0.010	0.16	0.17	0.03	0.04	0.62	0.64
D- Interactions (F. test):												
A × B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
A × C	*	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B × C	*	*	*	*	*	*	*	*	*	*	*	*
A × B × C	*	*	*	*	*	*	*	*	*	*	*	*

*** Calculated as 17 tunnels/fed.**

Table 7. Fruits number/plant, fruits fresh weight/plant, early fruits yield and total fruits yield of cucumber as affected by the interaction among cultivars, grafting and foliar application treatments during 2017/2018 and 2018/2019 seasons

Characters			Fruits number/plant		Fruits fresh weight/ plant (kg/plant)		Early fruits yield (ton/tunnel)		Early fruits yield (ton/fed)*		Total fruits yield (ton/tunnel)		Total fruits yield (ton/fed)*	
Cultivars	Grafting	Foliar	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019	2017/ 2018	2018/ 2019
King -53	Grafting	Control	124.5	128.3	12.78	13.17	0.679	0.702	11.55	11.94	2.55	2.63	43.47	44.78
		Ascorbic acid	128.1	132.7	13.15	13.62	0.699	0.726	11.89	12.35	2.63	2.72	44.72	46.33
		Chitosan	131.3	136.3	13.48	13.99	0.717	0.746	12.18	12.69	2.69	2.79	45.85	47.59
		Salicylic acid	135.2	140.6	13.88	14.44	0.738	0.770	12.54	13.09	2.77	2.88	47.20	49.09
	Non-grafting	Control	119.2	121.6	12.23	12.48	0.650	0.665	11.06	11.31	2.44	2.49	41.61	42.44
		Ascorbic acid	123.3	126.5	12.66	12.99	0.673	0.692	11.44	11.77	2.53	2.59	43.05	44.17
		Chitosan	129.9	133.5	13.33	13.71	0.709	0.731	12.05	12.43	2.66	2.74	45.34	46.61
		Salicylic acid	126.7	130.4	13.01	13.38	0.691	0.714	11.76	12.13	2.60	2.67	44.23	45.52
Sultan	Grafting	Control	137.6	141.9	13.51	13.93	0.718	0.742	12.21	12.62	2.70	2.78	45.93	47.35
		Ascorbic acid	139.8	144.9	13.73	14.24	0.730	0.759	12.41	12.91	2.74	2.84	46.69	48.42
		Chitosan	144.2	149.8	14.19	14.73	0.754	0.785	12.81	13.36	2.83	2.94	48.22	50.10
		Salicylic acid	148.3	154.3	14.60	15.20	0.776	0.811	13.20	13.78	2.92	3.04	49.66	51.70
	Non-grafting	Control	131.5	134.3	12.88	13.15	0.685	0.701	11.64	11.93	2.57	2.63	43.81	44.73
		Ascorbic acid	136.9	140.5	13.43	13.80	0.714	0.735	12.14	12.51	2.68	2.75	45.68	46.91
		Chitosan	138.8	142.8	13.63	14.02	0.724	0.748	12.32	12.72	2.72	2.80	46.35	47.70
		Salicylic acid	144.1	148.5	14.18	14.60	0.754	0.779	12.81	13.24	2.83	2.92	48.22	49.66
LSD at 5 %			3.6	3.7	0.36	0.38	0.020	0.021	0.34	0.35	0.07	0.10	1.38	1.42

***calculated as 17 tunnels/fed.**

Table 8. Fruits dry matter percentage, total soluble solids "TSS" percentage and vitamin C content in cucumber fruits as affected by cultivars, grafting and foliar application treatments as well as their interactions during 2017/2018 and 2018/2019 seasons.

Characters	Fruits dry matter (%)		TSS (%)		Vitamin C (mg/100g F.W.)	
Treatments	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**	**2017/ 2018**	**2018/ 2019**
A- Cucumber cultivars:						
King-53	4.15	4.28	3.70	3.81	34.66	35.73
Sultan	4.38	4.52	3.90	4.02	36.52	37.69
B- Grafting treatments:						
Grafting	4.34	4.50	3.87	4.01	36.24	37.57
Non-grafting	4.19	4.30	3.73	3.83	34.93	35.85
C- Foliar application treatments:						
Control treatment	4.09	4.19	3.64	3.73	34.09	34.96
Ascorbic acid at 200ppm	4.21	4.34	3.75	3.87	35.13	36.23
Chitosan at 250 ppm	4.34	4.49	3.87	4.00	36.22	37.44
Salicylic acid at 200 ppm	4.43	4.58	3.94	4.08	36.92	38.21
LSD at 5 %	0.06	0.06	0.05	0.06	0.49	0.50
D- Interactions (F. test):						
A × B	NS	NS	NS	NS	NS	NS
A × C	NS	NS	NS	NS	NS	NS
B × C	*	*	*	*	NS	NS
A × B × C	*	*	*	*	*	*

Table 9. Fruits dry matter percentage, total soluble solids "TSS" percentage and vitamin C content in cucumber fruits as affected by the interaction among cultivars, grafting and foliar application treatments during 2017/2018 and 2018/2019 seasons.

Characters			Fruits dry matter (%)		TSS (%)		Vitamin C (mg/100 g F.W.)	
Cultivars	**Grafting**	**Foliar**	**2017/2018**	**2018/2019**	**2017/2018**	**2018/2019**	**2017/2018**	**2018/2019**
King-53	Grafting	Control	4.06	4.19	3.62	3.73	33.91	34.93
		Ascorbic acid	4.18	4.33	3.72	3.86	34.88	36.14
		Chitosan	4.29	4.45	3.82	3.96	35.76	37.12
		Salicylic acid	4.41	4.59	3.93	4.09	36.82	38.29
	Non-grafting	Control	3.89	3.97	3.47	3.54	32.45	33.10
		Ascorbic acid	4.03	4.13	3.58	3.68	33.58	34.45
		Chitosan	4.24	4.36	3.77	3.88	35.36	36.35
		Salicylic acid	4.14	4.26	3.68	3.79	34.50	35.51
Sultan	Grafting	Control	4.30	4.43	3.82	3.94	35.83	36.94
		Ascorbic acid	4.37	4.53	3.89	4.14	36.42	37.77
		Chitosan	4.52	4.68	4.03	4.17	37.61	39.07
		Salicylic acid	4.64	4.83	4.13	4.30	38.74	40.32
	Non-grafting	Control	4.10	4.18	3.65	3.73	34.17	34.89
		Ascorbic acid	4.27	4.39	3.80	3.91	35.63	36.59
		Chitosan	4.34	4.46	3.86	3.97	36.16	37.21
		Salicylic acid	4.51	4.64	4.01	4.03	37.61	38.74
LSD at 5 %			0.11	0.12	0.15	0.11	1.12	1.00

CONCLUSION

From the obtained results of this study, it is clear that grafting Sultan cucumber cultivar and spraying plants with salicylic acid at 200 ppm can be recommended in order to obtain the best plants performance (vegetative growth, leaf pigments, fruits yield and quality) under high plastic tunnels and the environmental conditions of Samannoud District, El-Gharbia Governorate, Egypt.

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استجابة بعض أصناف الخيار النامي تحت ظروف الأنفاق البلاستيكية العالية للتطعيم وبعض معاملات الرش الورقي

كوثر كامل أحمد ضوه ، السعيد السيد متولى ، ولاء محمد السعيد سويلم وأحمد فتحي فكري محمد مرجان

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الملخص

أقيمت تجربتان حقليتان خلال موسمي شتاء متتاليين 2018/2017 و 2019/2018 تحت الأنفاق البلاستيكية العالية بمزرعة خاصة بقرية بهبيت الحجارة بمركز سمنود بمحافظة الغربية، مصر لدراسة تأثير التطعيم وبعض مواد الرش الورقي (حمض الأسكوربيك ، الشيتوزان وحمض الساليسيليك) وكذلك التفاعل فيما بينهم على النمو الخضري، الصبغات ، محصول الثمار وجودتها لصنفين من الخيار (كينج -53 و سلطان). بالمقارنة بين الاصناف وجد أن صنف سلطان تفوق على صنف كينج -53 في جميع الصفات محل الدراسة في كلا موسمي الزراعة. كذلك أثبتت النباتات المطعومة كفاءتها حيث أشارت النتائج المتحصل عليها أن النباتات المطعومة سجلت أعلى النتائج للصفات المدروسة. أما بالنسبة لمواد الرش المستخدمة فقد أدى رش النباتات بحمض الساليسيليك بمعدل 200 جزء في المليون الى تسجيل أعلى قيم صفات النمو الخضري، الصبغات، محصول الثمار وجودتها يليه معاملة الرش الورقي بالشيتوزان بمعدل 250 جزء في المليون. كذلك أوضحت النتائج التي تم الحصول عليها من هذه الدراسة بامكانية بتطعيم صنف الخيار سلطان والرش الورقي للنباتات بحمض الساليسيليك بمعدل 200 جزء في المليون من أجل الحصول على أعلى صفات للنمو الخضري والصبغات وإجمالى محصول للثمار وأفضل صفات لجودة الثمار تحت الأنفاق البلاستيكية العالية تحت ظروف التجربة.