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(Original Article)

Impact of Seedling Dates and Different Foliar Applications on Growth and Productivity of Cucumber Hybrids (Barracuda.) under Protected Agricultural Systems

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Abstract

Two experiments were conducted to study the effect of two seedling dates and foliar application of Algae extract, Moringa extract, fulvic acid and Mepiquat chloride on some growth and fruit productivity of cucumber plants (*Cucumis sativus* L.) cv. barracuda at private farm in "Awlad Al-Sharif" village in Dirout city, Assiut Governorate, Egypt. Two experiments were conducted during the successive seasons of 2019/2020 and 2020/2021 inside greenhouses. Spraying cucumber plants was done with two concentrations three weeks after seedling two times at 15 day intervals each. The experiment was laid out in Randomized Complete Block Design (RCBD) with a split-plot arrangement in three replications. Seedling dates were assigned in the main plot and foliar application (with two concentrations) was arranged in sub-plot.

Results indicate that planting cucumber seedlings early in November under protected agricultural systems leads to significant effect on all traits under the study except fruit length and fruit diameter compared to the second seeding date, respectively. All foliar application treatments and their interactions gave highly response in all traits especially the high concentration of algae (3 g/m^3) and fulvic (3 g/m^3) compared with other treatments.

Keywords: *Cucumber, Seedling dates, Algae extract, Moringa extract, Fulvic acid, Mepiquat chloride*

Introduction

In the last three decades, Egypt's government has rapidly expanded to introduce many vegetable crops under protected cropping. Especially, greenhouse design and operation adapted with Egyptian climatic conditions (Zakher and Abdrabbo, 2014). Cucumber (*Cucumis sativus*) is considered one of the most important vegetable crops in Egypt, Cucumber is considered the fourth most important vegetable crop after tomato, cabbage, and onion (Tatlioglu, 1993). In Egypt, total greenhouse area for cucumber production increased gradually from 5395 thousand square meters in 2004 up to 11.915 million square meters in 2014, and the production increased from 60 thousand ton in 2004 up to 161 thousand ton

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in 2014 (Ministry of Agriculture, 2015). Foliar spraying is a new method for crop feeding which micro and macronutrients in form of liquid are absorbed by leaves (Nasiri *et al*., 2010).

Several investigations have studied the impacts of different concentration of different spraying applications on cucumber plants under greenhouse conditions. Sarhan *et al*., (2011) revealed that the highest values of cucumber (C.V. shadi) shoot and yield characteristics under plastic house were recorded by spraying 6 gm / L bread yeast and sprayed with a mixture of (0.33 ml / L Alga 600 + 2.5 ml / L Sea force 2). Furthermore, applied (75 and 100 %) of the recommended mineral N rate (NRR) combined with foliar application by (10 or 15 %) algae extract was considered the most favorable interaction treatments for maximizing yield and improving seeds quality (Dalia *et al*., (2014).

In order to decrease the recommended mineral fertilizers, Abd El-Hady and Abd-Elhamied (2018) found that soil fertilization of 75% from the recommended rate of NPK plus foliar application of NPK and foliar spray by Moringa leaf extract reduced production costs and mitigate the environmental pollution and protect the human health. Also, foliar of Moringa leaf extract at 20 percent recorded the highest production, minerals, and nutraceutical-related characteristics in stevia plants in comparison with other treatments (Hassan *et al.*, 2021).

Also, Hamail *et al*., (2014) study the impact of nitrogen fertilization forms and some bio-stimulants (humic acid, fulvic acid, EM and yeast extract) under high temperature on flowering characters, yield and its components of cucumber (*Cucumis sativus L*.) cv. Prince. They found that fulvic acid, as well as all bio-stimulants increased cucumber productivity in comparison to the control. Additionally, spraying cucumber plants by Humic acids (HA) at 3 g / L increased dry weight of leaves, branches and shoots/plant, chlorophyll a, b and total (a + b), number of fruits/plant, average fruit weight, yield/plant and yield /m^2 (Qassem *et al*., 2022).

Kim *et al*., (2011) study the impact of mepiquat chloride (MC) and trinexapac-ethyl on oil composition, seed yield and endogenous gibberellins content of flax cultivar. They found that spraying MC significantly increased seed oil yield (730 kg ha^{-1} by 27.0%) in comparison to the control. Seed and oil yield, and unsaturated fatty acids (oleic acid, linoleic acid and linolenic acid) were increased by foliar application of MC. Moreover, spraying onion leaves by 125 g ha^{-1} of mepiquat chloride at 35 DAT also recorded the maximum number of leaves (9.57), neck diameter (2.15 cm), root length (8.03 cm), total chlorophyll content (2.37 mg/g), bulb diameter (5.80 cm), bulb yield (53.27 kg per plot), yield ha^{-1} (295.93 ton) and B:C ratio (1.80:1) of onion (cv. Agrifound Light Red) (Pal *et al*., 2017).

Materials and Methods

The present experiments were carried out during the seasons of 2019/2020 and 2020/2021 at private farm in "Awlad Al-Sharif" village in Dirout city, Assiut Governorate, Egypt. Two experiments (Two greenhouses each season) were

conducted in order to study the impact of two seedling dates and foliar application of Algae extract, Moringa extract, fulvic acid and Mepiquat chloride on some growth, fruit quality and productivity of cucumber plants (*Cucumis sativus*) cv. Barracuda. Three weeks after seedling, cucumber plants were sprayed with two concentrations two times with 15-day intervals each. The experiment was laid out in Randomized Complete Block Design (RCBD) with a split-plot arrangement in three replications. Seedling dates were assigned in the main plot and foliar application (with two concentrations) was arranged in sub-plot.

Cucumber seeds were sown on the 1st and 25th of November in trays. Seedling trays were kept in the nursery greenhouse and followed by regular practices for 25 days where the transplants became 10 to 12 cm tall. Cucumber seedlings were planted in the two greenhouses; one on the 25th of November and the other on the 10th of December in both seasons, Soil in the plots had a pH of 7.38 and 7.44 in soil depth (0-20 and 20-40), respectively. ECe (dS m-1) recorded 3.07 and 4.18). Soil analysis raveled that total N, available phosphorus and potassium were sufficient. Measurements for each harvest were recorded from the two center rows. Total fruit weight of yield per experimental unit was evaluated from each treatment and harvest frequency. All agricultural management such as irrigation, fertilization and pest control were achieved for all treatments as recommended. Cucumber fruits were harvested 5 times and the weight was recorded in each collection.

Sub main plot (Treatments: Foliar application)

T1. Spraying distilled water (Control)

T2. Spraying Algae extract at rate of 2 g/m^3

T3. Spraying Algae extract at rate of 3 g /m^3

T4. Spraying Moringa extract at rate of 5%

T5. Spraying Moringa extract at rate of 10%

T6. Spraying Fulvic acid at rate of 2 g /m^3

T7. Spraying Fulvic acid at rate of 3 g /m^3

T8. Spraying Mepiquat chloride at rate of 0.5 ml/L

T9. Spraying Mepiquat chloride at rate of 1 ml/L

Recorded data

Plant height (cm), it was measured after 120 days of transplant from the base of the plant to the terminal growing point of tagged plants using a meter scale of each plant of the measured experimental unit.

Fruit Yield: Cucumber fruits at marketable stage were harvested. At harvest time, data for some crop traits were recorded such as:

Fruit Set (%), it was estimated by dividing the cumulative number of fruits for the plants of the experimental unit by the total number of flowers and calculated as a percentage from the following equation:

Fruit Set (%) = (number of fruits formed/number of total flowers) × 100

Number of Fruits per Plant, it was calculated by counting the fruits of the experimental unit cumulatively from the beginning of the harvest until the end of the growing season and divided by the number of plants of the experimental unit.

Average Fruit weight per Plant (g), it was measured by a Balance Sensitive type (Mettler PC 4000), and the fresh fruit weight was calculated by dividing the weight of the experimental unit crop (g) by the number of fruits of the experimental unit.

Fruit Length (cm), it was measured using a ruler for a representative sample (20 fruits) selected randomly and for three picks (early, middle, and late) for each experimental unit. The length of the fruit was calculated by dividing the sum of the lengths of the fruits by their number.

Fruit Diameter (cm), it was measured by Vernier for a representative sample (20 fruits) selected randomly and for three picks (early, middle, and late) for each experimental unit. The diameter of the fruit was calculated for each by dividing the sum of the diameters by their number.

Early Fruit Yield per Greenhouse (ton), it was calculated by the weight of the fruits of the first seven pickings of plants in the experimental unit and multiplied by the ratio between the total greenhouse area of 240 square meters and the experimental unit area of 10 square meters.

Total Fruit yield per greenhouse (ton), it was calculated from the yield of the experimental unit by weighing the yield of plants in the experimental unit and multiplying it by the ratio between the total greenhouse area 240 m^2 and the area of the experimental unit 10 square meters.

Statistical analyses

Obtained results were statistically analyzed using the analysis of variance (ANOVA) procedure for each year was measured. Subsequently, combined ANOVA analysis was tested over two years (Gomez and Gomez, 1984). Useful mean comparisons were determined through the status of significance of the different total variance partitions. Means were separated using the Least Significance Difference (LSD) test at 0.05 level of probability.

Result and Discussion

Effect of seedling dates

Data of all characters recorded as influenced by seedling dates are presented in Figures (1, 2 and 3) and Tables (5-8). Most traits under the study were significantly affected by seedling dates including plant height (cm), fruit set (%), average fruit weight per plant (g), number of fruits per plant, early fruit yield per greenhouse and total fruit yield per greenhouse. Meanwhile, fruit length (cm) and

fruit diameter (cm) were insignificantly affected by seedling dates in the first and second season, respectively.

Generally, mean values of plant height and fruit set due to early seedlings date (D1) recorded the highest value in comparison to the second seedlings date (D2) in both seasons. The increase in plant height (Fig., 1 A and Table 5) and fruit set (Fig., 1 B and Table 5) due to seedling date D1were recorded (3.82% and 4.43 %) and (4.50% and 5.19%) in comparison to D2 in the first and second seasons, respectively.

Also, the improvement in average fruit weight per plant (g) (Fig., 2 A and Table 6) recorded (4.03% and 4.45%) in comparison to the second seedlings date (D2) in both seasons. Moreover, obtained results raveled that number of fruits per plant (Fig., 2 B and Table 6) was also significantly increased by (3.38 and 3.73%) compared to the second seedlings date (D2) in both seasons.

Early fruit yield per greenhouse (ton) (Fig. 3 A and Table 8) and total fruit yield per greenhouse (ton) (Fig. 3 B and Table 8) were positively affected by seedling dates. The increase percentages due to early seedling date (D1) compared to (D2) in early fruit yield per greenhouse (ton) and total fruit yield per greenhouse recorded (4.17 % and 4.84 %) and (3.24 % and 3.70%) in the first and second season, respectively (Fig., 3 A and B and Table 8).

The superiority of the first seedling date over the second in plant length and yield characteristics may be due to the prevailing climatic changes, which may be ideal for the first seedling date over the second, especially the temperature (optimum temperature of ≤ 25 °C) as reported by Pal *et al*., (2020). Many researchers reported that cucumber growth is influenced by genetic and environmental factors, and is therefore, variable according to the growing season and region (Staub and Bacher 2004, Eifediyi and Samson, 2009, Nwofia *et al*., 2015 and Eldlgamony *et al*., (2022). The obtained results may be attributed to the performance of cucumber hybrids which influenced by the planting dates and environmental conditions and as such is variable depending on growing season and region (Staub and Bacher, 2004).

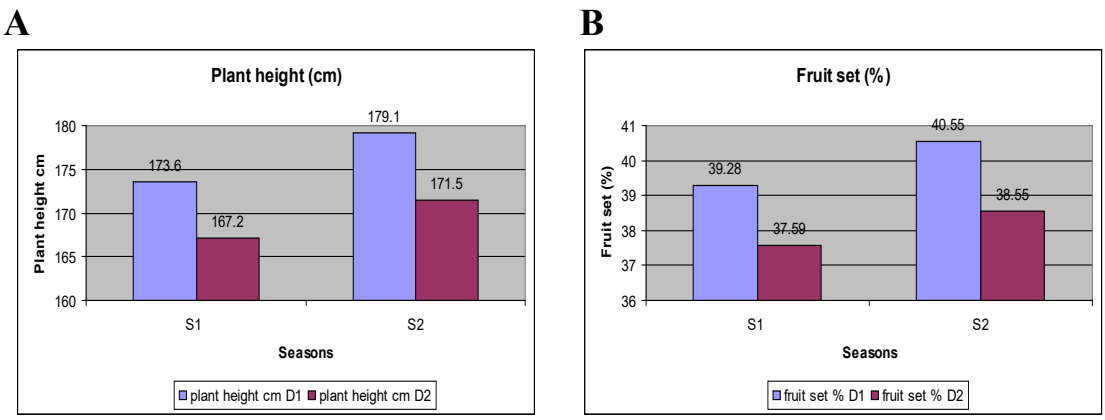

Fig 1. Effect of seedling dates on (A) Plant height (cm) and (B) Fruit set (%) in the first and second seasons.

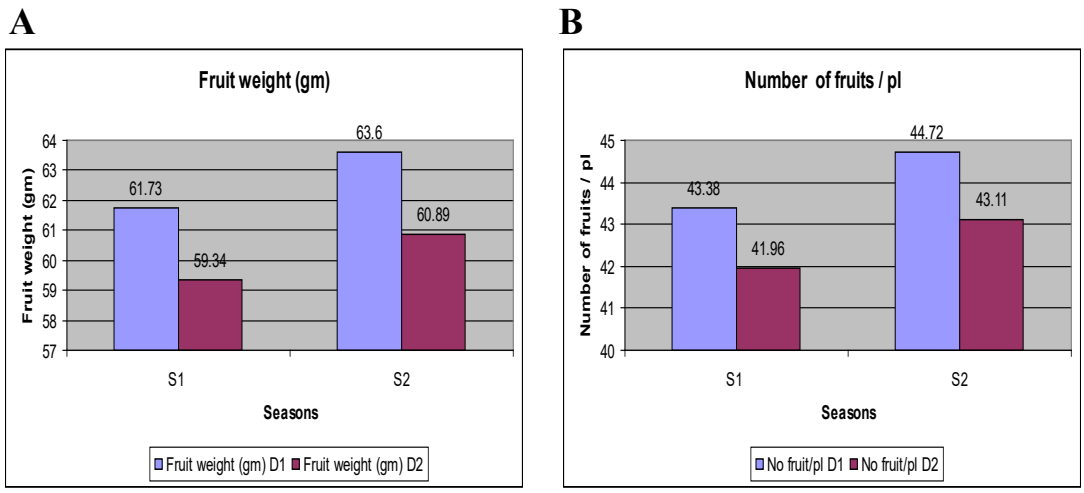

Fig 2. Effect of seedling dates on (A) Average Fruit Weight per Plant (g) and (B) Number of Fruits per Plant in the first and second seasons.

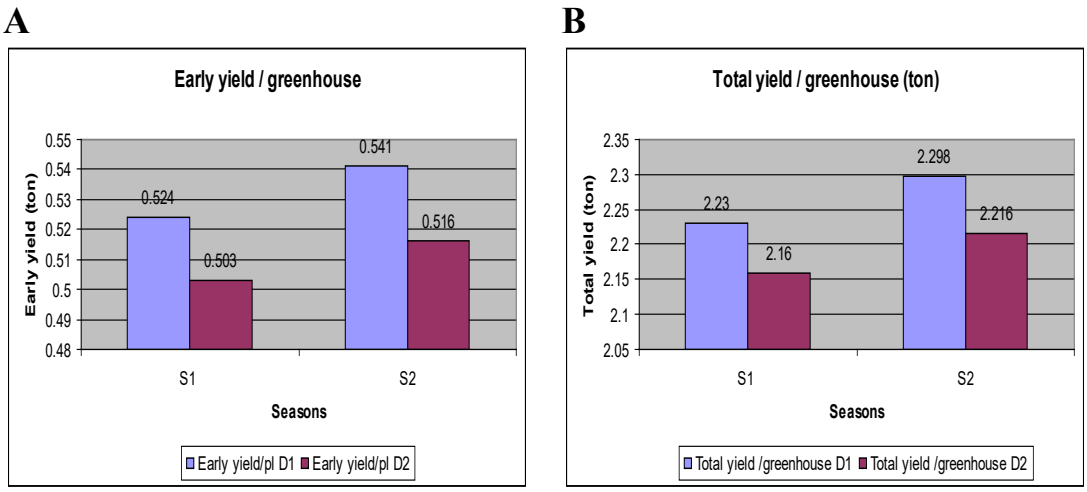

Fig 3. Effect of seedling dates on (A) Early Fruit Yield per Greenhouse (ton) and (B) Total Fruit Yield per Greenhouse (ton) in the first and second seasons.

Effect of foliar application

The main effects of foliar application treatments recorded significant effects on all cucumber characters in comparison to the control treatment in (T1).

Plant height (cm)

Data presented in Table (1) recorded that the maximum increase percentage in plant height (cm) in comparison to the control in T1 occurred to foliar application of Algae extract (T3) at a rate of 3 g /m^3 (T3) which represented an increase percentage (25.93 % and 27.9%) in the first and second season, respectively. Also, Moringa extract significantly increased cucumber plant height either in less (5%) or in high (10%) concentration by (10.33 and 13.33%) over the control (T1) in the first season, respectively. While the increase reached (10.23% and 12.26%) over the control (T1) in the second season, respectively.

The obtained results show that foliar application of fulvic acid significantly increased the mean values of cucumber plant height (cm) compared to the control. Data stated that high dose of Mepiquat chloride in (T9) surpassed the least dose in

(T8) in plant height by (2.91% and 3.73%) in the first and second season, respectively.

The increase in cucumber growth might be due to foliar applications to their contents of Auxins, Cytokinins which induce physiological activities (Gollan and Wright, 2006) also might due to the minerals Zn, Cu and B content in the seaweed extracts, which have a great role in cell division and enlargement and induce the photosynthesis and then a great shoot growth (Lopez *et al*., 2008)., or might also due to the macronutrient content in seaweed extracts. Macronutrients have a great role in plant nutrients like nitrogen, potassium and phosphorous which are very essential for the growth and development of the plant (Attememe, 2009). Many research workers reported the significant effect of growth regulator on various crops; Farouk (2015) on potato, Abd El-Mageed *et al*., (2017) on squash, Eladawy (2017) on artichoke, Abd El-Hady and Abd-Elhamied (2018) on cucumber.

Fruit set (%)

The main effects of foliar application treatments Table (1) recorded significant effects on fruit set in comparison to the control treatment (T1) in the first and second season, respectively. The maximum values of cucumber fruit setting were obtained as results of foliar application of algae extract (T3) in both seasons. It significantly increased fruit set by (67.15% and 69.78%) in comparison to the control treatment in the first and second season, respectively. Additionally, the increase percentage in fruit set recorded (24.01% and 37.08%) and (28.98% and 35.90%) over the control treatment (T1) as result of foliar application of Moringa extract in the first and second season, respectively. Also, Fulvic acid at ($2g/m^3$) in (T6) and ($3g/m^3$) in (T7) increased fruit setting by (55.93% and 59.07%) and (59.07% and 58.24%) in the first and second season, respectively. Observations raveled that Mepiquat chloride treatment in (T8 and T9) had fewer effects on fruit set despite their moral effect.

Table 1. Main effect of foliar application treatments on plant height (cm) and fruit set (%) of cucumber plants in the first and second seasons

Foliar treatments		Plant height (cm)		Fruit set (%)	
		S1	S2	S1	S2
T1	Control	150.0	153.4	28.07	28.69
T2	Algae extract ($2g/m^3$)	181.4	187.3	43.44	44.84
T3	Algae extract ($3g/m^3$)	188.9	196.2	46.92	48.71
T4	Moringa extract (5%)	165.5	169.1	34.81	35.57
T5	Moringa extract (10%)	170.0	172.2	38.48	38.99
T6	Fulvic acid ($2g/m^3$)	176.4	183.9	43.77	45.64
T7	Fulvic acid ($3g/m^3$)	184.5	188.7	44.38	45.40
T8	Mepiquat chloride (0.5ml/l)	156.3	160.5	34.87	35.81
T9	Mepiquat chloride (1.0ml/l)	161.0	166.5	31.22	32.29
F-test		**	**	*	**
LSD (0.05)		3.26	4.11	0.86	0.76

In this respect, the improvement in fruit set due to Moringa extract foliar application might be due to its components of natural compounds; cytokinin (zeatin), antioxidants and macro and micronutrients, essential mineral, fibers, protein, sugars and vitamins (Iqbal and Bhanger 2006, Mohamed *et al.*, 2020).

Many investigators reported the positive effect of foliar application on various crops. Abd-Elrhem (2017) reported that using Moringa leaf extract (MLE) increased vegetative growth, yield and quality of snap bean.

Favorable effect of fulvic acid may be attributed to the dependence of female flower bud initiation on hormone like activity of fulvic acid., or may be due to accelerate plant anabolism for plant growth and flowering. These results are in harmony with the findings of Abou Kamar (2012). Additionally, Hamail *et al*., (2014) found that foliar spraying of cucumber plants with fulvic acid (20 ml/l.) as one of bio-stimulants significantly increased fruit setting compared to the untreated treatment. These results are in harmony with (Gollan and Wright 2006, Lopez *et al*., 2008 and Attememe, 2009).

Fruit length (cm)

Data of fruit length (cm) recorded as influenced by cucumber foliar treatments are presented in Table (2). Main effects of treatments recorded significant impacts of foliar application of all foliar treatments on mean fruit length except fulvic acid (T7) and Mepiquat chloride (T8 and T9) comparing to the control treatment (T1). Data show clearly that the maximum value of fruit length was obtained due to foliar application by fulvic acid ($3g/m^3$) in (T7). The increase in fruit length reached (14.22% and 14.81%) compared to the control treatment (T1) in the first and second season, respectively. It is worthwhile to mention here that, fulvic acid ($3g/m^3$) in (T7) could be considered the most effective spraying treatment than all other treatments in increase cucumber fruit length. These results may be due to the ability of fulvic acid to promote hormonal activity in plant (Swelam, 2012). El-Nemr *et al*., (2012) showed that fruit setting has significant responses especially with the high concentration of humic acid (3 g/L) and Ecormon (0.45 cm/L) in comparison to all other treatments and they added that foliar sprays of humic acid (HA) and bio-stimulators led to positive effect on plant growth, fruit set and improvement production of cucumber plants.

Table 2. Main effect of foliar application treatments on fruit length (cm) and fruit diameter (cm) of cucumber plants in the first and second seasons

Foliar treatments		Fruit length (cm)		Fruit diameter (cm)	
		S1	S2	S1	S2
T1	Control	10.97	11.21	2.467	2.522
T2	Algae extract ($2g/m^3$)	11.25	11.62	2.653	2.740
T3	Algae extract ($3 g/m^3$)	11.12	11.49	2.587	2.673
T4	Moringa extract (5 %)	11.62	11.87	2.800	2.858
T5	Moringa extract (10 %)	11.50	11.65	2.788	2.824
T6	Fulvic acid ($2 g/m^3$)	11.35	11.79	2.712	2.817
T7	Fulvic acid ($3 g/m^3$)	12.53	12.87	2.908	2.987
T8	Mepiquat chloride (0.5 ml/l)	12.04	12.38	2.837	2.917
T9	Mepiquat chloride (1.0 ml/l)	11.87	12.27	2.818	2.913
F-test		*	*	*	*
LSD (0.05)		0.671	0.576	0.081	0.075

Fruit diameter (cm)

The tabulated results in Table (2) showed that all foliar application treatments significantly increased mean fruit diameter (cm) in comparison to the control in (T1) in both seasons. The percentage increase in fruit diameter due to foliar application of Algae extract (T3) were (7.53% and 8.64%) over the control in (T1) in the first and second season, respectively. While the percentage increase in fruit diameter due to foliar application (T4) reached (4.86% and 5.98%) over the control in (T1) in the first and second season, respectively.

Concerning the effect of Moringa foliar application, date show that, spraying Moringa extract at 5% concentration (T5) increased fruit diameter by (13.49% and 13.32%) in the first season. While the increase due to Moringa extract at 10% concentration (T6) were (13.01% & 11.87%) over the control treatment (T1) in the second season.

Foliar application with fulvic acid (T7) twice after transplanting at a rate of 3 mg/m^3 (T7) recorded the highest values of fruit diameter (2.908 and 2.987 cm). On the other hand, control treatment gave the lowest values of fruit diameter (cm) (2.467 and 2.522) in the first and second seasons, respectively. The increase percentage in fruit diameter, due to foliar application with fulvic acid (T7) was (17.88% and 18.44%) over the control in the first and second seasons, respectively. Obtained results indicated also, that Mepiquat chloride significantly increased fruit diameter either with the fewer doses (0.5 ml/l) in (T8) or in higher dose (1.0 ml/l) in (T9) over the control treatment in both seasons. Observation proved that foliar application with fulvic acid (3g/m^3) gave the maximum increase percentage in fruit diameter in comparison to all treatments under the study.

The importance of fulvic acid as one of natural products as humic acid in increasing fruit diameters may be due to its content of phytohormones (Shevchenko (2008) and may be to its ability to promote hormonal activity in plant (Swelam, 2012). As for humic acid effect, El-Nemr *et al*., (2012) stated that humic acid (3 g/L) and bio-stimulators (0.45 cm/L Ecormon) improved all morphological characters' parameters including height of cucumber plants (*Cucumis sativus* L.) cv. Beta-Alpha (Quartz F1). Similar results were obtained by Al-Madhagi (2019) on cucumber as for humic acid effect, Belal (2020) on tomato.

Average fruit weight per plant (g)

Results recorded in Table (3) show clearly that there was a significant difference among foliar treatments compared to the control on fruit weight in both seasons. All foliar application significantly increased fruit weight in comparison to the control treatment (T1) in both seasons. The obtained date revealed that, the increase in fruit weight due to various foliar applications could be arranged ascending as following; Mepiquat chloride, Moringa extract, fulvic acid (T7) then algae extract.

Treating cucumber plant with foliar application of algae extract at a rate of 3 gm/m^3 in (T3) recorded the highest fruit weight increase by (44.99% and 43.30%)

in comparison to the control treatments (T1) in 2019/2020 and 202o/2021 seasons, respectively. In this context, Abd El-Hady and Abd-Elhamied (2018) reported about the significant effect of foliar applications on cucumber crops.

Table 3. Main effect of foliar application treatments on Average fruit weight per plant (g) and Number of fruits per plant of cucumber plants in the first and second seasons.

Foliar treatments		Average fruit weight per plant (g)		Number of fruits per plant	
		S1	S2	S1	S2
T1	Control	50.50	51.63	37.39	38.22
T2	Algae extract (2 g/m^3)	63.09	65.18	43.84	45.45
T3	Algae extract (3 g/m^3)	71.20	73.59	51.22	53.20
T4	Moringa extract (5 %)	59.40	60.69	41.20	42.09
T5	Moringa extract (10 %)	61.00	61.81	41.44	41.98
T6	Fulvic acid (2 g/m^3)	61.77	64.16	42.85	44.51
T7	Fulvic acid (3 g/m^3)	66.50	68.32	45.53	46.75
T8	Mepiquat chloride (0.5 ml/l)	54.43	55.96	39.85	40.93
T9	Mepiquat chloride (1.0 ml/l)	56.97	58.90	40.74	42.12
F-test		*	**	*	**
LSD (0.05)		0.751	0.861	0.86	0.76

Number of fruits per plant

Results presented in Table (3) show clearly that there was a significant effect of foliar treatments compared to control treatment (T1) in both seasons. Foliar application of algae extract at 3 mg / m^3 (T3) after transplanting recorded the highest values of Number of fruits per plant (51.22 and 53.20) with increasing percentage (36.98% and 39.19%) over the control treatment (T1) in the first and second season, respectively.

The obtained results found that, the increase percentages of number of fruits per plant due to foliar application of all treatment under the study were varied depended to regulator type and its concentration. The ascending order of foliar treatments on Number of fruits per plant could be arranged as following; Mepiquat chloride, Moringa, fulvic acid then algae extract.

These results may be due to its content of macro and micro trace elements (N, P, Fe, Cu, Zn, Co, Mo, Mn, Ni) and metabolites, as well as various hormones (IAA and IBA), cytokinins, vitamins, enzymes and amino acids, which enhance seed germination and all growth, yield, traits, improved quality (Blunden, 1997).

Early fruit yield per greenhouse (ton)

Results demonstrated in Table, (4) indicated that total early yield were significantly affected by foliar application, this effectiveness depended on type and concentration of spraying compound. All foliar application treatment significantly increased the early yield compared to the control treatment (T1). Foliar application of algae extract (T3) recorded the maximum cucumber early yield with values of (0.855 ton and 0.884 ton/greenhouse) in the first and second seasons, respectively. Observation in Table (3) revealed that spraying algae extract T3 gave the maximum significant values of the average fruit harvest yield / greenhouse in both

seasons. Cucumber Plants sprayed with algae extract (T3) increased fruit harvest early yield /greenhouse by (38.12 and 38.12 %) in comparison to the control treatment (T1) in both seasons, respectively. These results could be explained under the basis that algae foliar application had a significant stimulatory effect on growth parameters as reported by Saha *et al*., (2018) or due to its containing macro – and micro-nutrient, necessary amino acid, essential vitamins and plant growth regulators which stimulate the growth and quality yield of crops. These results in agreement with Almaroai and Eissa (2020) stated that foliar application of 9% algal extract after 4 weeks of transplanting and 3 weeks later for onion increased the bulb yield by 67 and 102%, in successive seasons, respectively.

Early cucumber yield (ton/greenhouse) which was calculated from the first seven pickings was significantly affected by foliar application of Moringa extract. Increasing the concentration extract from 5% to 10% leads to increasing the early production of cucumber yield. Tabulated data in Table (4) revealed that the increase percentage of early yield reached (13.99 and 13.03%) due to spraying the high concentration of Moringa extract in the first and second seasons, respectively. These finding are going with those obtained by Abd El-Hady and Abd-Elhamied (2018) on cucumber and Farouk (2015) on potato.

Concerning the effect of bio-stimulants on early fruit yield per greenhouse, results in the same Table (4) show that fulvic acid caused significant increase in all these characters. In this respect, Hamail *et al*., (2014) reported that values of cucumber early yield were obtained from planted sprayed with fulvic acid (2.42 and 2.27 ton/fed) compared to (1.65 and 1.75 ton/fed) with increasing percentage (46.66 % and 29.71%) during 2011 and 2012 seasons, respectively.

Table 4. Main effect of foliar application treatments on early fruit yield per greenhouse (ton) and Total fruit yield per greenhouse (ton) of cucumber plants in the first and second seasons

Foliar treatments		Early fruit yield per greenhouse (ton)		Total fruit yield per greenhouse (ton)	
		S1	S2	S1	S2
T1	Control	0.265	0.271	1.894	1.936
T2	Algae extract (2 g/m^3)	0.619	0.640	2.293	2.369
T3	Algae extract (3 g/m^3)	0.855	0.884	2.671	2.761
T4	Moringa extract (5 %)	0.436	0.445	2.087	2.132
T5	Moringa extract (10 %)	0.497	0.503	2.160	2.189
T6	Fulvic acid (2 g/m^3)	0.529	0.549	2.222	2.308
T7	Fulvic acid (3 g/m^3)	0.743	0.763	2.395	2.461
T8	Mepiquat chloride (0.5 ml/l)	0.318	0.326	2.002	2.058
T9	Mepiquat chloride (1.0 ml/l)	0.363	0.375	2.031	2.099
F-test		*	*	*	**
LSD (0.05)		0.089	0.072	0.120	0.132

Also, foliar application of mepiquat chloride at a concentration of (T9) increased early yield by (14.15 % and 15.03%) over the first concentration (T8) in the first and second seasons, respectively. Abo Al-Nagaa (2019) found that, rock potassium with mepiquat chloride recorded the highest productivity of fresh and dry weights of potato plants (*Solanum tuberosum* L. cv. Spunta), total tuber yield

and yield components in comparison to the control treatment (T1). This increase may be attributed to enhancing chlorophyll synthesis as proved by Bangarswamay *et al*., (2001) on pigeon pea, Cheema *et al*., (2009) on cowpea and Pal *et al*., (2017) on onion.

Total fruit yield per greenhouse (ton)

Data in Table (4) show clearly significantly effect of all foliar application on total cucumber yield in both seasons. Foliar application of algae extract (T3) recorded the maximum cucumber yield. Cucumber Plants sprayed with algae extract (T3) increased fruit harvest yield /greenhouse by (41.02% and 42.61 %) in comparison to the control treatment (T1) in both seasons, respectively.

Data obtained show clearly that increasing Moringa extract concentration from 5% in T4 to 10% in T5 gave significant increase in total cucumber yield. Total cucumber yield value was recorded (2.087 and 2.132 ton/greenhouse) as a result of foliar application by Moringa extract at 5% in the first and second seasons, respectively. Increasing Moringa extract to 10% concentration gave (2.160 and 2.189) ton in the first and second seasons, respectively. The improvement of total yield of cucumber could be explained under the bases that increasing Moringa extract concentration might be enhanced vegetative growth and helps in mobilization of nutrients to fruits which lead to improve fruit yield and quality. These results are going with those obtained by Farouk (2015) on potato, Abd El-Mageed *et al*., (2017) on squash and Eladawy (2017) on artichoke.

Data in the same Table (4) show that fulvic acid caused significant increase percentage in total harvest yield (ton /greenhouse) reached (17.31 % and 26.45%) in the first season, respectively. While, this increase, recorded (19.21% and 27.11%) in the second season, respectively. These results agreed with Hamail *et al*., (2014) Khalil *et al*., (2011) and Soliman (2011) on cucumber.

Effects of the interaction between seedling dates and foliar application

Data presented in Table (5) shows the interaction effects between seedling dates and foliar application treatments on all traits under the study; plant height (cm) and fruit set (%).

Obtained results revealed that the application of algae extract at a rate of 3 g/m^3 (T3) recorded the maximum values of plant height (191.3 and 199.6 cm) at the first seedling date (D1) in both seasons, respectively. The percentage increase in plant height reached (24.54% and 27.13%) over the control treatment in the first and second seasons, respectively. Also, fruit set was clearly affected by this interaction under all seedlings date. The interactions reveal that treating the early cultivated cucumber plants (D1) with algae extract at a rate of $3g/m^3$ (T3) recorded the maximum increase in fruit set compared to all other treatment under the study in the first and second seasons. Interaction effects between seedling days and foliar application revealed that fulvic acid at a rate of 3 gm/m^3 (T7) gave the maximum fruit length (12.73 cm under (D1) and (12.74 and 13.00 cm) under (D1 and D2) in the second season in comparison to the control treatment (T1) treatments (Table 5)

Table 5. Interaction effect of seedling dates and foliar application treatments on plant height (cm) and fruit set (%) of cucumber plants in the first and second seasons

Foliar Treatments	Plant height (cm)						Fruit set (%)					
	S1			S2			S1			S2		
	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean
T1 Control	153.6	146.4	**150.0**	157.0	149.7	**153.4**	28.51	27.62	**28.07**	29.15	28.24	**28.69**
T2 Algae extract (2 g/m^3)	183.7	179.1	**181.4**	191.5	183.1	**187.3**	43.71	43.16	**43.44**	45.56	44.12	**44.84**
T3 Algae extract (3 g/m^3)	191.3	186.5	**188.9**	199.6	192.7	**196.2**	47.52	46.31	**46.92**	49.58	47.85	**48.71**
T4 Moringa extract (5 %)	169.5	161.4	**165.5**	173.3	164.8	**169.1**	35.71	33.91	**34.81**	36.51	34.63	**35.57**
T5 Moringa extract (10 %)	173.6	166.3	**170.0**	175.7	168.7	**172.2**	39.34	37.62	**38.48**	39.82	38.16	**38.99**
T6 Fulvic acid (2 g/m^3)	179.6	173.1	**176.4**	187.2	180.6	**183.9**	44.72	42.81	**43.77**	46.61	44.66	**45.64**
T7 Fulvic acid (3 g/m^3)	187.5	181.4	**184.5**	193.6	183.8	**188.7**	45.32	43.44	**44.38**	46.78	44.01	**45.40**
T8 Mepiquat chloride (0.5 ml/l)	159.8	152.7	**156.3**	163.4	157.6	**160.5**	36.11	33.62	**34.87**	36.92	34.70	**35.81**
T9 Mepiquat chloride (1.0 ml/l)	163.7	158.3	**161.0**	170.8	162.2	**166.5**	32.60	29.84	**31.22**	34.01	30.57	**32.29**
Mean	**173.6**	**167.2**		**179.1**	**171.5**		**39.28**	**37.59**		**40.55**	**38.55**	
F-test		**			**			*			**	
LSD (0.05)		4.76			**4.11**			**1.21**			**0.98**	

The interaction effects between seedlings date and foliar treatments Table (6) show significant effect on mean values of fruit length (cm) and fruit diameter (cm). Interaction effects between seedling days and foliar application revealed that fulvic acid at a rate of 3 gm/m^3 (T7) gave the maximum fruit length (12.73 cm under (D1) and (12.74 and 13.00 cm) under (D1 and D2) in the second season in comparison to the control treatment (T1) treatments (Table 5). The maximum values of fruit diameter (2.912) were obtained as results of (T7) at the second cultivation time in the first season. Meanwhile, at the second season, the maximum values of fruit diameter (2.999) were obtained as results of (T7) at the first cultivation time in the second season, respectively.

Table 6. Interaction effect of seedling dates and foliar application treatments on fruit length (cm) and Fruit diameter (cm) of cucumber plants in the first and second seasons.

Foliar Treatments	Fruit length (cm)						Fruit diameter (cm)					
	S1			S2			S1			S2		
	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean
T1 Control	10.83	11.10	**10.97**	11.07	11.35	**11.21**	2.433	2.501	**2.467**	2.487	2.557	**2.522**
T2 Algae extract (2 g/m^3)	11.20	11.30	**11.25**	11.58	11.66	**11.62**	2.602	2.703	**2.653**	2.691	2.790	**2.740**
T3 Algae extract (3 g/m^3)	11.10	11.13	**11.12**	11.58	11.39	**11.49**	2.572	2.602	**2.587**	2.683	2.663	**2.673**
T4 Moringa extract (5 %)	11.60	11.63	**11.62**	11.86	11.88	**11.87**	2.804	2.791	**2.800**	2.867	2.850	**2.858**
T5 Moringa extract (10 %)	11.50	11.49	**11.50**	11.64	11.65	**11.65**	2.771	2.804	**2.788**	2.805	2.844	**2.824**
T6 Fulvic acid (2 g/m^3)	11.30	11.40	**11.35**	11.69	11.89	**11.79**	2.702	2.722	**2.712**	2.794	2.840	**2.817**
T7 Fulvic acid (3 g/m^3)	12.33	12.73	**12.53**	12.74	13.00	**12.87**	2.903	2.912	**2.908**	2.999	2.974	**2.987**
T8 Mepiquat chloride (0.5 ml/l)	11.97	12.10	**12.04**	12.25	12.50	**12.38**	2.802	2.871	**2.837**	2.867	2.966	**2.917**
T9 Mepiquat chloride (1.0 ml/l)	11.83	11.90	**11.87**	12.34	12.19	**12.27**	2.813	2.823	**2.818**	2.935	2.891	**2.913**
Mean	**11.52**	**11.64**		**11.86**	**11.95**		**2.711**	**2.748**		**2.792**	**2.819**	
F-test		*			*			*			*	
LSD (0.05)		**0.832**			**0.710**			**0.87**			**0.082**	

Interaction effects of seedling dates and foliar spray on average fruit weight per plant (g) recorded that treating cucumber plant by foliar application of algae extract at a rate of 3 g/m^3 at the first seedling date (D1) gave the highest fruit weight percentage (40.13% & 43.00%) as compared with control treatments in the first and second seasons, respectively (Table, 7). Also, number of fruits per plant was significantly affected by the interaction between seedling dates and foliar application (Table 7) in the first and second seasons, respectively. The highest number of fruits per plant (54.13 and 56.47) was obtained at the first seedling date (D1) and treating cucumber plant by algae extract at 3 g/m^3 (T3) in comparison to

all other interactions in the first and second seasons, respectively. These results may be due to its containing of macro and micro trace nutrients (N, P, Fe, Cu, Zn, Co, Mo, Mn, Ni) and metabolites, as well as various hormones (IAA and IBA), cytokinins, vitamins, enzymes and amino acids, which enhance seed germination and all growth, yield, traits, improved quality as reported by Blunden, (1997).

Table 7. Interaction effect of seedling dates and foliar application treatments on Average fruit weight per plant (g) and Number of fruits per plant of cucumber plants in the first and second seasons.

Foliar Treatments	Average fruit weight per plant (g)						Number of fruits per plant					
	S1			S2			S1			S2		
	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean
T1 Control	52.33	48.67	**50.50**	53.50	49.76	**51.63**	38.11	36.67	**37.39**	38.96	37.49	**38.22**
T2 Algae extract (2 g/m^3)	64.02	62.16	**63.09**	66.20	64.16	**65.18**	44.01	43.67	**43.84**	45.82	45.08	**45.45**
T3 Algae extract (3 g/m^3)	73.33	69.07	**71.20**	76.51	70.68	**73.59**	54.13	48.31	**51.22**	56.47	49.92	**53.20**
T4 Moringa extract (5 %)	60.12	58.67	**59.40**	61.46	59.92	**60.69**	41.13	41.26	**41.20**	42.05	42.14	**42.09**
T5 Moringa extract (10 %)	61.67	60.33	**61.00**	62.43	61.19	**61.81**	42.16	40.71	**41.44**	42.68	41.29	**41.98**
T6 Fulvic acid (2 g/m^3)	62.33	61.20	**61.77**	64.46	63.85	**64.16**	43.02	42.67	**42.85**	44.49	44.52	**44.51**
T7 Fulvic acid (3 g/m^3)	67.33	65.67	**66.50**	69.57	67.07	**68.32**	46.12	44.93	**45.53**	47.61	45.89	**46.75**
T8 Mepiquat chloride (0.5 ml/l)	56.21	52.65	**54.43**	57.52	54.40	**55.96**	40.37	39.33	**39.85**	41.27	40.60	**40.93**
T9 Mepiquat chloride (1.0 ml/l)	58.26	55.67	**56.97**	60.78	57.02	**58.90**	41.36	40.11	**40.74**	43.15	41.09	**42.12**
Mean	**61.73**	**59.34**		**63.60**	**60.89**		**43.38**	**41.96**		**44.72**	**43.11**	
F-test		*			*			*			*	
LSD (0.05)		**0.862**			**0.921**			**1.13**			**0.86**	

Regarding interaction effects between seedling dates and foliar application on early fruit yield per greenhouse (ton) and total fruit yield per greenhouse (ton) results were tabulated in Table (8).

Maximum early fruit yield per greenhouse (ton) were recorded (0.897 and 0.936 ton) as a result of the interaction between early seedling date (D1) and Algae foliar application twice after seedling in the first and second seasons, respectively (Table 8). Additionally, maximum values of total fruit yield per greenhouse (ton) were recorded at the first seedling date (D1) which reached (2.803 and 2.924 ton) in the first and second seasons, respectively (Table 8).

Table 8. Interaction effect of seedling dates and foliar application treatments on Early total fruit yield per greenhouse (ton) and Total fruit yield per greenhouse (ton) of cucumber plants in the first and second seasons.

Foliar Treatments	Early fruit yield per greenhouse (ton)						Total fruit yield per greenhouse (ton)					
	S1			S2			S1			S2		
	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean
T1 Control	0.271	0.259	**0.265**	0.277	0.265	**0.271**	1.934	1.853	**1.894**	1.977	1.894	**1.936**
T2 Algae extract (2 g/m^3)	0.622	0.616	**0.619**	0.643	0.636	**0.640**	2.304	2.282	**2.293**	2.383	2.356	**2.369**
T3 Algae extract (3 g/m^3)	0.897	0.813	**0.855**	0.936	0.832	**0.884**	2.803	2.539	**2.671**	2.924	2.598	**2.761**
T4 Moringa extract (5 %)	0.440	0.431	**0.436**	0.450	0.440	**0.445**	2.093	2.081	**2.087**	2.140	2.125	**2.132**
T5 Moringa extract (10 %)	0.501	0.492	**0.497**	0.507	0.499	**0.503**	2.179	2.141	**2.160**	2.206	2.171	**2.189**
T6 Fulvic acid (2 g/m^3)	0.539	0.518	**0.529**	0.557	0.540	**0.549**	2.246	2.198	**2.222**	2.323	2.293	**2.308**
T7 Fulvic acid (3 g/m^3)	0.759	0.726	**0.743**	0.784	0.741	**0.763**	2.448	2.342	**2.395**	2.529	2.392	**2.461**
T8 Mepiquat chloride (0.5 ml/l)	0.323	0.312	**0.318**	0.331	0.322	**0.326**	2.016	1.987	**2.002**	2.063	2.053	**2.058**
T9 Mepiquat chloride (1.0 ml/l)	0.368	0.358	**0.363**	0.384	0.367	**0.375**	2.045	2.016	**2.031**	2.134	2.065	**2.099**
Mean	**0.524**	**0.503**		**0.541**	**0.516**		**2.230**	**2.160**		**2.298**	**2.216**	
F-test		*			*			*			*	
LSD (0.05)		**0.123**			**0.098**			**0.211**			**0.234**	

These results could be explained that algae foliar application had a significant stimulatory effect on growth parameters as reported by Saha et al., (2018) or due to containing macro – and micro-nutrient, necessary amino acid, essential vitamins and plant growth regulators which stimulate the growth and quality yield of crops.

This aforementioned result is in agreement with Almaroai and Eissa (2020) stated that foliar application of 9% algal extract after 4 weeks of transplanting and 3 weeks later for onion increased the bulb yield by 67 and 102%, in successive seasons, respectively.

In summary, interactions effects show clearly that the maximum early fruit yield per greenhouse (ton) and total fruit yield per greenhouse (ton) were obtained by foliar application with Algae extract (T3) under early cultivation (D1) in the first and second seasons, respectively.

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تأثير مواعيد زراعة الشـــتلات والرش الورقي على نمو وإنتاجية هجين الخيار (البراكودا) في ظل الزراعة المحمية

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قسم الخضر، كلية الزراعة، جامعة أسيوط، مصر.

الملخص

أجريت تجربتان لدراســة تأثير ميعادين لزراعة شــتلات الخيار والرش الورقي بتركيزين مختلفين لكل من (مسـتخلص الطحالب وخلاصــة المورينجا وحمض الفولفيك وكلوريد الميبيكات) على بعض نمو ومحصــول وجودة نباتات الخيار (*Cucumis sativus* L.) صــنف. باراكودا في مزرعة خاصة بقرية "أولاد الشريف" بمدينة ديروط بمحافظة أسيوط، مصر.

أجريت التجارب خلال المواســم المتعاقبة لعامي 2020/2019، 2022/2020 داخل البيوت المحمية. تم رش نباتات الخيار مرتين كل 15 يومًا بتركيزين من كل من (مســتخلص الطحالب (algae extract) ومسـتخلص أوراق المورينجا (Moringa extract) وحمض الفولفيك (Fulvic acid) وكلوريد ميبيكات (Mepiquat chloride) بعد ثلاثة أسـابيع من الشـتل. تم وضـع "مواعيد زراعة الشتلات" في القطع الرئيسية، وتم وضع معاملات الرش الورقي في القطع الفرعية، بثلاث مكررات، على التوالي. تتكون التجربة من 2 لميعاد الشتل × 9 معاملات رش على الأوراق = 18 معاملة × 3 مكررات لكل معاملة. تم تخصيص صوبه (9 × 40 م) لكل تاريخ شتل في كل موسم زراعي.

تشـير النتائج إلى أن زراعة شـتلات الخيار في وقت مبكر من شـهر نوفمبر في ظل النظم الزراعية المحمية أدت إلى تأثير معنوي على جميع الصـفات تحت الدراسـة باسـتثناء طول الثمرة وقطر الثمار مقارنة بتاريخ الشــتل الثاني على التوالي. أعطت جميع معاملات الرش الورقي وتفاعلاتها استجابات عالية في جميع الصفات خاصة التركيز العالي لمستخلص الطحالب (3 جم / م^3) والفولفيك (3 جم / م^3) مقارنة بالمعاملات الأخرى.