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USING OF MORINGA LEAF EXTRACT FOR STIMULATES GROWTH AND YIELD OF CUCUMBER (*CUCUMIS SATIVUS* L.)

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ABSTRACT: ***A greenhouse study was conducted in 2017 and 2018 growing seasons to evaluate the growth and yield of cucumber (Cucumis sativus L.) F_1 hybrid cv. 'Hesham' in response to foliar application with three concentrations (1:40, 1:30 and 1:20) of moringa leaf extract. Cucumber growth traits (plant height, leaf area, number of leaves, fresh and dry weight of leaves and stems) and flowering traits (number of flowers, number of days to the first female flower and fruit set %) were significantly enhanced following the foliar application with moringa leaf extract. The growth and development of cucumber fruits (fruit fresh and dry weight, and fruits total yield) were also promoted in response to the treatments. moringa leaf extract treatments markedly increased the endogenous hormone levels (auxins, gibberellins and cytokinins) and enhanced the activity of the antioxidant enzymes catalase, peroxidase and superoxide dismutase in cucumber leaves. This stimulation effect revealed that moringa leaf extract might be utilized as an effective natural and safe biostimulant in organic agricultural production.***

Key words: ***Moringa leaf extract; phytohormones; biostimulants; antioxidant enzymes; yield.***

INTRODUCTION

Cucumber (*Cucumis sativus* L.) a member of Cucurbitaceae family and very popular for salad-vegetable crop that is eaten fresh or as pickles (Bisognin 2002). It has high nutritive values, rich in proteins, carbohydrates, fats, minerals and vitamins (Rahman *et al.,* 2008; Zhao *et al.,* 2014). Its fruits have antioxidant activity (Kumar *et al.,* 2010; Nema *et al.,* 2011) and tyrosinase inhibitory activity (Gandía-Herrero *et al.,* 2003). The total area planted with cucumber in Egypt was 50383 feddans (21541 ha) with a total annual production of 488723 tons of cucumbers (FAO, 2017).

Biostimulants are natural substances that have the ability to modify physiological processes in plants leading to the improvement of plant productivity (Yakhin *et al.,* 2017). It consists of single or mixed plant extracts containing amino acids, vitamins, enzymes and hormones or animal extracts containing mainly amino acids and peptides (Basak, 2008). Application of biostimulants has been proved to be a good agricultural production technique for achieving high-quality yield of crop plants and being environmentally friendly (Parađiković *et al.,* 2011). Various plant extracts have been used instead of synthetic chemical substances for enhancing the growth and yield of many crops such as tea seed extract on strawberry (Andresen and Cedergreen, 2010), moringa leaf extract on snap bean (Elzaawely *et al.,* 2017a), *Asclepias syriaca*, grape seeds and spruce bark on beans (Ignat *et al.* 2009).

Moringa oleifera Lam., has been used as an inorganic fertilizer (Phiri, 2010), as it has high nutritional and medicinal values (El Sohaimy *et al.* 2015). It also contains high amounts of phytohormones such as salicylates, auxins, cytokinins and gibberellins (Elzaawely *et al.* 2017a).

Although the use of natural biostimulants in agriculture gained an increasing interest, many of them do not have scientific claims. In this study, we investigate the potential of moringa leaf extract as plant growth regulators on plant growth, flowering, fruits yield and quality of cucumber plants.

MATERIALS AND METHODS

Preparation of moringa leaf extract

Fresh leaves of moringa were collected from trees grown in the Experimental Farm, Faculty of Agriculture, Tanta University, Egypt. Aqueous extract of fresh moringa leaves was prepared by mixing 30 g of fresh leaves (immediately after collection) with 300 mL of distilled water in a household blender for 15 min. The obtained solution of moringa leaves was filtered through muslin cloth and the volume was adjusted at the ratio of 1:10 (w/v) by distilled water. The solutions were separately diluted with distilled water at the ratios of 1:20, 1:30, and 1:40 (w/v) immediately before application. The previous solution was analyzed for its hormone profile and the results are presented in Table 2.

Plant material and experimental site

Seeds of cucumber Hesham F_1 hybrid were purchased from the National Research Center at Dokki, Giza, Egypt. The experiment was carried out in a plastic greenhouse (30 m length × 9 m width × 3.25 m height) at the Experimental Farm of the Faculty of Agriculture, Tanta University, Tanta (30° 47′N: 31° 0′E), Egypt.

Cucumber seedlings were planted on the 6th and 9th January in the 2017 and 2018 seasons, respectively at 50 cm apart in both sides of the ridges. The analysis of the experimental soil (Table 1) was performed according to Ryan *et al.* (1996).

Experimental design

The agricultural practices were applied as recommended for the commercial cucumber production under the plastic greenhouse condition.

Five treatments comprising three concentrations of moringa leaf extract (MLE) at the ratio of 1:40, 1:30 and 1:20 (w/v) and distilled water used as a control were applied three times as foliar spray at 30, 45 and 60 days after transplanting (DAT), in both seasons. The experiment was designed in randomized complete blocks (RCB) in a factorial arrangement with three replicates for each treatment. The plot area was 14 m^2 (14 m length × 1 m width).

Table 1. The physico-chemical properties of the experimental soil.

Texture (%)			pH	N	P	K	EC	Ca^{++}	Mg^{++}	Na^{+}	HCO_3^{-}	Cl^{-}	SO_4^{-}
Sand	Silt	Clay		mg 100 g^{-1} soil			(dS m^{-1})	meq L^{-1}					
14.23	37.11	48.66	7.99	47.8	7.1	154.87	1.3	5.93	5.53	17.2	5.86	10.75	7.83

Table 2: Phytohormone levels (µg ml^{-1}) of aqueous extract of moringa leaf extract (MLE).

	Salicylic acid	Auxins	Gibberellins	Cytokinins	Abscisic acid
MLE	1.900	2.329	0.308	0.222	0.213

Growth analysis attributes

Three plants were randomly chosen from each plot at 60 and 75 DAT to determine the leaf area index (LAI), relative growth rate (RGR), and net assimilation rate (NAR) according to the following equations (Salisbury, 1996):

1) LAI = leaf area per plant/ground area per plant.
2) RGR (g g^{-1} day^{-1}) = $(\ln m_2 - \ln m_1)/(t_2 - t_1)$.
3) NAR (g m^2 day^{-1}) = $[(m_2 - m_1)/(t_2 - t_1)] \times [(\ln LA_2 - \ln LA_1)/(LA_2 - LA_1)]$.

Where m_1 and LA_1 refer to the total plant biomass and leaf area at 60 DAT (t_1), respectively; and m_2 and LA_2 refer to the total plant biomass and leaf area at 75 DAT (t_2), respectively.

Other growth parameters of cucumber including plant height, leaf area per plant, number of leaves per plant, and fresh and dry weight of leaves and stem per plant were estimated at 75 DAT.

Flowering traits

Number of flowers per plant, days to the first female flower and fruit set (%) were determined.

Fruits Yield and its Quality

Cucumber fruits at marketable stage were harvested twice a week. Number of fruits/plant, average fruit length, fruit diameter, fresh and dry weight of fruit and total yield in each treatment were recorded. Total soluble solids (TSS) of fruits were measured using a hand refractometer.

Chemical composition

Total chlorophyll in leaves was calculated as described by Wellburn (1994). Percentage of N, P, and K were determined colorimetrically in the fourth leaf from apical bud of three plants at 75 DAT following AOAC (1995). The percentage of N, P, and K, Fe, Zn, Mn and Cu were determined in fruits at harvest according to the AOAC (1995).

Hormonal determination

Endogenous phytohormones (auxins, gibberellins, cytokinins and abscisic acid) were quantitatively determined in cucumber leaves using High-Performance Liquid Chromatography (HPLC) according to Koshioka *et al.* (1983) and Nicander *et al.* (1993).

Enzyme assays

Cucumber leaf samples were prepared and the activity of catalase (CAT), peroxidase (POX) and superoxide dismutase (SOD) was assayed according to Semida and Rady (2014).

Statistical analysis

Analysis of variance (ANOVA) was carried out on each measurement, and the results were analyzed using the GLM procedure of SAS v.8 (SAS Inst., Cary, NC, USA). The least significant differences (LSD) between the means were estimated at 95 % confidence level.

RESULTS

Results in Table 2 proved that both moringa leaf extract (MLE) contain high content of various phytohormones, with a clear superiority to the MLE in Auxin followed by Salicylic acid.

Growth attributes

Table 3 shows that the greatest values of leaf area index (LAI), relative growth rate (RGR), and net assimilation rate (NAR) in both seasons were displayed on the MLE concentrations (1:20, 1:30, and 1:40) comparing with control.

Similarly, growth attributes of cucumber Hesham F_1 hybrid were significantly enhanced in response to foliar spray either with MLE at different concentrations (1:20, 1:30, and 1:40) compared to the control (Table 4). All MLE concentrations particularly MLE 1:20 improved significantly ($P < 0.05$) all studied growth parameters including plant height, total leaf area per plant, number of leaves per plant, and leaves fresh & dry weight, in both seasons, and there is no significant difference was founded between all the MLE concentrations and the control treatment in the stem fresh and dry weights (Table 4). In this concern, Culver *et al.* (2012), Abou El-Nour & Ewais, 2017, and Elzaawely *et al*. (2017a) had reported that foliar application of MLE can be used as a plant biostimulant for enhancing tomato, pepper and snap bean growth parameters and productivity. Moringa leaves are rich in zeatin (naturally occurring cytokinin) hormone that enhances plant growth (Nagar *et al.* (2006) and Maswada *et al.,* 2017).

Flowering traits

In both seasons, all flowering traits were significantly stimulated in comparison with the control in response to MLE applications (Table 5). It is clear that the maximum stimulation was recorded with the high dose of MLE (1:20), as it increased the number of flowers/plant, decreased the days to 1st female flower, and increased the fruit set (%) by 18.2%, 9.2% and 10.7% over control in the 2017 growing season, respectively; and by 38.4%, 44.8% and 17.1% over control in the 2018 growing season, respectively.

Table 3: Leaf area index (LAI), relative growth rate (RGR) and net assimilation rate (NAR) of cucumber in response to moringa leaf extract (MLE) during 2017 and 2018 seasons.

Treatments	Season 2017			Season 2018		
	LAI	RGR ($g\ g^{-1}\ day^{-1}$)	NAR ($g\ cm^{-2}\ day^{-1}$)	LAI	RGR ($g\ g^{-1}\ day^{-1}$)	NAR ($g\ cm^{-2}\ day^{-1}$)
Control	2.25 d	0.02598 d	0.00275 c	2.39 d	0.02559 d	0.00301 c
MLE 1:40	2.٦٨ c	0.02801 c	0.00314 b	2.81 c	0.02898 c	0.00336 b
MLE 1:30	2.7٨ b	0.02852 b	0.00326 b	2.91 b	0.02944 b	0.00347 b
MLE 1:20	2.89 a	0.02931 a	0.00342 a	3.00 a	0.02987 a	0.00359 a
L.S.D. at 5%	0.٠8	0.00041	0.00014	0.06	0.00031	0.00011

- Values are means of three replicates in each treatment.
- Means values in each column followed by the same letter are not significantly different ($P \le 0.05$).

Table 4: Growth traits of cucumber in response to moringa leaf extract (MLE) during 2017 and 2018 seasons.

Treatments	Plant height (cm)	Leaf area plant^{-1} (dm^2)	No. of leaves plant^{-1}	Leaves weight plant^{-1}		Stem weight plant^{-1}	
				fresh (g)	dry (%)	fresh (g)	dry (%)
			Season 20١7				
Control	16٩.9 d	7٤.81 d	29.67 c	157.32 d	6.01 d	60.29	٩,٤
MLE 1:40	182.02 c	84.٩٦ c	35.17 b	171.89 c	6.28 c	62.54	9.11
MLE 1:30	18٧.16 b	87.54 b	36.٥6 b	175.76 b	6.45 b	63.19	9.1٤
MLE 1:20	191.53 a	8٩.76 a	37.٩٨ a	181.43 a	6.62 a	64.08	9.1٥
L.S.D. at 5%	٢,٨٩	.١85	١,٤0	٢.75	0.15	N. S	N. S
			Season 20١8				
Control	17١.3 d	٦٧.67 d	3٠.48 c	163.99 d	6.04 c	٥7.87	٩,٠٣
MLE 1:40	18٢.32 c	٧٨.08 c	3٤.٠٣ b	178.05 c	6.25 b	58.99	9.09
MLE 1:30	1٨٧.34 b	8١.56 b	3٥.٣٩ ab	183.19 b	6.38 a	60.87	9.11
MLE 1:20	192.95 a	8٥.21 a	36.٧4 a	186.27 a	6.49 a	61.54	9.١٢
L.S.D. at 5%	3.99	.٢29	١,٣٩	2.95	0.11	N. S	N. S

- Values are means of three replicates in each treatment.

- Means values in each column followed by the same letter are not significantly different ($P \leq 0.05$).

Table 5: Flowering traits of cucumber in response to moringa leaf extract (MLE) during 2017 and 2018 seasons.

Treatments	Season 2017			Season 2018		
	No. flowers Plant^{-1}	Days to 1st female flower	Fruit set (%)	No. flowers Plant^{-1}	Days to 1st female flower	Fruit set (%)
Control	48.93 d	44.21 a	45.99 d	45.96 d	45.01 a	47.02 d
MLE 1:40	55.41 c	41.87 b	48.47 c	53.99 c	41.14 b	49.52 c
MLE 1:30	56.65 b	40.99 c	49.53 b	55.61 b	40.39 c	50.11 b
MLE 1:20	57.83 a	40.13 d	50.89 a	56.78 a	39.22 d	50.87 a
L.S.D. at 5%	0.99	0.65	0.75	1.09	0.67	0.69

- Values are means of three replicates in each treatment.

- Means values in each column followed by the same letter are not significantly different ($P \leq 0.05$).

Fruits yield and its quality

The cucumber fruit yield and its quality were greatly enhanced due to MLE foliar application compared to the control in both seasons (Table 6). It was observed that the high dose of MLE (1:20) caused the maximum increase in number of fruits/plant, average of fruit fresh weight and fruits total yield of cucumbers by 33.9%, 20.5% and 46.6% in the 2017 season, respectively; and by 31.5%, 25.6% and 37.3% in the 2018 season, respectively (Table 6). Furthermore, the TSS percentage was also increased upon the foliar application of MLE, and the positive effect was dose dependent (Table 6). Elzaawely *et al.* 2017a, Matthew 2016, and Mvumi *et al.* (2012 and 2013) confirmed this on snap bean, pepper, maize, beans and tomato buttressing the work of Fuglie (2000) that there were increased crop yields when crops were sprayed with MLE.

Chemical composition and chlorophyll content of leaves

Mineral nutrients (N, P, and K) as well as total chlorophyll of cucumber leaves were significantly enhanced over control in response to MLE application in both seasons (Table 7). This finding have also been supported by Yameogo *et al.* (2011) and El-Mageed *et al.* (2017) they found that *Moringa oleifera* extract have been reported to be a rich source of important minerals as Ca, Mg, K, Fe, Zn, P, S, Cu, Mn, Se and Na which boosted plants to accumulate progressively beneficial elements, which increase the plant nutrient status. Azra *et al.* (2013), El-Mageed *et al.* (2017) and Hanafy, (2017), also found an increase in chlorophyll contents when MLE was applied to wheat and soybean plants under drought conditions.

Table 6: Fruits yield and its quality of cucumber in response to moringa leaf extract (MLE) during 2017 and 2018 seasons.

Treatments	Fruit					T.S.S (%)	Total yield (kg plant^{-1})
	No. plant^{-1}	length (cm)	diameter (cm)	fresh weigh (g)	dry weight (%)		
			Season 20١7				
Control	22.25d	15.9 d	2.75 c	141.73 c	3.99 c	3.51 c	3.46 d
MLE 1:40	27.06 c	19.07 c	3.15 b	161.32 b	4.45 b	3.87 b	4.65 c
MLE 1:30	28.51 b	19.66 b	3.47 a	165.48 b	4.67 ab	4.04 ab	4.85 b
MLE 1:20	29.79 a	20.39 a	3.68 a	170.76 a	4.89 a	4.19 a	5.07 a
L.S.D. at 5%	1.11	0.44	0.22	4.59	0.25	0.19	0.099
			Season 20١8				
Control	22.99 d	17.99 d	2.84 c	138.89 c	4.09 b	3.57 c	3.814 d
MLE 1:40	28.00 c	20.63 c	3.23 b	163.78 b	4.60 a	3.89 b	4.867 c
MLE 1:30	29.11 b	21.27 b	3.41 ab	168.66 a	4.63 a	4.00 ab	5.104 b
MLE 1:20	30.23 a	21.99 a	3.59 a	174.43 a	4.75 a	4.09 a	5.272 a
L.S.D. at 5%	1.05	0.49	0.25	4.75	0.19	0.13	0.115

- Values are means of three replicates in each treatment.
- Means values in each column followed by the same letter are not significantly different ($P \leq 0.05$).

Table 7: Chemical composition and total chlorophyll of cucumber leaves in response to moringa leaf extract (MLE) during 2017 and 2018 seasons.

Treatments	Season 2017				Season 2018			
	N (%)	P (%)	K (%)	TC (mg g^{-1} FW)	N (%)	P (%)	K (%)	TC (mg g^{-1} FW)
Control	2.55 c	0.50 c	3.49 c	0.46 c	2.78 b	0.50 c	3.44 c	0.47 c
MLE 1:40	3.02 b	0.60 b	3.90 b	0.60 a	2.98 a	0.59 b	3.85 b	0.59 a
MLE 1:30	3.07 ab	0.63 a	3.99 ab	0.57 ab	3.02a	0.61 ab	3.92 ab	0.56 ab
MLE 1:20	3.11 a	0.65 a	4.07 a	0.54 b	3.05 a	0.63 a	3.99 a	0.54 b
L.S.D. at 5%	0.05	0.02	0.09	0.03	0.07	0.02	0.11	0.023

- N: nitrogen, P: phosphorus, K: Potassium, TC: total chlorophyll.
- Values are means of three replicates in each treatment.
- Means values in each column followed by the same letter are not significantly different ($P \leq 0.05$).

Chemical composition of the fruits

Results in Table 8 indicates that the application of MLE promoted the quality of cucumber fruits through increasing of the mineral nutrients in the fruits. Except for Mn and Cu, other minerals such as N, P, K, Fe, and Zn were significantly enhanced by MLE applications particularly MLE at 1:20, in both seasons (Table 8). Abdalla & El-Khoshiban (2012) on tomato, Mohammed *et al.* (2013) on onion bulb, Abdalla (2014) on rocket, and Zaki & Rady (2015) on *Phaseolus vulgaris* they reported that accumulations of some nutritive elements as K and Ca, carbohydrate and ascorbic acid (vitamin C) in different parts of plants were increased as a consequence of spraying by MLE in compared with untreated plants (control).

Endogenous hormone levels in cucumber leaves

Endogenous phytohormones in cucumber leaves such as auxins, gibberellins and cytokinins were markedly increased with respect to the control in response to foliar application of MLE (Table 9), in both seasons. As compared to control, ABA concentration was decreased in response to MLE treatments. It is obvious that maximum concentrations of auxins, gibberellins and cytokinins as well as the lowest ABA levels were obtained when MLE at 1:20 was applied. It is also observed from the results in Table 9 that addition of MLE stimulated auxins, gibberellins and cytokinins over control by 71.6%, 24.1% and 64.9%, in 2017 season, respectively; and by 63.3%, 16.3% and 51.8%, in the 2018 season, respectively. Meanwhile, MLE significantly decreased ABA concentration over control by 31.7% and 32.6%, in the 2017 and 2018 growing seasons, respectively. The foliar application of MLE30 alone or in combination with drought stress caused increase in both IAA and GA3 contents. On the other hand, ABA content showed highly significant decrease as compared with control plants (Hanafy, 2017). Similarly, Abdalla (2013) reported that treated rocket (*Eruca vesicaria*) plants with Moringa extract increased the levels of phytohormones.

Table 8: Chemical composition of cucumber fruits in response to moringa leaf extract (MLE) during 2017 and 2018 seasons.

Treatments	N (%)	P (%)	K (%)	Fe (mg kg^{-1})	Zn (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})
				Season 20١7			
Control	1.98c	0.39 c	2.37 c	79.73 c	35.95 d	27.34	15.42
MLE 1:40	2.29b	0.47 b	3.54 b	100.7 b	41.63c	28.65	17.56
MLE 1:30	2.35ab	0.48 b	3.62 ab	109.4 b	42.86 b	29.01	17.99
MLE 1:20	2.41a	0.497 a	3.71 a	118.8 a	44.02 a	29.08	18.23
L.S.D. at 5%	0.08	0.015	0.09	9.1	1.09	N.S	N.S
				Season 20١8			
Control	1.96c	0.37 d	2.42 c	83.79 c	38.12 c	27.98	15.81
MLE 1:40	2.29b	0.44 c	3.66 b	100.2 b	42.03 b	28.49	17.61
MLE 1:30	2.38a	0.46 b	3.74 ab	106.8 ab	42.92 ab	28.75	17.95
MLE 1:20	2.43a	0.47 a	3.82 a	113.2 a	43.01 a	28.93	18.15
L.S.D. at 5%	0.07	0.013	0.08	8.6	0.94	N.S	N.S

- N: nitrogen, P: phosphorus, K: Potassium, Fe: Iron, Zn: Zinc, Mn: Manganese, Cu: cupper
- Values are means of three replicates in each treatment.
- Means values in each column followed by the same letter are not significantly different ($P \le 0.05$).

Table 9: Endogenous phytohormones (µg g^{-1} FW) of cucumber leaves in response to moringa leaf extract (MLE) during 2017 and 2018 seasons.

Treatments	Auxins	Gibberellins	Cytokinins	Abscisic acid
		Season 2017		
Control	2.732 c	11.699 d	0.652 c	0.0858 a
MLE 1:40	4.302 b	13.391 c	0.931 b	0.0628 b
MLE 1:30	4.462 b	13.975 b	1.004 ab	0.0589 b
MLE 1:20	4.689 a	14.523 a	1.075 a	0.0541 c
L.S.D. at 5%	0.177	0.491	0.075	0.0039
		Season 2018		
Control	3.045 c	12.613 d	0.658 c	0.0911 a
MLE 1:40	4.587 b	14.019 c	0.870 b	0.0698 b
MLE 1:30	4.735 b	14.392 b	0.934 ab	0.0663 c
MLE 1:20	4.973 a	14.721 a	0.999 a	0.0614 d
L.S.D. at 5%	0.165	0.343	0.066	0.0028

- Values are means of three replicates in each treatment.
- Means values in each column followed by the same letter are not significantly different ($P \le 0.05$).

Enzyme activity in cucumber leaves

Enzyme activity of cucumber leaves including catalase (CAT), peroxidase (POX) and superoxide dismutase (SOD) were markedly increased compared to control in response to foliar application of MLE, in both seasons (Table 10). These results is in a harmony with Zaki & Rady (2015) reported that MLE (30) application used as seed soaking or foliar spray were caused significant increase in the antioxidant enzymes glutathione reductase (GR), superoxide dismutase (SOD) and ascorbate peroxidase (APX) in common bean (Phaseolus vulgaris L.) plants. This extract of *Moringa* can prevent oxidative effect and afford significant protection against oxidative damage by modulate the gene expression responsible for metabolic processes and defense system.

Conclusion

In this study, foliar application of moringa leaf extract (MLE) had the ability to promote the vegetative growth and physiological traits of cucumber (*Cucumis sativus* L.) leading to the positive enhancement in the yield and nutritional quality of cucumber fruits. This promotion of the physiological traits of cucumber plants was accompanied by an increase in the endogenous hormone levels and enzymes activity. Our study proved and support the assumption that MLE might be utilized as effective natural and most importantly safe bio-stimulants to reduce the use of synthetic agrochemicals in organic agricultural production and consequently substitution of hazard chemicals by natural ones in the production of high-quality vegetables and fruits.

Disclosure statement

No potential conflict of interest was reported by the authors.

Table 10: Enzymes activity (µg g^{-1} FW h^{-1}) of cucumber leaves in response to moringa leaf extract (MLE) during 2017 and 2018 seasons.

Treatments	Season 2017			Season 2018		
	CAT	POX	SOD	CAT	POX	SOD
Control	93.86 c	137.34 d	219.49 d	99.65 d	128.01 c	205.27 d
MLE 1:40	133.25 b	183.36 c	247.11 c	156.66 c	189.02 b	263.68 c
MLE 1:30	138.11 a	189.75 b	258.35 b	165.21 b	194.43 a	270.32 b
MLE 1:20	141.32 a	194.82 a	265.21 a	171.69 a	198.85 a	279.11 a
L.S.D. at 5%	3.25	2.99	5.65	3.61	4.59	5.99

POX: Peroxidase, CAT: Catalase, SOD: Superoxide dismutase

- Values are means of three replicates in each treatment.

- Means values in each column followed by the same letter are not significantly different ($P \leq 0.05$).

REFERENCES

Abdalla, M.M. (2013). The potential of Moringa oleifera extract as a biostimulant in enhancing the growth, biochemical and hormonal contents in rocket (*Eruca vesicaria subsp. sativa*) plants. International J. of Plant Phys. and Biochemistry, 5, 42–49.

Abdalla, M.M. (2014). Boosting the growth of rocket plants in response to the application of *Moringa oleifera* extracts as a bio stimulant. Life Science Journal, 11(11): 1113-1121.

Abdalla, M.M and N. El-Khoshiban (2012). The palliative effect of bio-organic fertilizer on lead pollution in *Lycopersicum esculentum* plants. J. Basic.App. Sci., (8): 1-12.

Abou El-Nour, H.H. and N.A. Ewais (2017). Effect of *Moringa oleifera* leaf extract (MLE) on pepper seed germination, seedlings improvement, growth, fruit yield and its quality. Middle East J. Agric. Res. 6: 448-463.

Andresen, M. and N. Cedergreen (2010). Plant growth is stimulated by tea-seed extract: a new natural growth regulator. Hort. Sci. 45, 1848-1853.

AOAC, (1995). Official Methods of Analysis of Association of Official Analytical Chemists. 16th ed. Association of Official Analytical Chemists International Press. Arlington VA, USA

Azra, Y., S.M.A. Basra, R. Ahmad and A. Wahid (2012). Performance of late sown wheat in response to foliar application of Moringa oleifera Lam. leaf extract. Chilean Journal of Agricultural Research, 2, 92–97.

Basak, A. (2008). Biostimulators. Definitions, classification and legislation. In: Gawrońska H., (ed.) Biostimulators in Modern Agriculture. General Aspects. Editorial House Wieś Jutra, Warszawa, Poland, p 7-17.

Bisognin, D.A. (2002). Origin and evolution of cultivated cucurbits. Ciência Rural. 32, 715-723.

Culver, M., T. Fanuel and Z. Chiteka (2012). Effect of moringa extract on growth and yield of tomato. Greener J. Agric. Sci. 2 (5), 207-211.

El-Mageed, T.A.A., W.M. Semida and MM. Rady (2017). Moringa leaf extract as biostimulant improves water use efficiency, physio-biochemical attributes of squash plants under deficit irrigation. Agric Water Manag. 193: 46-54.

El Sohaimy, S.A., G.M. Hamad, S.E. Mohamed, M.H. Amar and R.R. Al-Hindi (2015). Biochemical and functional properties of *Moringa oleifera* leaves and their potential as a functional food. Global Adv. Res. J. Agric. Sci. 4, 188-199.

Elzaawely, A.A., M.E. Ahmed, H.F. Maswada and T.D. Xuan (2017a). Enhancing growth, yield, biochemical, and hormonal contents of snap bean (*Phaseolus vulgaris* L.) sprayed with moringa leaf extract. Arch. Agron. Soil Sci. 63, 687-699.

Elzaawely, A.A., M.E. Ahmed, H.F. Maswada, Al-Araby, Xuan, T.D., (2017b). Growth traits, physiological parameters and hormonal status of snap bean (*Phaseolus vulgaris* L.) sprayed with garlic cloves extract. Arch. Agron. Soil Sci. 64 (8), 1068-1082.

FAO. (2017). Food and Agriculture Organization of the United Nations. FAOstat: Food and Agriculture data 2017. http://www.fao.org/faostat/en/#home (accessed December 15, 2019).

Fuglie, L. J. (2000). New Uses of Moringa Studied in Nicaragua: ECHO's

Technical Network Site-networking global hunger solutions. ECHO, Nicaragua.

Gandía-Herrero, F., M. Jiménez, J. Cabanes, F. García-Carmona and J. Escribano (2003). Tyrosinase inhibitory activity of cucumber compounds: enzymes responsible for browning in cucumber. J. Agric. Food Chem. 51, 7764-7769.

Hanafy, R. S. (2017). Using *Moringa olifera* Leaf Extract as a Bio-fertilizer for Drought Stress Mitigation of Glycine max L. Plants. Egypt. J. Bot. 57 (2): 281-292.

Ignat, I., A. Stîngu, I. Volf and V.I. Popa (2009). Natural bioactive compounds as plant growth regulators. Sci. Pap. Ser. Agron. 52, 187-192.

Khoshgoftarmanesh, A.H., S. Khodarahmi and M. Haghighi (2014). Effect of silicon nutrition on lipid peroxidation and antioxidant response of cucumber plants exposed to salinity stress. Arch. Agron. Soil Sci. 60, 639-653.

Koshioka, M., J. Harada, M. Noma, T. Sassa, K. Ogiama, J.S. Taylor, S.B. Rood, R.L. Legge and R.P. Pharis (1983). Reversed phase C18 high performance liquid chromatography of acidic and conjugated gibberellins. J. Chromatgr. 256, 101-115.

Kumar, D., S. Kumar, J. Singh, B.D. Vashistha, N. Singh (2010). Free radical scavenging and analgesic activities of *Cucumis sativus* L. fruit extract. J. Young Pharm. 2, 365-368.

Matthew, A. (2016). Moringa leaf extract on the growth and yield of pepper (*Capsicum annuum* L.). ARPN J. Agric. Biol. Sci. 11 (3), 107-109.

Maswada, H.F., U.A. Abd El-Razek, A.A. El-Sheshtawy and AA. Elzaawely (2017). Morpho-physiological and yield responses to exogenous moringa leaf extract and salicylic acid in maize (*Zea mays* L.) under water stress. Arch Agron Soil Sci. DOI: 10.1080/03650340.2017.1406079.

Muhammed, R., M.M. Olorukooba, J.A. Akinyaju and E.A. Kambai (2013). Evaluation of different concentrations and frequency of foliar application of moringa extract on growth & yield of onion, (*Allium cepa* L). Agrosearch, 13(3): 196-205.

Mvumi, C., F. Tagwira and A. Z. Chiteka (2012). Effect of moringa extract on growth and yield of tomato. Greener Journal of Agricultural Sciences. 2(5): 207-211.

Mvumi, C., F. Tagwira and A. Z. Chiteka (2013). Effect of moringa extract on growth and yield of maize and common beans. Greener Journal of Agricultural Sciences. 3(1): 055-062.

Nagar, P. K., R. I. Iyer and P. K. Sircar (2006). Cytokinins in developing fruits of *Moringa pterigosperma* Gaertn. Physiol Plant. 55: 45-50.

Nema, N.K., N. Maity, B. Sarkar, P.K. Mukherjee (2011). *Cucumis sativus* fruit-potential antioxidant, anti-hyaluronidase, and anti-elastase agent. Arch. Dermatol. Res. 303, 247-252.

Nicander, B., U. Stahi, P.O. Bjorkman and E. illberg (1993). Immunoaffinity co- purification of cytokinins and analysis by high performance liquid chromatography with ultraviolet spectrum detection. Planta. 189, 312-320.

Parađiković, N., T. Vinković, I.V. Vrček, I. Žuntar, M. Bojić and M. Medić-Šarić, (2011). Effect of natural biostimulants on yield and nutritional quality: an example of sweet yellow pepper (*Capsicum annuum* L.) plants. J. Sci. Food Agric. 91, 2146-2152.

Phiri, C. (2010). Influence of *Moringa oleifera* leaf extracts on germination and early seedling development of major cereals. Agric. Biol. J. North Am. 1, 774-777.

Rahman, A.H.M.M., M. Anisuzzaman, F. Ahmed, A.K.M. Rafiul Islam and A.T.M. Naderuzzaman (2008). Study of nutritive value and medicinal uses of cultivated cucurbits. J. Applied Sci. Res. 4, 555-558.

Ryan, J., S. Garabet, K. Harmsen, A. Rashid (1996). A soil and plant analysis manual adapted for the West Asia and North Africa Region. ICARDA Technical Bulletin. International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. pp. 140.

Salisbury F.B., 1996. Units, symbols and terminology for plant physiology: a reference for presentation of research results in the plant sciences. Oxford University Press, Inc; NY, p. 234.

Semida, W.M. and M.M. Rady (2014). Presoaking application of propolis and maize grain extracts alleviates salinity stress in common bean (*Phaseolus vulgaris* L.). Sci. Hort. 168: 210-217.

Wellburn, A.R. (1994). The spectral determination of chlorophylls a and b, as well as total carotenoids, using various solvents with spectrophotometers of different resolution. J. Plant Physiol. 144: 307-313.

Yakhin, O.I., A.A. Lubyanov, I.A. Yakhin, P.H. Brown (2017). Biostimulants in plant science: a global perspective. Front. Plant Sci. 7, 2049.

Yameogo, C.W., M.D., Bengaly, A. Savadogo, P.A. Nikiema and S.A. Traore (2011). Determination of chemical composition and nutritional values of *Moringa oleifera* leaves. Pak. J. of Nutrition, 10(3): 264-268.

Zaki, S.S. and M.M. Rady (2015). Moringa oleifera leaf extract improves growth, physiochemical attributes, antioxidant defense system and yields of salt stressed *Phaseolus vulgaris* L. plants. International Journal of Chem. Tech Research, 8 (11): 120–134.

Zhao, L., J.R. Peralta-Videa, C.M. Rico, J.A. Hernandez-Viezcas, Y. Sun, G. Niu, A. Servin, J.E. Nunez, M. Duarte-Gardea, J.L. Gardea-Torresdey (2014). CeO_2 and ZnO nanoparticles change the nutritional qualities of cucumber (*Cucumis sativus*). J. Agric. Food Chem. 62: 2752-2759.

استخدام مستخلص أوراق المورينجا لتحسين نمو ومحصول الخيار

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الملخص العربى

تمت الدراسة تحت ظروف الصوبة فى موسمين متتاليين ٢٠١٧ و٢٠١٨ وتم تقييم استجابة نمو وانتاجية الخيار الصنف الهجين هشام للرش الورقى بثلاثة تركيزات (١:٢٠، ١:٣٠، ١:٤٠) بمستخلص اوراق المورينجا. وتم تحسين صفات نمو الخيار (طول النبات والمساحة الورقية وعدد الأوراق والوزن الطازج والجاف لكل من الاوراق وسيقان النباتات) وصفات التزهير (عدد الازهار وعدد الأيام حتى اول زهرة ونسبة العقد) معنويا نتيجة الرش الورقى بمستخلص المورينجا. كما تم تعزيز نمو وتطور بعض الصفات الثمرية (الوزن الطازج والجاف للثمار ومحصول الثمار الكلى) نتيجة المعاملة الورقية بمستخلص أوراق المورينجا. أدت معاملة النباتات بمستخلص أوراق المورينجا الى زيادة ملحوظة لمستوى الهرمونات الداخلية (الاوكسينات والجبريلينات والسيتوكينينات) كما زادت من نشاط إنزيمات مضادات الاكسدة الكاتلاز، والبيروكسيديز وسوبراكسيد الديسميوتاز في أوراق الخيار. وكشف هذا التأثير التحفيزى ان مستخلص اوراق المورينجا يمكن استخدامه كمنشط حيوي طبيعي وآمن فعال فى الانتاج الزراعي العضوي.

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