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Application of Biostimulants and Gibberellic Acid Improves the Growth, Flowering and Corm Production in *Gladiolus grandiflorus* L.

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ABSTRACT

Improving the growth and productivity of flower bulbs via biostimulants is a very imperative topic. Therefore two field experiments were conducted during 2016/2017 and 2017/2018 seasons to investigate the efficacy of moringa leaf extract (MLE), seaweed and/or GA_3 treatments on improving the growth, flowering and corm production of gladiolus. MLE was extracted and diluted at a ratio of 1:30 (v:v). Seaweed was applied at 1g/L. Moreover, the applied concentrations of GA_3 were 0, 50, 100 and 150 mg/L. The growth characters and flowering attributes were significantly improved compared with the control due to MLE or seaweed as a solely treatment or even in combination with GA_3 concentrations in both experimental seasons. The productivity of corm and cormlets was also enhanced by using both biostimulants and/or GA_3 application. Furthermore, the chemical analysis indicate that N, P, K, total chlorophyll and total carbohydrate content were increased in gladiolus leaves treated with MLE or seaweed and/or GA3 treatments in both seasons. Conclusively, MLE, seaweeds and/or GA_3 applications enhanced the growth characters flowering attributes and corm production of gladiolus. The most effective treatment was MLE and GA_3 at 100 mg/L. MLE and seaweeds may be applied as a promise and ecofriendly plant growth stimulants to modulate the growth and productivity of gladiolus.

Keywords: Biostimulants, GA_3, flowering spikes, chlorophyll, carbohydrates, corm production

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.), commonly called queen of bulbous flowers, belongs to Iradiaceae family and it is the seventh important flower crops of the world (Sable *et al*., 2015). Gladiolus genus is native of South Africa including 180 species (Sinha and Roy, 2002). Gladiolus spikes gained popularity worldwide because of their economic value as a cut flower crop. Higher demand of gladiolus spikes in international market is due to big florets, attractive spikes, amazing colors and long vase life (Farid-Uddin *et al*., 2002). There is a great need to produce desirable quantity with considerable quality of this economic crop for the improvement of production technology degradation (Younis *et al*., 2018). Flowering bulbs including gladiolus required much nutrition for growth and development. Non-judicious application of chemical fertilizers rarely ensures flower quality and generates environmental issues as well (Mattner *et al*., 2013). Therefore, the production of cut flowers needs to be enhanced by adopting improved horticultural techniques (Sable *et al*., 2015).

Recently, discovering alternative sources of biostimulants has been the focus of interest worldwide for improving the crop productivity and achieving the sustainable agriculture (Abdalla, 2013). Biostimulants decrease chemical fertilizers requirement, hence less environment degradation (Younis *et al*., 2018). Additionally, they offer resistance against several stresses subsequently increased the quality of product (Bulgari *et al*., 2015). Plant biostimulants contain several bioactive compounds that may enhance different physiological processes, hence stimulate the plant growth as well as productivity (Ali *et al*., 2018). Otherwise, increasing nutrient use efficiency via biostimulants has been documented (Bulgari *et al*., 2015).

One of the most effective biostimulants is moringa leaf extract (MLE) that can be used as an alternative source of chemical fertilizers (Phiri and Mbewe, 2010). MLE has achieved massive attention due to its useful applications and containing amino acids, cytokinins like zeatin, flavonoid, carotenoids, antioxidants such as ascorbic acid, vitamins, phenolics, macro and micro nutrients (Latif and Mohamed, 2016; Ali *et al*., 2018).

MLE has been used to enhance the growth and production of several crops with higher economic return (Ashraf *et al*., 2016). MLE application improved the growth, flowering attributes and corm production in gladiolus (Younis *et al*., 2018). MLE improved the postharvest quality and longevity of gladiolus cut spikes. It also improved the floret opening, total phenolics and the antioxidant enzymes activities through oxidative stress alleviation, maintaining water relations and photosynthetic pigments (Hassan and Fetouh, 2019). The plant height, leaf area, leaf number and yield of basil were considerably increased due to MLE application (Prabhu *et al*., 2010). Interestingly, Aslam *et al*. (2016) found that MLE treatment significantly enhanced the chlorophyll and soluble protein contents in spinach leaves compared to the other growth regulators investigated. It could be noticed that the most reports published on MLE as biostimulants were carried out on grain or vegetable crops however, scarce studies have been found on flowering bulbs including gladiolus.

Recently, marine algae (seaweeds) are considered a new promising biostimulant that contain macro and micro nutrients, proteins, polyamines, growth regulators and vitamins therefore stimulated the plant growth and improved the productivity (Abd El-Moniem and Abd-allah, 2008; Safinaz and Ragaa, 2013). Recent report proved that seaweed as biofertilizers are useful not only due to their N, P and K contents but also due to the presence of trace elements and several metabolites like to growth regulators (Thirumaran *et al*., 2009). El-Khateeb *et al*. (2018) on *Spathiphyllum wallisii* L. reported that foliar application of algae increased leaf number and area, promoted the growth, enhanced the photosynthetic pigments and improved the carbohydrate content. However, scarce data are available about seaweed application on flowering bulbs including gladiolus.

Plant growth regulators have significant role in modifying the plant growth and flowering and are effective in enhancing growth, flowering and corm production in gladiolus (Sable *et al*., 2015). Several researchers have been worked to explore the effects of gibberellic acid (GA_3) on growth and flowering in gladiolus. GA_3 is involved in increasing plant height, leaf area, number of leaves per plant, shoot dry weight and flower diameter of gladiolus (Siraj and Al-Safar, 2006). GA_3 application was found to shorten the number of days required to flowering, improve spike length, floret diameter, floret number/ spike and shoot elongation (Sajid *et al*., 2015). Although using growth regulators in gladiolus production received more attention, the available information is still very meager (Sable *et al*., 2015). Keeping the economic importance of gladiolus and the roles of biostimulants and GA_3 in mind, the present study was therefore designed to find out whether the foliar application of MLE, seaweed and/or GA_3 could increase the growth, flowering attributes and corm production on *Gladiolus grandiflorus* L. cv. Rose Supreme.

MATERIALS AND METHODS

Plant materials

Two field experiments were carried out at the Faculty of Agriculture, Menoufia University, Shibin El-Kom (30°33′24.8″N 31°00′51.3″E) during 2016/ 2017 and 2017/2018 winter seasons to study the effects of MLE and seaweed and/or GA_3 on the growth, flowering attributes and corm production on *Gladiolus grandiflorus* L. cv. Rose Supreme. After preparing the experimental soil, it was divided into 1.5 x 2 m plots that contained three rows. The distance between rows was 50 cm while the distance among hills were 25 cm. Gladiolus corms used in this study that imported from Holland with size of (8-10 cm in diameter) were sown on October 1st in both seasons in hills. The physical properties of experimental soil were (16.31 % sand, 36.17 %silt, 47.52 % clay). The soil chemical properties were (EC, 1.43 dsm^{-1}, pH, 7.98, OM, 1.47 %, SO_4^{-2}, 44.49 (meq L^{-1}), Ca^{+2}, 42.11 (meq L^{-1}), Na^+, 2.17 (meq L^{-1}), Cl^-, 0.48 (meq L^{-1}), HCO_3, 1.93 (meq L^{-1}), total N^+, PO_4^{-3}, K^+ were 0.21, 0.030 and 0.039 %, respectively). The other cultural practices needed during the growth were done when required.

Treatments and experimental design

Moringa oleifera, Lam. young leaves were harvested from grown trees cultivated in the Experimental Farm of Horticulture. To elaborate MLE, the freshly young leaves were extracted with little water in a fabricated machine according to Yasmeen *et al*. (2012). Then the extract was purified and the supernant was diluted using distilled water at a ratio of 1:30 (v:v). The spraying was repeated three times at one month interval, while control plants were sprayed with distilled water only. Fresh MLE was used at each application and spraying the extract was done by hand sprayer. The commercial product acadian™, marine algae extract powder, was used as a source of seaweed (red algae). Seaweed was applied at 1g/L using distilled water. The spraying was repeated three times at one month interval, while control plants were sprayed with distilled water only. The concentrations of GA_3 applied in this experiment were 0, 50, 100 and 150 mg/L. GA_3 was foliar sprayed after 30, 60 and 90 days from planting. Control plants were distilled water sprayed. The design of the experiment was split plot in a randomized complete block design (RCBD) according to Snedecor and Cochran (1980) with three replicates. The biostimulants (MLE and Seaweed) were randomly distributed in the main plot while the sub-plots were occupied with GA_3 treatments.

Investigated growth, flowering and corm production characters

At harvesting stage (opening the first floret), the vegetative growth and flowering attributes were recorded: plant height (cm), number of leaves/plant, number of days from planting to flowering, spike length (cm), spike diameter cm), spike fresh and dry weights (g) and number of florets/spike. The spikes were cut and three leaves were left on each plant. Six weeks later, the new corms and cormlets were obtained and the following data were recorded: corm diameter (cm), corm fresh and dry weights (g), number of cormlets/plant and fresh weight of cormlets (g).

Nutrient elements assessment

Leaf samples were oven dried at 70 ˚C for 48 hours. Then, dry samples were milled for obtaining suitable material to analyze the nutrient content. For mineral content analysis, samples (0.5 g) were digested in sulphuric and perchloric acids method (Piper, 1967; Jackson, 1978). Nitrogen was determined by micro-Kjeldhl method according to Black *et al.* (1965), phosphorus were colorimetrically assessed at 660 nm while potassium was measured using flame photometer as described by Jackson (1978).

Chlorophyll determination

The chlorophyll content in the gladiolus fresh leaves was assessed according to Metzner *et al*. (1965) method. The fresh samples were collected at flowering stage and were extracted in acetone then the extract was spectrophotometrically investigated. The total chlorophyll was recorded as mg/g based on fresh weight.

Total carbohydrates assessment

Total carbohydrate percentages were determined in dried leaves according to Herbert *et al.* (1971).

Statistical analysis

The obtained results of each season were subjected to the analysis of variance (ANOVA) using SPSS 13.3 program. Statistical differences were investigated using LSDs at $P \leq 0.05$ probability level.

RESULTS AND DISCUSSION

Results

Growth characters, spike diameter and length

Data presented in Table (1) show that the plant height, number of leaves/plant, spike diameter and spike length were significantly increased due to foliar application of biostimulants or GA_3 compared to the control in both seasons. These parameters were gradually increased with increasing GA_3 concentration until 100 mg/L then slightly decreased by 150 mg/L level. Otherwise, Applying MLE was superior to seaweed treatment in this respect. The interaction between biostimulants and GA_3 was also effective and the best results were obtained by the treatment of MLE and 100 mg/L GA_3 in both seasons. This treatment increased the spike length by 62.01 and 74.07 % relative to the control in the first and second seasons, respectively.

Due to the presence of essential nutrients, antioxidants and phytohormones in MLE, it is considered as one of the valuable plant biostimulant (Rady and Mohamed, 2015) Furthermore, MLE might positively affect the endogenous level of phytohormones hence enhanced the plant growth (Ali *et al*., 2018). Moreover, MLE contained auxins that improve the cell elongation and promote the stem growth, giberellins that improve plant height and cytokinins that play a critical role in cell division promotion (Taiz and Zeiger, 2010). These results support the previous results of Younis *et al*. (2018) in gladiolus and Ali *et al*. (2018) in geranium. Safinaz and Ragaa (2013) reported that seaweed extracts contain macro and micro elements, vitamins, amino acids as well as many growth promoting substances like auxin and gibberellin that have positive effects on improving the plant growth and development. These results are in agreement with the results reported by Abd El-Moniem and Abd-allah (2008).

Increasing the plant height due to GA_3 application may be ascribed to its role in motivating cell enlargement which reflected in increasing the internodal distance. Additionally, this increase in plant height resulted in more leaves since GA_3 encourage the vegetative growth and therefore, enhanced the spike length and its diameter. Similar results were observed by Sable *et al*. (2015) and Sajid *et al*. (2015) in gladiolus. Among phytohormones observed in MLE, auxins improve the cell elongation and promote the stem growth while giberellins enhance plant height and cytokinins play a critical role for cell division promotion and apical dominance modification (Taiz and Zeiger, 2010).

Table 1. Effect of foliar application with biostimulants and/or GA3 on plant height, number of leaves/plant, spike length and spike diameter of gladiolus in 2016/2017 and 2017/2018.

Treatments: Biostimulants	GA_3 level (mg/L)	Plant height (cm)	No. of leaves/ plant	Spike diameter (cm)	Spike length (cm)	Plant height (cm)	No. of leaves /plant	Spike diameter (cm)	Spike length (cm)
		2016/2017 season				2017/2018 season			
Control	0	63.10	6.30	0.81	39.25	57.22	6.35	0.80	36.22
	50	66.61	6.76	0.84	42.33	60.70	6.67	0.86	39.03
	100	70.34	7.68	0.88	44.55	65.30	7.32	0.90	44.35
	150	68.43	7.66	0.86	43.41	63.70	7.68	0.86	43.25
MLE	0	74.36	8.66	0.91	53.73	76.39	9.11	0.90	56.95
	50	77.52	10.33	0.91	56.18	80.39	11.31	1.01	60.82
	100	82.45	11.66	0.94	63.95	85.83	12.66	1.09	63.05
	150	80.11	12.08	0.84	61.29	83.70	11.66	0.91	61.75
Seaweed	0	71.42	8.33	0.81	54.77	65.85	8.33	0.84	51.12
	50	72.83	12.17	0.88	57.18	68.83	10.66	0.87	55.25
	100	76.44	11.66	0.98	59.42	74.44	11.33	0.96	59.33
	150	75.31	11.39	0.91	58.37	74.50	11.27	0.80	58.25
LSD 0.05 Biostimulants X GA_3		3.76	0.57	0.23	2.18	3.65	0.54	0.22	2.06
Biostimulants (M)	Control	67.12	7.10	0.85	42.39	61.73	7.01	0.86	40.71
	MLE	78.61	10.68	0.90	58.79	81.58	11.19	0.98	60.64
	Seaweed	74.00	10.89	0.90	57.44	70.91	10.40	0.87	55.99
LSD 0.05 Biostimulants		1.87	0.33	0.14	1.48	1.74	0.29	0.12	1.41
GA_3 (M)	0	69.63	7.76	0.84	49.25	66.49	7.93	0.85	48.10
	50	72.32	9.75	0.88	51.90	69.97	9.55	0.91	51.70
	100	76.41	10.33	0.93	55.97	75.19	10.44	0.98	55.58
	150	74.62	10.38	0.87	54.36	73.97	10.20	0.86	54.42
LSD 0.05 GA_3		2.13	0.45	0.18	1.73	2.04	0.37	0.15	1.66

Flowering attributes

Data in Table (2) indicate that, days from planting to flowering, number of florets/ spike, spike fresh and dry weights of gladiolus considerably affected by biostimulants and/or GA_3 treatments in the two experimental seasons. GA_3 application decreased the period from planting to flowering especially with the lowest level (50 mg/L) compared to higher levels or untreated control. MLE and seaweed treatments decreased that period as well compared to the control in both seasons. The interaction between biostimulants and GA_3 treatments did not significantly affect that period in most cases. Additionally, the floret number/spike as well as fresh and dry weights of spikes were significantly enhanced due to MLE or seaweed treatments compared to the control. Increasing the GA_3 level gradually increased those attributes till 100 mg/L while the highest GA_3 level decreased these values but still significant to the control. This trend was observed when GA_3 was applied solely or in combination with MLE or seaweed in both seasons.The effects of biostimulants and/or GA_3 was more observed when they interacted and the highest values in this concern were recorded by applying MLE and GA_3 at 100 mg/L in both seasons.

The results of the current study are in conformity with the results of Sable *et al*. (2015) and Sajid *et al*. (2015) in gladiolus. The increment in floret number, fresh and dry weights of spikes could be explained through the positive effects of biostimulants and/or GA_3 in improving the vegetative growth which reflected in enhancing the flower attributes. Such increment due to the application of GA_3 has already been reported by Younis *et al*. (2018) in gladiolus.

Table 2. Effect of foliar application with biostimulants and/or GA_3 on days to flowering, number of florets/spike and fresh and dry weights of spikes gladiolus in 2016/2017 and 2017/2018 seasons.

Treatments: Biostimulants	GA_3 level (mg/L)	Days to flowering	No. of florets/ spike	Spike fresh weight (g)	Spike dry weight (g)	Days to flowering	No. of florets/ spike	Spike fresh weight (g)	Spike dry weight (g)
		2016/2017 season				2017/2018 season			
Control	0	126.24	10.44	59.28	6.33	125.65	9.79	55.44	6.12
	50	121.60	11.16	60.09	7.43	120.40	10.63	57.09	7.15
	100	124.53	11.63	64.52	8.47	119.59	11.17	63.49	7.68
	150	125.16	10.79	63.17	7.55	122.12	10.70	63.44	7.29
MLE	0	125.84	12.25	69.99	8.23	124.47	12.03	69.98	8.22
	50	122.75	12.59	72.13	8.88	120.33	12.17	74.19	8.87
	100	119.68	13.73	79.18	9.09	118.67	13.33	81.89	9.58
	150	120.18	13.64	77.06	8.95	120.54	12.85	79.34	9.17
Seaweed	0	124.47	11.89	62.77	7.53	124.84	10.35	61.88	6.45
	50	121.56	12.12	68.64	7.46	120.67	11.42	63.55	7.48
	100	120.38	12.68	75.28	8.98	119.42	11.34	77.40	8.69
	150	121.48	12.38	73.06	7.98	120.75	11.69	75.89	8.43
LSD 0.05 Biostimulants X GA_3		5.48	0.46	3.29	0.33	5.53	0.48	3.31	0.35
Biostimulants (M)	Control	124.38	11.01	61.77	7.45	121.94	10.57	59.87	7.06
	MLE	122.11	13.05	74.59	8.79	121.00	12.60	76.35	8.96
	Seaweed	121.97	12.27	69.94	7.99	121.42	11.20	69.68	7.76
LSD 0.05 Biostimulants		3.89	0.34	1.94	0.27	3.77	0.33	1.90	0.26
GA_3 (M)	0	125.52	11.53	64.01	7.36	124.99	10.72	62.43	6.93
	50	121.97	11.96	66.95	7.92	120.47	11.41	64.94	7.83
	100	121.53	12.68	72.99	8.85	119.23	11.95	74.26	8.65
	150	122.27	12.27	71.10	8.16	121.14	11.75	72.89	8.30
LSD 0.05 GA_3		4.27	0.38	2.27	0.29	4.38	0.39	2.21	0.30

Corm production

Data in Table (3) indicated that the corm diameter, corm fresh and dry weights, number of cormlets and fresh weight of cormlets were significantly increased as a result of foliar application of biostimulants and/or GA_3 compared to the control in both seasons. The abovementioned parameters were higher when MLE was applied compared to seaweeds treatment in both seasons. It has been reported that MLE is a valuable biostimulant due to containing phytohormones and essential nutrients which reflected in improving corm productivity (Rady and Mohamed, 2015). Our results are in accordance with the results of Younis *et al.* (2018) in gladiolus. Enhancing the corm productivity due to seaweed application may be ascribed to elements, vitamins, amino acids as well as many growth promoting substances detected in seaweed (Safinaz and Ragaa, 2013) and improved the metabolism processes that reflected in more vegetative growth and high corm productivity of gladiolus. Similar findings have been reported by Abd El-Moniem and Abd-allah (2008).

Increasing the concentration of GA_3 gradually increased those characters till 100 mg/L however, applying 150 mg/L treatment has no impact relative to 100 mg/L. Moreover, the interaction between MLE or seaweeds with GA_3 treatments revealed that the corm production attributes was positively affected by both of them and the best results were observed by the treatment of MLE and 100 mg/L GA_3 in both seasons. These results are in agreement with Sajid *et al.* (2015) in gladiolus. The positive effects of GA_3 on corm productivity have been previously reported (Sudhakar and Kumar, 2012).

Nutrient elements, chlorophyll and carbohydrate contents

It is evident from Table (4) that application of biostimulants and/or GA_3 enhanced the N, P, K, total chlorophyll content and total carbohydrates in gladiolus leaves compared to the control in the two seasons. Applying MLE and seaweed significantly increased those parameters relative to the untreated plants. MLE was superior to seaweed in this respect in both seasons. The increment in those parameters was gradual with increasing the GA_3 concentration while the highest level did not increase them significantly compared with 100 mg/L. The effects of biostimulants and/or GA_3 were more pronounced when they interacted and the highest values in this concern were recorded by applying MLE and GA_3 at 100 mg/L. in both seasons.

The improvement in N, P and K could be ascribed to the fact that the leaves of moringa are rich in minerals (Rady *et al.*, 2013) hence; MLE application increased the nutrients uptake. Similar findings have been reported in geranium (Ali *et al.*, 2018). Increasing the total chlorophyll content in gladiolus leaves could be ascribed to considerable amounts of chlorophyll and carotenoids found in MLE (Rady *et al.*, 2013). Moreover, moringa leaves are rich in cytokinins that play a role in biosynthesis of chlorophyll (Taiz and Zeiger, 2010). These results are in agreement of the results obtained by Ali *et al*. (2018) who reported that the photosynthetic pigments were increased due to MLE treatment. Increasing the carbohydrate content in gladiolus leaves is in accordance with the findings of Latif and Mohamed (2016) who revealed that MLE application resulted in notable effects as overall increase of total sugar concentrations.

Increasing the N, P, K, total chlorophyll content and total carbohydrates in gladiolus leaves by seaweeds application supported the other results obtained by Subramaniyan and Malliga (2011). Similarly, El-Khateeb *et al*. (2018) found that seaweed application enhanced the nutrition status, photosynthetic pigments and improved the carbohydrate content. The effective role of GA_3 in enhancing the growth may reflect in increasing the uptake of nutrient elements and increasing the efficiency of photosynthetic system and therefore, the total chlorophyll and carbohydrates were increased. It has been reported that GA_3 treatment retards chlorophyll degradation and high leaf chlorophyll content was remained in gladiolus (Faraji *et al*., 2011).

Table 3. Effect of foliar application with biostimulants and/or GA_3 on corm production of gladiolus in 2016/2017 and 2017/2018 seasons.

Treatments: Biostimulants	GA_3 level (mg/L)	Corm diameter (cm)	Corm FW (g)	Corm DW (g)	No. of cormlets	FW of cormlets (g)	Corm diameter (cm)	Corm FW (g)	Corm DW (g)	No. Of cormlets	FW of cormlets (g)
		2016/2017 season					2017/2018 season				
Control	0	4.14	31.99	4.83	55.17	17.44	3.58	30.05	4.86	49.77	16.99
	50	4.83	33.05	5.66	84.34	24.23	4.70	35.33	5.57	81.84	24.75
	100	5.17	37.95	7.15	120.42	36.05	5.13	39.13	9.34	118.57	33.22
	150	4.95	36.78	6.77	116.13	32.40	4.79	38.71	8.25	113.98	31.33
MLE	0	4.89	47.28	6.55	125.15	33.37	4.48	42.10	6.46	90.77	32.23
	50	5.61	58.89	8.66	136.78	35.22	5.26	54.33	8.58	103.32	34.31
	100	5.93	67.45	11.35	163.43	43.49	5.91	74.56	11.27	159.35	46.75
	150	5.83	66.43	10.66	154.50	41.35	5.85	71.25	10.93	133.77	44.21
Seaweed	0	4.40	43.60	5.77	95.76	27.37	4.21	35.22	5.48	87.55	25.98
	50	5.35	45.07	7.04	112.15	31.08	5.17	49.33	6.95	101.33	32.48
	100	5.33	49.92	8.05	156.74	43.44	5.39	53.13	9.25	145.68	43.62
	150	5.53	55.83	8.18	143.07	40.35	5.43	51.36	8.86	128.46	34.06
LSD 0.05 Biostimulants X GA_3		0.34	2.34	0.38	5.89	2.15	0.33	2.30	0.39	5.92	2.25
Biostimulants (M)	Control	4.77	34.94	6.10	94.02	27.53	4.55	35.81	7.01	91.04	26.57
	MLE	5.57	60.01	9.31	144.97	38.36	5.38	60.56	9.31	121.80	39.38
	Seaweed	5.15	48.61	7.26	126.93	35.56	5.05	47.26	7.64	115.76	34.04
LSD 0.05 Biostimulants		0.25	1.89	0.26	4.17	1.65	0.23	1.82	0.28	4.22	1.61
GA_3 (M)	0	4.48	40.96	5.72	92.03	26.06	4.09	35.79	5.60	76.03	25.07
	50	5.26	45.67	7.12	111.09	30.18	5.04	46.33	7.03	95.50	30.51
	100	5.48	51.77	8.85	146.86	40.99	5.48	55.61	9.95	141.20	41.20
	150	5.44	53.01	8.54	137.90	38.03	5.36	53.77	9.35	125.40	36.53
LSD 0.05 GA_3		0.28	1.94	0.30	4.66	1.76	0.27	1.91	0.31	4.71	1.78

Table 4. Effect of foliar application with biostimulants and/or GA_3 on N, P, K, total chlorophyll and total carbohydrates of gladiolus in 2016/2017 and 2017/2018.

Treatments: Biostimulants	GA_3 level (mg/L)	N (%)	P (%)	K (%)	Total Chloro-phyll (mg/ g FW)	Total carbo-hydrates (%)	N (%)	P (%)	K (%)	Total Chloro-Phyll (mg/ g FW)	Total carbo-hydrates (%)
		2016/2017 season					2017/2018 season				
Control	0	1.64	0.24	1.73	0.92	10.34	1.59	0.21	1.69	0.91	10.28
	50	1.66	0.25	1.74	0.97	10.84	1.63	0.24	1.71	0.97	10.72
	100	1.68	0.29	1.79	1.03	11.07	1.67	0.27	1.76	1.09	11.03
	150	1.71	0.28	1.80	1.15	11.14	1.69	0.27	1.75	1.11	11.05
MLE	0	1.63	0.29	1.75	0.95	10.28	1.55	0.24	1.70	1.03	10.43
	50	1.73	0.32	2.18	1.23	13.76	1.69	0.30	1.97	1.21	12.89
	100	1.82	0.36	2.48	1.31	14.53	1.78	0.37	2.39	1.32	14.19
	150	1.81	0.35	2.41	1.30	14.42	1.75	0.36	2.36	1.30	14.12
Seaweed	0	1.64	0.27	1.74	0.96	10.33	1.56	0.23	1.71	0.97	10.26
	50	1.71	0.35	1.97	1.13	12.59	1.66	0.27	1.91	1.09	12.55
	100	1.79	0.39	2.35	1.24	13.18	1.74	0.35	2.25	1.29	13.69
	150	1.78	0.39	2.30	1.25	13.20	1.72	0.34	2.27	1.27	13.64
LSD 0.05 Biostimulants X GA_3		0.24	0.027	0.11	0.057	1.38	0.27	0.025	0.08	0.062	1.56
Biostimulants(M)	Control	1.67	0.27	1.77	1.02	10.85	1.65	0.25	1.73	1.02	10.77
	MLE	1.75	0.33	2.21	1.20	13.25	1.69	0.32	2.11	1.22	12.91
	Seaweed	1.73	0.35	2.09	1.15	12.33	1.67	0.30	2.04	1.16	12.54
LSD 0.05 Biostimulants		0.16	0.006	0.07	0.048	1.29	0.16	0.008	0.07	0.051	1.38
GA_3 (M)	0	1.64	0.27	1.74	0.94	10.32	1.57	0.23	1.70	0.97	10.32
	50	1.70	0.31	1.96	1.11	12.40	1.66	0.27	1.86	1.09	12.05
	100	1.76	0.35	2.21	1.19	12.93	1.73	0.33	2.13	1.23	12.97
	150	1.77	0.34	2.17	1.23	12.92	1.72	0.32	2.13	1.23	12.94
LSD 0.05 GA_3		0.08	0.004	0.05	0.029	1.05	0.08	0.003	0.03	0.030	1.07

CONCLUSION

As a conclusion, MLE, seaweeds and/or GA_3 applications enhanced the growth characters and flowering attributes of gladiolus. Additionally, the corm production, nutrient status, chlorophyll and total carbohydrates were also improved. To maximizing the growth and productivity of gladiolus, the treatment of MLE and GA_3 at 100 mg/L was recommended. MLE and seaweeds may be used as ecofriendly plant growth stimulants to modulate the growth and productivity of gladiolus.

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المعاملة بالمنشطات الحيوية وحمض الجبرلليك تحسن من نمو وازهار وانتاج الكورمات في نبات الجلاديولس

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يعتبر تحسين النمو والانتاج في الأبصال المزهرة عن طريق المنشطات الحيوية من الموضوعات الملحة.. لذلك أجريت تجربتان حقليتان خلال موسمي٢٠١٦/٢٠١٧ و ٢٠١٧/٢٠١٨ لدراسة فاعلية استخدام الرش بمستخلص أوراق المورينجا والأعشاب البحرية وكذلك المعاملة بحمض الجبرلليك في تحسين النمو والازهار وانتاج الكورمات في نبات الجلاديولس. تم استخدام مستخلص أوراق المورينجا بعد تخفيفه بنسبة ١:٣٠ (حجم/حجم) بينما تم استخدام الأعشاب البحرية بتركيز ١ جم/لتر. وكانت التركيزات المستخدمة من حمض الجبرلليك صفر، ٥٠، ١٠٠ و ١٥٠ مجم/لتر. وأوضحت نتائج هذه التجربة أن خصائص النمو والأزهار قد تحسنت معنويا نتيجة المعاملة بأي من مستخلص أوراق المورينجا أوالأعشاب البحرية كمعاملة فردية وكذلك بمعاملة التفاعل بين أي منهما مع المعاملة بحمض الجبرلليك مقارنة بالنباتات الغير معاملة في كل من موسمي التجربة. كما أوضحت النتائج أن انتاج الكورمات والكريمات قد تحسن أيضا باستخدام المعاملة بهذه المنشطات الحيوية أو المعاملة بحمض الجبرلليك. فضلا عن ذلك فقد بينت نتائج التحليل الكيميائي أن نسبة النيتروجين والفوسفور والبوتاسيوم والمحتوي الكلي للكلوروفيل والكربوهيدرات بالأوراق قد ازدادت باستخدام الرش بمستخلص أوراق المورينجا أو الأعشاب البحرية وكذلك بمعاملة التفاعل بين أي منهما مع المعاملة بحمض الجبرلليك مقارنة بنباتات الكنترول في كل من الموسمين. وفي النهاية فان استخدام الرش بمستخلص أوراق المورينجا والأعشاب البحرية وكذلك المعاملة بحمض الجبرلليك قد حسنت خصائص النمو والازهار وانتاج الكورمات في نبات الجلاديولس وكانت أفضل المعاملات في هذا الصدد هي الرش بمستخلص أوراق المورينجا مع حمض الجبرلليك بتركيز ١٠٠مجم/لتر. يمكن استخدام الرش بمستخلص أوراق المورينجا والأعشاب البحرية كمنشطات نمو طبيعية واعدة وصديقة للبيئة لتحسين النمو والانتاجية في نبات الجلاديولس.