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RESPONSE OF TUBEROSE (*POLIANTHES TUBEROSA* L.) PLANTS TO CHITOSAN AND SEAWEED FOLIAR APPLICATION

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ABSTRACT: Chitosan and seaweed extract are natural stimulants that are used to improve plant growth and flowering. Therefore, two pot experiments on tuberose plants were conducted during the two consecutive seasons of 2017 and 2018 at Horticulture Research Station at Mansoura, Dakahlia Governorate, Egypt. The aim of the study was to evaluate the response of tuberose plant (single flowers known as Balady variety) to different concentrations of chitosan (CHT) and seaweed extract (SWE) rates on growth, flowering, bulb production and some chemical constituents. Tuberose plant was sprayed six times per season with different concentrations and rates of natural stimulants under study i.e. T1 (control), T2 (20 ppm CHT), T3 (40 ppm CHT), T4 (60 ppm CHT), T5 (0.5 cm^3/l SWE), T6 (1.0 cm^3/l SWE), T7 (1.5 cm^3/l SWE), T8 (20 ppm CHT + 0.5 cm^3/l SWE), T9 (40 ppm CHT + 1.0 cm^3/l SWE) and T10 (60 ppm CHT + 1.5 cm^3/l SWE). These ten treatments were laid out in a randomized complete block design (RCBD) with three replicates. Generally, chitosan or/and seaweed extract treated tuberose showed significant increase ($p<0.05$) in plant growth, flowering and bulb production. Chitosan at higher concentration plus the higher rate of seaweed extract T10 (60 ppm CHT + 1.5 cm^3/l SWE) increased the plant height, leaf number per plant and leaf width as well as number of florets/spike, spike length, rachis length and spike fresh weight. In confirmation of this, the same treatment (T10) resulted in higher values of bulb diameter and dry weight of bulb compared to the other treatments under study and unsprayed plants. In most cases, total nitrogen, total phosphorus and potassium percentages in the leaves and bulbs as well as total chlorophyll in the leaves were significantly increased by using T10 followed by T4 and T9 compared to the other ones under study. Moreover, natural stimulants (chitosan and seaweed extract) should be frequently applied in the farms to get the best growth and flowering of the tuberose plants.

Key words: *Polianthes tuberosa*, chitosan, seaweed extract, growth, flowering, chlorophyll.

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INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) is considered as one of the most important and popular cut flowers all over the world as well as in Egypt. It belongs to family Amaryllidacea. It has adequate economic chance for cut flower commerce and volatile oil industry (Alan *et al*., 2007). Tuberose plants are used as ornamental garden plants with beautiful flowers. Its flowers are used in perfume industry and is used also as emetic and diuretic activity. Bulbs are utilized for curing pustules in babies (Rammamurthy *et al*., 2010). Flower spikes of tuberose have varied utilizations in vases and bouquets, whilst large flowers are used for producing

garlands and other floral arrangements (Deshmukh, 2012).

Actually, natural stimulants consisting in a variety of substances such as chitosan and seaweed extract that are utilized to increase plant growth and get better quality of their yields are of great benefit in horticulture and agriculture production (Calvo *et al*., 2014). Chitosan is a natural polymer with a poly-cationic kind, which has many usages in agriculture practices e.g., as an elicitor, soil modifier, films and fungicide (Deepmala *et al*., 2014). Moreover, it holds nitrogen in the basal unit of its formularization ($C_{11}H_{17}O_7N_2$), which is considered one of the most serious nutritious elements in plants and soil alike (Ibraheim and Mohsen, 2015). The results from the literature point out that, when treating plants, chitosan can increase the growth, flowering and corms production of potted freesia (Salachna and Zawadzińska, 2014), improve growth and bulb yield of pineapple lily (Byczyńska, 2018) and increase the plant defense versus the attack of pathogens (Malerba and Cerana, 2018).

The usage of seaweed extract for several crops was a great significance as it contains high levels of micro elements and vitamins as well as organic matter and fatty acids and also seaweeds contain several growth promoting substances i.e. auxin, cytokinins and abscisic acid which encourage plant development and growth and increase plant tolerance to different environmental stresses (Zhang *et al*., 2003), increase nutrient acquisition (Turan and Kose, 2004), promote total bulb yield and its components as well as content of the nitrogen percentage of onion bulb tissues (Shafeek *et al*., 2015) and improve bulb diameter, bulb fresh weight g/plant, total yield of garlic (Rady *et al*., 2018).

Therefore, the present study was designed to discover the response of tuberose plants to different concentrations of chitosan and different rates of seaweed extract on plant growth, flowering and bulb production as well as chemical contents of leaves and bulbs.

MATERIAL AND METHODS

The present study was carried out during the two consecutive seasons of 2017 and 2018 in Horticulture Research Station at Mansoura, Dakahlia Governorate, Egypt, to study the influence of foliar application of some natural stimulants (chitosan and seaweed extract) compounds on growth, flowering and bulb production as well as chemical composition of tuberose plants.

Tuberose bulbs cultivar Balady were obtained from a private nursery at El-Kanater El-Khairia, Qalubia Governorate, Egypt, during the end of March. Bulbs were chosen of diameter (4-5 cm), where the bulbs were cleaned, washed and treated with a fungal disinfectant (called No Blight 50% thiram), then they cured and stored for two weeks at a temperature of 7 °C ± 2. Bulbs were planted in pots of 25 cm diameter filled with 6 kg of sand:peat moss (1:1 v/v) during 15th April in the two seasons. Three grams of granular fertilizer of N:P:K; 18:18:18 were added to each plant/pot. Four doses were added monthly from June till August. After two months of planting, the tuberose plants were sprayed with natural stimulants once every 15 days, from the beginning of June till the end of August of each season (6 times sprayed on the vegetative parts). Commercial seaweeds extract product was utilized. Seaweeds extract contained nitrogen, magnesium, sulfur, boron, molybdenum and alganic acid at (6, 6, 9.6, 0.5, 0.26 and 4%, respectively) as well as some organic matter and plant hormones.

The experiment included 10 treatments from natural stimulants as follows:

T1. Foliar application with tap water (control).
T2. Foliar application with chitosan (CHT) at 20 ppm concentration.
T3. Foliar application with CHT at 40 ppm.
T4. Foliar application with CHT at 60 ppm.
T5. Foliar application with seaweed extract (SWE) at 0.5 cm^3/l.
T6. Foliar application with SWE at 1.0 cm^3/l.
T7. Foliar application with SWE at 1.5 cm^3/l.

T8. Foliar application with at 20 ppm CHT + 0.5 cm^3 SWE/l.
T9. Foliar application with 40 ppm CHT + 1.0 cm^3 SWE/l.
T10. Foliar application with 60 ppm CHT + 1.5 cm^3 SWE /l.

These ten treatments were laid out in a randomized complete block design (RCBD), with three replicates.

Data recorded:

Plant growth: after 65 days from planting date, plant height (cm) and number of leaves/plant as well as leaf width (cm) were recorded.

Flowering parameters: flowering date (days), number of florets/spike, spike length (cm), rachis length (cm) and fresh weight of flowering spike (g) were determined.

Bulb production: diameter of produced bulb (cm) and it's dry weight bulb (g).

Chemical constituents: total nitrogen, total phosphorus and potassium percentages in dried leaves and bulbs were determined according to Chapman and Pratt (1978). Also, total chlorophyll and carotenoids contents in tuberose fresh leaves were analyzed according to AOAC (1990).

Statistical analysis:

Data were statistically analyzed using the analysis of variance according to Snedecor and Cochran (1980). Least significance difference (LSD) was used to differentiate means at 5% level of probability. The means were compared using computer program of Statistix version 9 (Analytical software, 2008).

RESULTS AND DISCUSSION

Plant growth:

It is quite clear from data presented in Table (1) that, plant height, number of leaves per plant and leaf width of *Polianthes tuberosa* gradually increased by increase the concentrations of CHT and rates of SWE during both seasons. All chitosan and seaweed extract treatments significantly increased tuberose growth parameters compared to control. The tallest plants were achieved with 60 ppm CHT + 1.5 cm^3 SWE/l in the two seasons. The increases in number of leaves per plant were about 37.35 and 43.64% for 60 ppm CHT + 1.5 cm^3 SWE/l, 31.35 and 32.36% for 60 ppm CHT and 13.43 and 15.46% for 1.5 cm^3 SWE/l over the control in 1st and 2nd seasons, respectively. However, Salachna and Zawadzińska (2014) reported that treating freesia corms with chitosan solution before planting had a stimulatory influence on the plant height and the number of leaves. El-Gamal and Ahmed (2016) indicated that

Table 1. Influence of chitosan (CHT) and seaweed extract (SWE) on plant height (cm), number of leaves/plant and leaf width (cm) of *Polianthus tuberosa* plant during 2017 and 2018 seasons.

Treatments	Plant height (cm)		Number of leaves/plant		Leaf width (cm)	
	2017	2018	2017	2018	2017	2018
Control	45.53	50.27	22.33	23.67	0.91	1.00
20 ppm CHT	54.93	56.20	25.67	25.67	1.17	1.33
40 ppm CHT	59.00	60.50	26.67	27.00	1.41	1.52
60 ppm CHT	69.13	70.40	29.33	31.33	1.72	1.88
0.5 cm^3/l SWE	49.53	52.00	25.33	25.67	1.01	1.18
1.0 cm^3/l SWE	54.40	55.53	24.67	25.33	1.36	1.56
1.5 cm^3/l SWE	59.33	61.00	25.33	27.33	1.44	1.56
20 ppm CHT+0.5 cm^3/l SWE	62.93	64.70	26.67	26.00	1.56	1.62
40 ppm CHT+1.0 cm^3/l SWE	66.37	67.57	29.67	31.33	1.70	1.80
60 ppm CHT+1.5 cm^3/l SWE	70.70	71.77	30.67	34.00	1.88	2.11
LSD at 5 %	2.44	3.68	2.12	2.19	0.21	0.17

CHT= chitosan; SWE= seaweed extract.

foliar application of chitosan at all utilized concentrations (20, 40, 60 and 80 ppm) significantly advanced the vegetative growth characters of coriander in terms of plant height and number of branches per plant.

The presence of several nutrients, growth hormones, vitamins and other constituents in the seaweed extract might be very considerable beneficial to the crops but their level should be allocated to improve growth and productivity (Crouch *et al*., 1992). Foliar application of seaweeds extract gave the highest stimulatory effect on onion plant growth characters *i.e.* plant length and number of leaves as well as fresh and dry weight of leaves (Shafeek *et al*., 2015).

Flowering parameters:

Data of both seasons presented in Tables (2 and 3) indicate that, the earliest flowering resulted significantly from applying 60 ppm CHT + 1.5 cm^3 SWE/l treatment as occurred after 69.33 and 69.00 days followed by 40 ppm CHT + 1.0 cm^3 SWE/l treatment after 71.00 and 69.67 days. However, in the control treatment flowering occurred after

Table 2. Influence of chitosan (CHT) and seaweed extract (SWE) on number of days to flowering, number of florets/spike and spike length (cm) of *Polianthus tuberosa* plant during 2017 and 2018 seasons.

Treatments	Number of days to flowering		Number of florets/spike		Spike length (cm)	
	2017	2018	2017	2018	2017	2018
Control	93.33	92.00	25.33	26.33	52.97	52.00
20 ppm CHT	83.00	79.33	32.33	34.00	57.93	58.77
40 ppm CHT	79.00	76.67	39.00	41.33	60.33	61.37
60 ppm CHT	70.00	70.00	45.67	46.67	68.53	67.87
0.5 cm^3/l SWE	88.33	86.67	28.00	28.67	55.50	57.23
1.0 cm^3/l SWE	84.33	80.00	29.33	30.67	56.57	57.73
1.5 cm^3/l SWE	81.67	78.67	32.00	34.33	59.23	59.60
20 ppm CHT+0.5 cm^3/l SWE	77.00	75.67	40.00	41.67	59.67	60.50
40 ppm CHT+1.0 cm^3/l SWE	71.00	69.67	44.33	46.67	68.67	67.70
60 ppm CHT+1.5 cm^3/l SWE	69.33	69.00	45.67	47.67	65.80	64.13
LSD at 5 %	3.41	2.58	1.71	1.65	1.63	1.47

CHT= chitosan; SWE= seaweed extract.

Table 3. Influence of chitosan (CHT) and seaweed extract (SWE) on rachis length (cm) and fresh weight of spike (g) of *Polianthus tuberosa* plant during 2017 and 2018 seasons.

Treatments	Rachis length (cm)		Fresh weight of spike (g)	
	2017	2018	2017	2018
Control	21.20	21.93	41.47	42.33
20 ppm CHT	27.33	28.93	46.27	47.70
40 ppm CHT	27.83	29.17	48.93	50.00
60 ppm CHT	29.50	32.17	53.23	54.30
0.5 cm^3/l SWE	22.80	24.93	44.83	45.13
1.0 cm^3/l SWE	25.37	26.37	46.27	46.83
1.5 cm^3/l SWE	27.07	27.73	46.90	47.57
20 ppm CHT+0.5 cm^3/l SWE	28.37	29.20	50.97	51.97
40 ppm CHT+1.0 cm^3/l SWE	29.40	31.07	54.70	56.40
60 ppm CHT+1.5 cm^3/l SWE	30.10	33.80	57.63	58.77
LSD at 5 %	1.93	1.68	2.27	2.14

CHT= chitosan; SWE= seaweed extract.

93.33 and 92.00 days from planting in the first and second seasons, respectively. Furthermore, all natural stimulants treatments under study significantly increased number of florets per spike, spike length, rachis length and fresh weight of tuberose spike compared to control in both seasons. The highest values in this concern were recorded by the treatments of T10 (60 ppm CHT + 1.5 cm^3 SWE/l), T4 (60 ppm CHT) and T9 (40 ppm CHT + 1.0 cm^3 SWE/l) compared to the other ones under study. The increases in fresh weight of spike were about 38.97 and 38.84% for 60 ppm CHT + 1.5 cm^3 SWE/l over the control in 1st and 2nd seasons, respectively. As a result of coating *Ornithogalum saundersiae* bulbs in a chitosan solution before planting the plants were higher and flowered earlier (Salachna *et al*., 2015). Also, application of chitosan enhanced inflorescence length of pineapple lily, inflorescence width and began flowering earlier than the control ones (Byczyńska, 2018). Furthermore, El-Sayed *et al*. (2018) found that adding seaweed extract at 1% revealed significant increase in the flower diameter of dahlia plants, duration and dry weight of flower while a significant increase in number of days needed to reach flowering was recorded with all fertilizer treatments in both seasons. The maximum flowering duration of jasmine (*Jasminum sambac* Ait.) was recorded when seaweed extract was used as foliar spray at 5% concentration (Sowmiya and Karuppaiah, 2019).

Bulb production:

Data listed in Table (4) suggest that, the best treatment increasing diameter and dry weight of produced bulb was that 60 ppm CHT + 1.5 cm^3 SWE/l with significant difference between the other treatments under study in both seasons. Generally, all concentrations of chitosan and rates of seaweed extract significantly increased tuberose bulb production compared to control. Increasing CHT concentrations and SWE rates gradually increased the above-mentioned parameters in the 2017 and 2018 seasons. Also, Ramos-Garcia *et al*. (2009) demonstrated that the production of gladiolus corms increased as a result of utilizing the chitosan as natural stimulant. The highest increase in the corm weight was recorded as a result of treating freesia plants with chitosan (Salachna and Zawadzińska, 2014). However, soaking garlic bulbs in seaweed extra at a rate of 3 ml/l can be recommended for obtaining higher bulb (Rady *et al*., 2018).

Chemical constituents:

As shown in Table (5) that, total nitrogen, total phosphorus and potassium

Table 4. Influence of chitosan (CHT) and seaweed extract (SWE) on the produced bulb diameter (cm) and bulb dry weight (g) of *Polianthus tuberosa* plant during 2017 and 2018 seasons.

Treatments	Produced bulb diameter (cm)		Produced bulb dry weight (g)	
	2017	2018	2017	2018
Control	1.58	1.64	16.47	16.98
20 ppm CHT	2.02	2.19	19.85	21.33
40 ppm CHT	2.23	2.30	22.13	23.27
60 ppm CHT	2.34	2.42	23.12	25.47
0.5 cm^3/l SWE	1.68	1.72	17.31	17.96
1.0 cm^3/l SWE	1.72	1.75	18.77	20.74
1.5 cm^3/l SWE	1.84	1.90	21.36	22.71
20 ppm CHT+0.5 cm^3/l SWE	2.19	2.25	22.00	24.17
40 ppm CHT+1.0 cm^3/l SWE	2.37	2.45	23.27	25.48
60 ppm CHT+1.5 cm^3/l SWE	2.51	2.67	25.58	28.90
LSD at 5 %	0.07	0.05	1.26	1.12

CHT= chitosan; SWE= seaweed extract.

Table 5. Influence of chitosan (CHT) and seaweed extract (SWE) on total nitrogen, total phosphorus and potassium percentages in the leaves of *Polianthus tuberosa* plant during 2017 and 2018 seasons.

Treatments	Total nitrogen (%)		Total phosphorus (%)		Potassium (%)	
	2017	2018	2017	2018	2017	2018
Control	1.633	1.707	0.198	0.208	2.043	2.147
20 ppm CHT	2.097	2.200	0.225	0.239	2.160	2.240
40 ppm CHT	2.220	2.253	0.236	0.256	2.227	2.243
60 ppm CHT	2.333	2.400	0.268	0.284	2.353	2.403
0.5 cm^3/l SWE	1.777	1.830	0.214	0.220	2.090	2.187
1.0 cm^3/l SWE	1.857	1.970	0.235	0.238	2.210	2.247
1.5 cm^3/l SWE	2.093	2.177	0.242	0.258	2.263	2.283
20 ppm CHT+0.5 cm^3/l SWE	2.233	2.273	0.256	0.268	2.337	2.397
40 ppm CHT+1.0 cm^3/l SWE	2.370	2.450	0.269	0.297	2.403	2.553
60 ppm CHT+1.5 cm^3/l SWE	2.630	2.763	0.324	0.346	2.587	2.683
LSD at 5 %	0.109	0.054	0.029	0.026	0.071	0.054

CHT= chitosan; SWE= seaweed extract.

percentages in tuberose leaves were significantly increased with all treatments of chitosan and seaweed extract compared to control in both seasons. The highest values in this respect were obtained by the treatment of T10 (60 ppm CHT + 1.5 cm^3 SWE/l). The increases in potassium percentage in the leaves was about 26.63 and 24.97% for T10 over the control in 1st and 2nd seasons, respectively. The same trend was achieved with the same treatment (T10) regarding N, P and K percentages in tuberose bulbs in the first and second seasons Table (6). The increases in total nitrogen percentage in tuberose bulbs were about 43.72 and 46.67% for T10 over the control in 1st and 2nd seasons, respectively. The lowest values in NPK percentages of bulbs were noticed when tuberose plant sprayed with tap water (control treatment) compared to the tested treatments under study. In addition, spraying tuberose plants 6 times/season with mixture of natural stimulants at 60 ppm CHT+1.5 cm^3 SWE/l significantly increased total chlorophyll and carotenoids contents in the leaves compared to control (sprayed with tap water) as shown in Table (7). Likewise, all treatments under study (from T2 to T10) significantly increased leaf pigments compared to control in the two seasons.

Furthermore, Dzung *et al*. (2011) found that as a result of spraying coffee seedlings by chitosan solutions, the content of chlorophylls and carotenoids in the leaves was increased by 46.38-73.5% in plants grown in the greenhouse when compared to the control. Treating the *Eucomis bicolor* plants with chitosan at 50 mg/l had the great beneficial influence on the relative chlorophyll content in the leaves (Byczyńska, 2018). *Dracaena surculosa* plants sprayed with chitosan contained the highest total nitrogen percentage and chlorophyll a of leaves; also, it increased with increasing the chitosan concentrations (El-Khateeb *et al*., 2018). Seaweed extracts (SWE) have been found to improve nutrients availability and nutrients uptake of *Amaranthus tricolor* from the soil (Aziz *et al*., 2011). Moreover, the N, P and K (%) of the leaves of dahlia as well as the total content of chlorophyll were significantly stimulated with seaweed extract at 1% rate compared to the control (El-Sayed *et al*., 2018). The application of 0.5% SWE resulted in a significant increase in mineral contents (N, P, and K) of onion bulbs (Abbas *et al*., 2020).

CONCLUSION

The above results pointed out that the tuberose growth and flowering quality as well as chemical constituents of the leaves and bulbs responded to natural stimulants

Table 6. Influence of chitosan (CHT) and seaweed extract (SWE) on total nitrogen, total phosphorus and potassium percentages in bulbs of *Polianthus tuberosa* plant during 2017 and 2018 seasons.

Treatments	Total nitrogen (%)		Total phosphorus (%)		Potassium (%)	
	2017	2018	2017	2018	2017	2018
Control	1.147	1.200	0.117	0.135	1.167	1.213
20 ppm CHT	1.267	1.300	0.197	0.196	1.400	1.453
40 ppm CHT	1.327	1.390	0.200	0.208	1.487	1.533
60 ppm CHT	1.527	1.597	0.208	0.212	1.627	1.713
0.5 cm^3/l SWE	1.237	1.250	0.173	0.180	1.213	1.240
1.0 cm^3/l SWE	1.263	1.273	0.189	0.192	1.213	1.250
1.5 cm^3/l SWE	1.270	1.297	0.193	0.196	1.270	1.310
20 ppm CHT+0.5 cm^3/l SWE	1.460	1.550	0.193	0.197	1.533	1.593
40 ppm CHT+1.0 cm^3/l SWE	1.553	1.630	0.199	0.210	1.597	1.730
60 ppm CHT+1.5 cm^3/l SWE	1.637	1.760	0.213	0.219	1.773	1.887
LSD at 5 %	0.039	0.40	0.007	0.007	0.058	0.048

CHT= chitosan; SWE= seaweed extract.

Table 7. Influence of chitosan (CHT) and seaweed extract (SWE) on total chlorophyll and carotenoids contents (mg/100 g as fresh weight) in leaves of *Polianthus tuberosa* plant during 2017 and 2018 seasons.

Treatments	Total chlorophyll content (mg/100 g as F.W.)		Carotenoids content (mg/100 g as F.W.)	
	2017	2018	2017	2018
Control	0.363	0.392	0.246	0.264
20 ppm CHT	0.488	0.505	0.363	0.372
40 ppm CHT	0.522	0.554	0.371	0.381
60 ppm CHT	0.564	0.584	0.377	0.389
0.5 cm^3/l SWE	0.412	0.424	0.307	0.325
1.0 cm^3/l SWE	0.424	0.443	0.337	0.355
1.5 cm^3/l SWE	0.484	0.510	0.366	0.380
20 ppm CHT+0.5 cm^3/l SWE	0.539	0.571	0.333	0.354
40 ppm CHT+1.0 cm^3/l SWE	0.580	0.606	0.350	0.393
60 ppm CHT+1.5 cm^3/l SWE	0.573	0.625	0.386	0.425
LSD at 5 %	0.026	0.011	0.016	0.011

CHT= chitosan; SWE= seaweed extract.

mixture as a foliar spray. In general, the 60 ppm CHT + 1.5 cm^3 SWE/l treatment gave the highest values of growth, flowering parameters and bulb production of tuberose (*Polianthes tuberosa*, L.) plants grown in pots under Dakahlia Governorate conditions.

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إستجابة نباتات التبروز (الزنبق) للرش الورقي بالشيتوزان ومستخلص الأعشاب البحرية

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يستخدم الشيتوزان ومستخلص الأعشاب البحرية كمنشطات طبيعية لتحسين نمو النبات والإزهار. لذلك، أجريت تجربتان على نباتات التبروز خلال الموسمين المتتاليين لأعوام ٢٠١٧ و ٢٠١٨ في محطة بحوث البساتين بالمنصورة، محافظة الدقهلية، مصر. كان الهدف من الدراسة هو تقييم استجابة نبات التبروز (ذو الأزهار المفرد والمعروفة باسم الصنف البلدي) لتركيزات مختلفة من الشيتوزان ومعدلات مستخلص الأعشاب البحرية على النمو، والإزهار، وإنتاج الابصال وبعض المكونات الكيميائية. تم رش نبات التبروز ٦ مرات خلال الموسم بتركيزات ومعدلات مختلفة من المنشطات الطبيعية قيد الدراسة، وكانت كالتالي: المعاملة الأولي (كنترول)، المعاملة الثانية (٢٠ جزء/مليون من الشيتوزان)، المعاملة الثالثة (٤ جزء/مليون من الشيتوزان)، المعاملة الرابعة (٦٠ جزء/مليون من الشيتوزان)، المعاملة الخامسة (٠,٥٠ سم^3/لتر من مستخلص الأعشاب البحرية)، المعاملة السادسة (١,٠٠ سم^3/لتر من مستخلص الأعشاب البحرية)، المعاملة السابعة (١,٥٠ سم^3/لتر من مستخلص الأعشاب البحرية)، المعاملة الثامنة (٢٠ جزء/مليون من الشيتوزان + ٠,٥٠ سم^3/لتر من مستخلص الأعشاب البحرية)، المعاملة التاسعة (٤٠ جزء/مليون من الشيتوزان + ١,٠٠ سم^3/لتر من مستخلص الأعشاب البحرية) والمعاملة العاشرة (٦٠ جزء/مليون من الشيتوزان + ١,٥٠ سم^3/لتر من مستخلص الأعشاب البحرية). تم وضع هذه المعاملات العشرة في تصميم تام العشوائية في ثلاث مكررات. بشكل عام، أدت معاملة التبروز بالشيتوزان أو/و مستخلص الأعشاب البحرية إلى زيادة معنوية ($p < 0.05$) في كل من نمو النبات، الإزهار وإنتاج الأبصال. أدى الشيتوزان بالتركيز الأعلى بالإضافة إلى المعدل الأعلى من مستخلص الأعشاب البحرية - المعاملة العاشرة (٦٠ جزء/مليون من الشيتوزان + ١,٥٠ سم^3/لتر من مستخلص الأعشاب البحرية) - إلى زيادة إرتفاع النبات، وعدد الأوراق لكل نبات وعرض الورقة وكذلك عدد الزهيرات/سلاح زهري، طول السلاح الزهري، طول حامل البراعم المزهرة والوزن الطازج للسلاح الزهري. وتأكيدًا على ذلك، أدى استخدام نفس المعاملة (المعاملة العاشرة) إلى للحصول على أعلى القيم لقطر البصلة المنتجة والوزن الجاف للبصلة المنتجة مقارنة بالمعاملات الأخرى قيد الدراسة والنباتات غير المعاملة. في معظم الحالات، زادت النسب المئوية للنيتروجين الكلي والفوسفور الكلي والبوتاسيوم في الأوراق والأبصال وكذلك الكلوروفيل الكلي في أوراق نبات التبروز بشكل ملحوظ باستخدام المعاملة العاشرة والذي يليها المعاملة الرابعة والمعاملة التاسعة مقارنة بالمعاملات الأخرى قيد الدراسة. علاوة على ذلك، يجب استخدام المنشطات الطبيعية (الشيتوزان ومستخلص الأعشاب البحرية) بشكل متكرر في المزارع للحصول على أفضل نمو وإزهار لنبات التبروز(الزنبق).