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RESPONSE OF *CALENDULA OFFICINALIS* TO COMPOST, CHITOSAN AND THIAMINE TREATMENTS

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ABSTRACT

The current work was carried out at the Nursery of Ornamental Plants, Faculty of Agriculture, Minia University, during the two growing seasons of 2021/2022 and 2022/2023, to examine the impact of compost levels (0, 250, 500 and 750 g/pot), chitosan (20 and 40 ppm), thiamine (25 and 50 ppm) treatments and their interactions on vegetative and flowering traits and some chemical constituents of *Calendula officinalis*, L. plant.

Data proved that all tested vegetative characters (plant height, number of main branches/plant, plant dry weight) and flowering measurements (total number of flowers/plant and total fresh and dry weights of flowers/plant), in addition to some chemical composition like photosynthetic pigments content in fresh leaves and nitrogen, phosphorus and potassium% in dry leaves were significantly increased with rising compost level facing the control. The treatment of 750 g/pot was more efficient in this concern. Also, chitosan and thiamine treatments led to an increase in all vegetative and flower traits as well as photosynthetic pigments and NPK percentages. The treatment of chitosan at 40 ppm was superior to other used treatments.

The best overall interaction treatment for the best vegetative and flowering traits was fertilizing plants with compost at 750 g/pot and sprayed *Calendula officinalis* with chitosan at 40 ppm.

Keywords: compost, chitosan, thiamine, calendula.

INTRODUCTION

Calendula officinalis, L. is an annual herbaceous plant belongs to the family (Asteraceae) originating from Southern Europe and the Eastern Mediterranean area. This species has the tradition name pot marigold, garden marigold, English marigold or Scotch marigold **(Pintea *et al*., 2003; Sardoei, 2014)**. The plant blooms over a long period, roughly continuously until the first heavy frost and the flowers are good for cutting flowers. The plant can successfully be used in home, garden, borders, flower beds and balcony plantings **(Golestani *et al*., 2013)**.

Because intensive consumption of mineral fertilizers in crop production causes environmental pollution and has a negative impact on ecosystems, adding compost as an organic material is a good strategy to reduce pollution while increasing crop productivity **(Khodadadi *et al*., 2013)**. Adding composted substances to different soil types makes the soil (especially, sandy soil) capable to bind more water, increases water availability for plant growth and improves its soil physical, chemical and biological properties. Consequence, it increases plant vegetative growth and flowering traits as well as yield productivity of the crop **(El-Sirafy *et al*., 1989** and **Khudus *et al*., 2021)**.

Chitosan is a natural, safe, and inexpensive biopolymer derived from chitin, the primary component of arthropod exoskeletons and fungal cell walls, and the second renewable carbon source after lignocellulosic biomass. Chitosan has lately received increased attention due to its antioxidant properties **(Huang *et al*., 2005)**.

Thiamine, also called B1, is required to develop many of the metabolic reactions as a co-enzyme, plays an important role in regulating growth and reducing the effects of environmental stresses on plants **(Fallahi *et al*., 2018)**. Also, it had a role in root growth and development.

As a result, the purpose of this research was to investigate the effects of compost and certain stimulants (chitosan and thiamine), as well as their interactions, on the growth features, flowering traits, and some chemical constituents of *Calendula officinalis* plant.

MATERIALS AND METHODS

During two growing seasons (2021/2022 and 2022/2023), this study was conducted at the Nursery of Ornamental Plants, Fac. Agric., Minia Univ. *Calendula officinalis* seeds (double orange flower) were obtained from the Nursery of Ornamental plants, Fac. Agric., Minia Univ. This work was set up at a split-Block Design with three replications. The main plots (A) include four compost levels (control, 250, 500 and 750 g/pot), while five treatments of stimulants employed the sub-plots (B) including; control, 20 and 40 ppm and thiamine at 25 and 50 ppm. Thus, the total treatments of the experiment were 20 (4 x 5).

The seeds of *Calendula officinalis* were sown on 1st October in the Nursery beds in the two seasons 2021 and 2022. Pot marigold seedlings were transplanted in plastic pots (30 cm in diameter) on 28th

October (after 4 weeks from cultivation) in both seasons. The plastic pots were filled with 9 kg sandy soil, containing one seedling. The soil properties (physical and chemical analysis) are listed in Table (a).

The compost under trade name El-Nile compost was bought from Egyptian company for solid waste utilization in New Minia City. In both seasons, the amounts of compost were added while the pots were being filled. Table (b) shows the physical and chemical parameters of the compost used.

Both of chitosan and thiamine were released from El-Gomhoria Company, Egypt. Each of chitosan and thiamine were sprayed by hand sprayer three times. The 1st dose was sprayed on 1st December during both seasons, the second two doses were applied 15 days interval) 15th and 30th December).

At the termination in both growing seasons (last week of April), the following data were recorded: vegetative growth parameter [main branches number per plant, plant height and plant dry weight], flowering aspects [total number of flowers/plant, and total weights (fresh and dry) of flowers/plant (g)] and some chemical constituents [chl. a, chl. b and carotenoids contents as well as N, P and K%].

Laboratory analysis:

According to **Fadl and Sari El-Deen (1978)**, the amounts of chlorophyll a, b, and carotenoids (mg/g fresh weight) in pot marigold fresh leaves samples were tested three weeks after the last treatment in both seasons. While nitrogen, phosphorus, and potassium percentages in dried leaves were determined using method of **ICARDA (2013)**.

Statistical analysis

The results were tabulated and statistically analyzed using **MSTAT-C (1986)**, and the LSD test at 0.05 was used to compare the means of the treatments.

RESULTS

1. Vegetative growth parameters:

Data listed in Table (1) proved that all used levels of compost led to a significant improvement in plant height, the main branches number and dry weight/plant relative to untreated plants in both seasons. The best values were achieved with 750 g compost/pot in both growing seasons.

The positive role of compost in enhancing vegetative growth was emphasized by **Gupta *et al*. (2014), Sardoei (2014)** and **Sharifian *et al*. (2014)** on *Calendula officinalis* and **Abdou *et al*. (2023)** on cineraria plant.

As for chitosan and thiamine treatments, data shown in Table (1) revealed that both stimulants significantly augmented all abovementioned characters facing to control in both seasons. In all cases, chitosan at 40 ppm and thiamine at 50 ppm were more effective than other treatments in this concern.

Our results are proved by **Abdel-Mola and Ayyat (2020), Najafi *et al*. (2021)** and **Akhtar *et al*. (2022)** on *Calendula officinalis*; **Ohta *et al*. (2000)**, on *Eustoma grandiflorum*; **Salachna *et al*. (2014)**, on *Ornithogalum saundersiae*; **Bistgani *et al*. (2016)**, on *Thymus daenensis* and **Chen *et al*.**

(2016), on *Begonia* × *hiemalis*, regarding the effect of chitosan. While **Hasan (2013) and Soltani *et al*. (2014)**, on *Calendula officinalis*, **Ahmed (2013)** and **Hashish *et al*. (2015)** on *Gladiolus grandiflorus* and **Abdou *et al*. (2015)** on coriander, concerning to thiamine.

The interaction between compost levels and both chitosan and thiamine treatments were significant for all tested traits i.e., plant height, number of main branches and dry weight/plant in both growing seasons. The highest values for pot marigold were compost at 750 g/pot plus chitosan at 40 ppm, followed by thiamine at 50 ppm in both seasons.

2. Flowering aspects:

Data shown in Table (2) observed that flowering aspects [total flowers number/plant and flowers total fresh and dry weights/plant] were significantly augmented by all used levels of compost (250, 500 and 750 g/pot) facing the control treatment in both seasons. Ascending increased in the abovementioned flowering characters with the rise in compost level was observed. Therefore, the greatest values were produced from the highest level of compost (750 g/pot).

The improvement of compost fertilization on flowering traits was mentioned by **Hasan *et al*. (2014)**, **Thakur *et al*. (2016)** and **Shaabani *et al*. (2022)** on *Calendula officinalis* and **Ghehsareh *et al*. (2011)** and **Abdou *et al*. (2023)** on cineraria plant.

For the role of stimulants treatments, data given in Table (2) demonstrated that flowers total number/plant and flowers total weights (fresh and dry)/plant were significantly improved owing to all treatments of stimulants comparing to control in both seasons. It could be observed that chitosan at 40 ppm was more suitable in this concern.

Similar results were reported by **Abdel-Mola and Ayyat (2020)** and **Akhtar *et al*. (2022)** on *Calendula officinalis* concerning the effect of chitosan. Also, **Hasan (2013)** and **Soltani *et al*. (2014)**, on *Calendula officinalis* L., **Hashish *et al*. (2015)**, on gladiolus plant and **Babarabie *et al*. (2018)** on chrysanthemum plant, for thiamine.

The effect of the interaction between the main and sub plots (compost levels and chitosan and thiamine) treatments was significant for total flowers number/plant and total flowers fresh and dry weights/plant. The highest flowers number/plant was found with plants fertilized with 750 g/pot and sprayed with chitosan at 40 ppm or thiamine at 50 ppm or the interaction treatment of compost at 500 g/pot with chitosan 40 ppm, in the 2021/2022 season. While, in the second season, the interaction treatment of compost at 750 g/pot in combination with chitosan at 40 ppm gave the highest overall flowers number/plant. Also, compost 750 g/pot plus chitosan at 40 ppm gave the heaviest weights of flowers either fresh or dry in both seasons.

3. Chemical constituents:

Data given in Tables (3 and 4) proved that all compost levels significantly enhanced chl. a, chl. b and carotenoids contents (mg/g fresh weight); and NPK % in the dry leaves of calendula in both experimental seasons

facing the check treatment. Adding compost at 750 g/pot produced the highest values of all chemical parameters.

These findings are agreed with the results mentioned by **Hasan *et al.* (2014)**, **Khalili *et al.* (2014)** and **Abd El-Fatah *et al.* (2019)** on pot marigold, **El-Hindi *et al.* (2006)** and **Abdou *et al.* (2023)** on cineraria, **Abdou (2003)** on chrysanthemum and **Marashi *et al.* (2021)** on zinnia.

Regard to the impact of chitosan and thiamine treatments, data given in Tables (3 and 4) pointed out that all concentrations of both stimulants significantly enhanced pigments, N, P and K% facing the control in both experimental seasons. Chitosan at 40 ppm was more effective than other treatments, followed by thiamine at 50 ppm.

Many authors showed that positive effect of chitosan in improving photosynthetic pigments such as **Abdel-Mola and Ayyat (2020)** and **Akhtar *et al.* (2022)** on *Calendula officinalis* and **Mazrou *et al.* (2021)** on *Matricaria chamomilla*, for the effect of chitosan. Similarly for the effect of thiamine was emphasized by **Soltani *et al.* (2014)** on *Calendula officinalis*, **Abdou *et al.* (2014)** and **Fallahi *et al.* (2018)** on sweet basil, **Ahmed (2013)** on gladiolus plant, **Al-Abbasi *et al.* (2015)** on *Zinnia elegans*, and **Awad (2019)** on borage plant.

The influence of the interaction between compost and chitosan or thiamine treatments had significant effect on chl. a, chl. b and carotenoids contents in addition to NPK % in both experimental seasons, except N % in 2022/2023 season. The greatest values were obtained from plants that received 750 g/pot compost and were sprayed with chitosan at a concentration of 40 ppm (in all cases), or thiamine at 50 ppm (in some cases) in both seasons.

DISCUSSION

From our results, it could be concluded that all vegetative growth, flowering and some chemical parameters were enhanced as supplying calendula plants grown in sandy soil with compost and sprayed with chitosan and thiamine. It may be due to adding compost improves soil physio-chemical properties (increase CEC, decrease soil pH and improved the most nutrient, structure, porosity and aggregation), therefore, improving plant growth **(Snyman *et al.*, 1998)**. Furthermore, chitosan treatments promote stomatal closure through ABA synthesis and photosynthesis, increase antioxidant enzymes through nitric oxide and hydrogen peroxide signaling paths, and induce the creation of sugars, amino acids, organic acids, and further metabolites required for osmotic stress-related adaptation, stress signaling, and energy metabolism **(Hidangmayum *et al.*, 2019)**. In addition, thiamine (vitamin B_1) is required for the formation of the coenzyme thiamine pyrophosphate, which is vital in glucose metabolism **(Robinson, 1973; Hendawy and Ezz EL-Din, 2010)**, sequence, improved growth and flowering productivity.

CONCLUSION

To obtain good growth and flower production of potted mzrigold plant, it should be fertilized plants with 750 g/pot compost and sprayed them with chitosan at 40 ppm three times.

Table (a): The physical and chemical analysis of the soil used in the study.

Soil character	Values		Soil Character	Values	
	2021/2022	2022/2023		2021/2022	2022/2023
Physical properties:					
Sand (%)	90.20	91.40	**Total N (%)**	0.02	0.02
Silt (%)	7.40	6.30	**Available P (ppm)**	3.45	2.53
Clay (%)	2.40	2.30	**Extractable K (mg/100 g soil)**	0.75	0.86
Soil type	Sandy	sandy			
Chemical properties:			**DTPA-Extractable nutrients:**		
pH (1:2.5)	8.13	8.35	**Fe (ppm)**	1.01	1.08
E.C. (dS/m)	1.10	1.12	**Cu (ppm)**	0.30	0.37
O.M. (%)	0.02	0.03	**Zn (ppm)**	0.31	0.28
$CaCO_3$ (%)	13.92	13.81	**Mn (ppm)**	0.49	0.60

Table (b): Chemical and physical properties of the used compost in both seasons of 2021/2022 and 2022/2023 as listed in factory label criteria.

Properties	Value	Properties	Value
Organic carbon (%)	25.1	Total P (%)	0.5
Humidity (%)	25	Total K (%)	1.0
Organic matter	44	Fe (ppm)	1750
C/N ratio	17.5	Zn (ppm)	60
pH (1:2.5)	8.0	Mn (ppm)	125
E.C. (m. mhos/cm.)	5.0	Cu (ppm)	200
Total N (%)	1.5		

Table (1): Effect of compost level, some stimulants (chitosan, vitamin B1) treatments and their interactions on plant height, number of main branches/plant and plant dry weight of *Calendula officinalis* in the two growing seasons (2021/2022 and 2022/2023).

Some stimulants treatments	Compost levels treatments (g/pot) (A)									
	0.0	250	500	750	Mean (B)	0.0	250	500	750	Mean (B)
	The 1st season (2021/2022)					The 2nd season (2022/2023)				
Plant height (cm)										
Control	26.1	28.7	30.7	32.3	**29.5**	26.7	29.1	31.1	32.6	**29.9**
Chitosan at 20 ppm	28.4	30.9	33.1	34.8	**31.8**	29.1	3p1.7	34	35.7	**32.6**
Chitosan at 40 ppm	29.0	31.6	33.8	35.5	**32.5**	29.8	32.4	34.7	36.5	**33.4**
Thiamine at 25 ppm	27.9	30.4	32.5	34.1	**31.2**	28.7	31.3	33.5	35.2	**32.2**
Thiamine at 50 ppm	28.8	31.4	33.6	35.3	**32.3**	31.06	33.84	36.22	38.04	**34.8**
Mean (A)	**28.0**	**30.6**	**32.7**	**34.4**		**29.1**	**31.7**	**33.9**	**35.6**	
L.S.D. at 5 %	**A: 1.3**		**B: 1.4**		**AB: 2.8**	**A: 0.8**		**B: 1.6**		**AB: 3.2**
Number of main branches/plant										
Control	4.76	5.28	5.73	6.16	**5.48**	5.11	5.57	5.96	6.26	**5.73**
Chitosan at 20 ppm	4.79	5.50	5.99	6.30	**5.65**	5.88	6.40	6.85	7.20	**6.58**
Chitosan at 40 ppm	5.78	6.54	6.75	7.05	**6.53**	7.10	7.74	8.27	8.69	**7.95**
Thiamine at 25 ppm	4.78	5.49	5.94	6.26	**5.62**	5.80	6.36	6.43	7.09	**6.42**
Thiamine at 50 ppm	5.69	6.27	6.58	6.91	**6.36**	6.66	7.25	7.76	8.15	**7.46**
Mean (A)	**5.16**	**5.82**	**6.20**	**6.54**		**6.11**	**6.66**	**7.05**	**7.48**	
L.S.D. at 5 %	**A: 0.30**		**B: 0.47**		**AB: 0.94**	**A: 0.27**		**B: 0.24**		**AB: 0.47**
Plant dry weight (g)										
Control	36.30	39.93	43.51	46.57	**41.58**	36.79	40.46	44.1	47.2	**42.14**
Chitosan at 20 ppm	37.18	40.89	44.56	47.69	**42.58**	38.29	41.39	45.12	48.31	**43.28**
Chitosan at 40 ppm	38.48	42.35	46.13	49.36	**44.08**	38.99	42.89	46.75	50.02	**44.66**
Thiamine at 25 ppm	37.10	40.44	44.42	47.57	**42.38**	37.72	41.42	44.77	48.22	**43.03**
Thiamine at 50 ppm	37.77	41.55	45.29	48.46	**43.27**	38.32	42.16	45.59	49.17	**43.81**
Mean (A)	**37.37**	**41.03**	**44.78**	**47.93**		**38.02**	**41.66**	**45.27**	**48.58**	
L.S.D. at 5 %	**A: 0.74**		**B: 0.59**		**AB: 1.18**	**A: 0.75**		**B: 0.46**		**AB: 0.92**

Table (2): Effect of compost level, some stimulants (chitosan, vitamin B1) treatments and their interactions on total number of flowers/plant and total flower fresh and dry weights/plant of *Calendula officinalis* in the two growing seasons (2021/2022 and 2022/2023).

Some stimulants treatments	Compost levels treatments (g/pot) (A)									
	0.0	250	500	750	Mean (B)	0.0	250	500	750	Mean (B)
	The 1st season (2021/2022)					The 2nd season (2022/2023)				
Total number of flowers/plant										
Control	35.05	42.72	47.57	55.19	**45.13**	36.57	45.91	51.83	56.07	**47.60**
Chitosan at 20 ppm	48.02	58.51	65.58	74.5	**61.65**	48.85	59.84	66.05	75.94	**62.67**
Chitosan at 40 ppm	64.07	69.56	84.75	87.16	**76.39**	64.78	77.12	85.31	97.06	**81.07**
Thiamine at 25 ppm	43.07	54.63	61.07	67.97	**56.69**	47.15	56.64	61.5	68.81	**58.53**
Thiamine at 50 ppm	58.30	66.23	74.29	82.24	**70.27**	56.03	67.37	76.37	85.16	**71.23**
Mean (A)	**49.70**	**58.33**	**66.65**	**73.41**		**50.68**	**61.38**	**68.21**	**76.61**	
L.S.D. at 5 %	**A: 2.41**		**B: 1.91**		**AB: 3.82**	**A: 0.88**		**B: 1.91**		**AB: 3.82**
Total flower fresh weight/plant (g)										
Control	70.41	86.22	96.18	111.36	**91.04**	75.93	89.98	100.13	112.69	**94.68**
Chitosan at 20 ppm	99.49	121.31	135.78	151.74	**127.08**	106.41	129.49	143.33	160.03	**134.82**
Chitosan at 40 ppm	141.79	168.20	188.61	209.01	**176.90**	144.71	172.09	191.56	213.99	**180.59**
Thiamine at 25 ppm	87.23	110.87	123.95	138.01	**115.02**	94.03	113.35	128.08	138.45	**118.48**
Thiamine at 50 ppm	118.10	142.16	159.61	176.55	**149.11**	124.63	149.68	166.22	186.24	**156.69**
Mean (A)	**103.40**	**125.75**	**140.83**	**157.33**		**109.14**	**130.92**	**145.86**	**162.28**	
L.S.D. at 5 %	**A: 0.80**		**B: 0.74**		**AB: 1.48**	**A: 1.09**		**B: 0.65**		**AB: 1.30**
Total flower dry weight/plant (g)										
Control	10.27	12.52	13.94	16.11	**13.21**	11.01	13.04	14.67	16.08	**13.70**
Chitosan at 20 ppm	13.96	16.94	19.02	21.03	**17.74**	14.93	18.11	19.93	22.16	**18.78**
Chitosan at 40 ppm	19.14	22.97	25.22	27.99	**23.83**	19.53	23.07	25.53	28.51	**24.16**
Thiamine at 25 ppm	12.14	15.37	17.14	19.36	**16.00**	12.92	15.61	17.69	19.16	**16.34**
Thiamine at 50 ppm	16.40	19.50	21.41	23.46	**20.19**	16.82	20.18	22.18	24.85	**21.01**
Mean (A)	**14.38**	**17.46**	**19.35**	**21.59**		**15.04**	**18.00**	**20.00**	**22.15**	
L.S.D. at 5 %	**A: 0.24**		**B: 0.22**		**AB: 0.44**	**A: 0.40**		**B: 0.35**		**AB: 0.70**

Table (3): Effect of compost level, some stimulants (chitosan, vitamin B1) treatments and their interactions on chlorophyll a, chlorophyll b and carotenoids content (mg/g f.w.) in fresh leaves of *Calendula officinalis* in the two growing seasons (2021/2022 and 2022/2023).

Some stimulants treatments	Compost levels treatments (g/pot) (A)									
	0.0	250	500	750	Mean (B)	0.0	250	500	750	Mean (B)
	The 1st season (2021/2022)					The 2nd season (2022/2023)				
Chlorophyll a content (mg/g f.w.)										
Control	3.132	3.544	3.721	3.832	**3.557**	3.356	3.591	3.770	3.884	**3.650**
Chitosan at 20 ppm	3.355	3.599	3.709	3.882	**3.636**	3.368	3.604	3.384	3.898	**3.564**
Chitosan at 40 ppm	3.393	3.631	3.813	3.927	**3.691**	3.410	3.649	3.831	3.946	**3.709**
Thiamine at 25 ppm	3.332	3.365	3.744	3.856	**3.574**	3.338	3.572	3.750	3.863	**3.631**
Thiamine at 50 ppm	3.381	3.618	3.799	3.913	**3.678**	3.393	3.631	3.812	3.926	**3.691**
Mean (A)	**3.319**	**3.551**	**3.757**	**3.882**		**3.373**	**3.609**	**3.709**	**3.903**	
L.S.D. at 5 %	**A: 0.120**		**B: 0.013**		**AB: 0.026**	**A: 0.174**		**B: 0.015**		**AB: 0.030**
Chlorophyll a content (mg/g f.w.)										
Control	1.054	1.107	1.140	1.151	**1.113**	1.068	1.122	1.156	1.167	**1.128**
Chitosan at 20 ppm	1.068	1.122	1.155	1.190	**1.134**	1.073	1.127	1.161	1.172	**1.133**
Chitosan at 40 ppm	1.131	1.165	1.199	1.211	**1.177**	1.087	1.141	1.175	1.187	**1.148**
Thiamine at 25 ppm	1.061	1.114	1.147	1.159	**1.120**	1.063	1.116	1.149	1.161	**1.122**
Thiamine at 50 ppm	1.081	1.135	1.169	1.181	**1.142**	1.081	1.135	1.169	1.181	**1.142**
Mean (A)	**1.079**	**1.129**	**1.162**	**1.178**		**1.074**	**1.128**	**1.162**	**1.174**	
L.S.D. at 5 %	**A: 0.014**		**B: 0.005**		**AB: 0.010**	**A: 0.012**		**B: 0.006**		**AB: 0.012**
Carotenoids content (mg/g f.w.)										
Control	1.154	1.211	1.247	1.259	**1.218**	1.169	1.227	1.264	1.276	**1.234**
Chitosan at 20 ppm	1.168	1.227	1.263	1.276	**1.234**	1.173	1.231	1.268	1.281	**1.238**
Chitosan at 40 ppm	1.181	1.240	1.277	1.290	**1.247**	1.187	1.246	1.283	1.296	**1.253**
Thiamine at 25 ppm	1.161	1.218	1.255	1.267	**1.225**	1.163	1.221	1.257	1.270	**1.228**
Thiamine at 50 ppm	1.177	1.236	1.273	1.286	**1.243**	1.181	1.240	1.277	1.290	**1.247**
Mean (A)	**1.168**	**1.226**	**1.263**	**1.276**		**1.175**	**1.233**	**1.270**	**1.283**	
L.S.D. at 5 %	**A: 0.011**		**B: 0.004**		**AB: 0.008**	**A: 0.012**		**B: 0.006**		**AB: 0.012**

Table (4): Effect of compost level, some stimulants (chitosan, vitamin B1) treatments and their interactions on nitrogen, phosphorus and potassium % in dry leaves of *Calendula officinalis* in the two growing seasons (2021/2022 and 2022/2023).

Some stimulants treatments	Compost levels treatments (g/pot) (A)									
	0.0	250	500	750	Mean (B)	0.0	250	500	750	Mean (B)
	The 1st season (2021/2022)					The 2nd season (2022/2023)				
Nitrogen (%)										
Control	3.145	3.302	3.401	3.435	**3.321**	3.172	3.731	3.431	3.465	**3.450**
Chitosan at 20 ppm	3.185	3.344	3.445	3.479	**3.363**	3.213	3.374	3.475	3.510	**3.393**
Chitosan at 40 ppm	3.240	3.398	3.495	3.536	**3.417**	3.272	3.434	3.481	3.575	**3.441**
Thiamine at 25 ppm	3.180	3.339	3.437	3.471	**3.357**	3.210	3.371	3.472	3.506	**3.390**
Thiamine at 50 ppm	3.200	3.359	3.458	3.050	**3.267**	3.231	3.392	3.495	3.530	**3.412**
Mean (A)	**3.190**	**3.348**	**3.447**	**3.394**		**3.220**	**3.460**	**3.471**	**3.517**	
L.S.D. at 5 %	**A: 0.043**		**B: 0.021**		**AB: 0.042**	**A: 0.036**		**B: 0.023**		**AB: N.S.**
Phosphorus (%)										
Control	0.201	0.211	0.217	0.220	**0.212**	0.211	0.222	0.233	0.235	**0.225**
Chitosan at 20 ppm	0.221	0.232	0.239	0.242	**0.234**	0.218	0.229	0.236	0.238	**0.230**
Chitosan at 40 ppm	0.256	0.269	0.277	0.280	**0.271**	0.260	0.273	0.291	0.285	**0.277**
Thiamine at 25 ppm	0.212	0.223	0.229	0.232	**0.224**	0.216	0.227	0.234	0.236	**0.228**
Thiamine at 50 ppm	0.243	0.255	0.263	0.266	**0.257**	0.246	0.258	0.266	0.269	**0.260**
Mean (A)	**0.227**	**0.238**	**0.245**	**0.248**		**0.230**	**0.242**	**0.252**	**0.253**	
L.S.D. at 5 %	**A: 0.003**		**B: 0.015**		**AB: 0.030**	**A: 0.003**		**B: 0.003**		**AB: 0.006**
Potassium (%)										
Control	1.33	1.46	1.57	1.69	**1.51**	1.36	1.47	1.60	1.71	**1.54**
Chitosan at 20 ppm	1.78	1.91	1.99	2.12	**1.95**	1.80	1.94	2.03	2.14	**1.98**
Chitosan at 40 ppm	1.87	1.98	2.15	2.31	**2.08**	1.90	2.00	2.19	2.35	**2.11**
Thiamine at 25 ppm	1.66	1.77	1.89	1.97	**1.82**	1.68	1.81	1.94	2.04	**1.87**
Thiamine at 50 ppm	1.76	1.79	2.03	2.13	**1.93**	1.77	1.84	2.04	2.15	**1.95**
Mean (A)	**1.68**	**1.78**	**1.93**	**2.04**		**1.70**	**1.81**	**1.96**	**2.08**	
L.S.D. at 5 %	**A: 0.09**		**B: 0.08**		**AB: 0.16**	**A: 0.10**		**B: 0.09**		**AB: 0.18**

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الملخص العربي

استجابة نباتات الأقحوان لمعاملات الكمبوست والشيتوزان والثيامين

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أُجري هذا العمل في مشتل نباتات الزينة، قسم البساتين، كلية الزراعة، جامعة المنيا، خلال موسمي النمو 2022/2021 و2023/2022، لاختبار تأثير مستويات الكمبوست (صفر – 250 – 500 – 750 جم/أصيص) والشيتوزان (20 و 40 جزء في المليون) والثيامين (250 و 50 جزء في المليون) والتداخل بينهم علي صفات النمو والتزهير وبعض المكونات الكيماوية لنبات الأقحوان.

أظهرت النتائج أن جميع صفات النمو الخضري (طول النبات –عدد الفروع الرئيسية/النبات –الوزن الجاف للنبات) وصفات النمو الزهري (العدد الكلي للنورات/نبات – الوزن الكلي الطازج والجاف للأزهار/النبات) وبعض المكونات الكيماوية (صبغات البناء الضوئي – النسبة المئوية للنيتروجين والفوسفور والبوتاسيوم) زادت زيادة معنوية نتيجة زيادة مستويات الكمبوست في مقابل معاملة الكنترول. وكانت المعاملة 750 جم/أصيص كمبوست هي الأكثر فعالية في هذا الشأن. أيضاً، أدت معاملات الشيتوزان والثيامين إلي زيادة جميع صفات النمو الخضري والزهري وكذلك الصبغات والنسبة المئوية للنيتروجين والفوسفور والبوتاسيوم، وكانت معاملة الشيتوزان عند 40 جزء في المليون متفوقة على جميع المعاملات الأخرى.

كانت أفضل معاملة تفاعل للحصول علي أفضل الصفات الخضرية والزهرية هي تسميد نبات الأقحوان بالكمبوست بـ 750 جم/أصيص ورش النبات بالشيتوزان عند تركيز 40 جزء في المليون.

الكلمات المفتاحية: الكمبوست – الشيتوزان – الثيامين – الأقحوان.