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Growth and flowering response of zinnia plant to spraying with tryptophan and chelated zinc

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Abstract

Zinnia elegans development and flowering parameters were studied in relation to two separate foliar treatments with tryptophan acid and chelated zinc. The study had a factorial design treatments, including different concentrations of tryptophan acid (0, 10, 20 and 30 mg/L) and chelated zinc (0, 20, 40 and 60 mg/L). The treatments were applied in a factorial experiment with two factors and three replications and the experiment was implemented using a completely randomized block design (R.C.B.D) $4 \times 4 \times 3 = 48$ were analyzed using analysis of variance (ANOVA) and comparisons were made. According to the Least Significant Difference test (L.S.D) at a probability level (0.05). The results showed that soil treated with 60 mg L⁻¹ tryptophan acid and with chelated zinc at 100 mg. L⁻¹ resulted in higher values of increase in dry weight, leaf content of total chlorophyll, leaf content of total soluble carbohydrates, and leaf content of nitrogen, number of pink flowers and flower diameter. The interaction was 60 mg. L⁻¹ tryptophan acid and 100 mg. L⁻¹ chelated zinc, which did not differ from the interaction of humic acid at the same concentration with 50 mg. L⁻¹ chelated zinc. The mentioned interaction treatments differed significantly from the individual treatments and was also significantly different from the control treatment in all the studied parameters.

Keywords: *Zinnia elegans*, tryptophan humic, chelated zinc, fertilization

1. Introduction

Zinnia elegans belongs to the family Asteraceae, and is a summer flowering annual plant native to Mexico. The plants are upright and bushy, with 8 cm long, ovate to lance-shaped, lightly hairy leaves ^[1]. The plants are upright and bushy, with 8 cm long, ovate to lance-shaped, lightly hairy leaves ^[2]. In the summer, broad-petaled purple flower heads with an average diameter of 4.5 cm look like daisies ^[3]. Dark red, orange, crimson, pink, and any other imaginable color are all available in zinnia flowers. Compared to their counterparts in other flowers, bicolor zinnias are truly stunning. In numerous regions of expansive plains and at various periods at different temperatures, zinnias bloom for more than four months ^[4]. When it rains in the summer in the plains, zinnias bloom ^[5]. Planting of zinnia seeds in the plains occurred throughout the months of February and March. The spacing between transplants was 40 cm × 30 cm. when the seedlings reached a height of approximately 5 cm (17 After around fifty days after transplanting ^[6]), the essential amino acid tryptophan performs double duty as both a proteinogenic molecule and a tryptophan-dependent metabolic intermediary in the (IAA) production pathway. Multiple enzyme-based processes can convert tryptophan to IAA ^[7]. These pathways include the indole-3-pyruvic acid indole-3-acetamide pathway, and the tryptamine pathways. Root, shoot, vascular system, and apical dominance control are all important plant growth processes that are regulated by IAA generated by this mechanism. Tryptophan treatments improves the growth of ornamental zinnia plants by strengthening their stock structures and increasing the efficiency of their flower-forming processes, leading to more visually appealing plants ^[8]. Tryptophan, an inexpensive natural alternative, is an attractive component for eco-friendly and long-term horticultural strategies. combining tryptophan with other growth-promoting chemicals improves plant performance even further. Zinc is one of the essential nutrients for plant growth due to its important role in building proteins. It is also crucial for the development and growth of plants and the completion of their life cycle as it regulates the consumption of sugar and increases

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the energy units needed to produce chlorophyll molecules, and helps in the formation of auxins^[9]. Also, the zinc element plays a vital role in several functions, including photosynthesis, formation of chlorophyll, DNA and RNA, protein synthesis, and its contribution to the synthesis of various enzymes for plant auxins, activation of hormones such as growth hormones and respiration enzymes. Moreover, the zinc element is involved in the activation of many enzymes regarding CO₂ assimilation during photosynthesis in which the presence of zinc is responsible for the activation of Fructose- 1,6-bisphosphatase, which is important in the distribution of six-carbon sugars in chloroplasts and cytoplasm, as well as carbonic anhydrase, which catalyzes the hydrogenation of CO₂ and the decomposition of carbonic acid into CO₂ and H₂O^[10]. Also, zinc has primarily structural functions in enzymes such as DNA polymerase and alcohol dehydrogenase, which leads to increased vegetative, flowering, and chemical growth. Thus, obtaining plants of high quality in terms of flowers and vase life in the plant to increase the symmetrical and ornamental value in gardens and parks is related to creating the layout and designing landscapes^[11]. This research aimed to identify the effect of spraying brassinolide as well as chelated zinc on the growth and flowering of geranium plants. Besides, determining the best combination treatment of both factors on growth and flowering indicators of the geranium plant^[12].

2. Materials and Methods

2.1 Experimental Site and Design

The experiment was carried out at the Agricultural Research Station of the College of Agriculture, - University of Al-Qasim Green, in a Plastic house covered with green netting, with a shade rate of 25% during the 2024-2025 agricultural season, to demonstrate the effect of tryptophan acid and chelated zinc on the growth and flowering of the zinnia plant. The seeds of the "Local variety on, into plastic pots with a diameter of (25 cm) and a height of (28 cm) containing a culture medium consisting of soil and peat moss at a ratio of 1:3. Soil samples used in agriculture were analyzed, along with their chemical and physical properties and suitability^[13]

Table 1: Physiochemical composition analyses of the potting soil.

The texture of potting soil (Sandy soil)	Profile	(%)
	Clay	16.28
	Silt	7.85
	Sand	74.18
Chemical analysis	Unit	Value
pH	-----	7.60
EC	Ds. M ⁻¹	3.70
N	mg. L ⁻¹	30.90
P	mg. L ⁻¹	12.30
K ⁺	mg. L ⁻¹	14.70
CaCO ₃	%	12.56
Orange matter (OM)	%	2.20

Table 2: Physiochemical composition analyses of potting-peat moss.

Chemical analyses	Unit	Value
pH	-----	7.86
EC	Ds.M ⁻¹	2.69
N	mg. L ⁻¹	140
P	mg. L ⁻¹	160
K ⁺	mg. L ⁻¹	180
Mg ⁺⁺	mg. L ⁻¹	100
S	mg. L ⁻¹	120

The experimental treatments included two factors the first factor was add humic acid at four concentrations (0, 10, 20 and 30) mg. L⁻¹, and the second factor was spraying chelated zinc at four concentrations: (0, 20, 40 and 60) mg. L⁻¹ three times with three replications as Complete Randomized Block Design (RCBD) the experiment data were collected and subjected to data analysis, where analysis of variance ANOVA was performed using the computing statistical program GenStat 12th. Differences among the treatment's means were compared according to the least significant difference (L.S.D) at a probability level of 0.05. The first and second factors were sprayed (was applied after the appearance of 4-5 true leaves), and spraying continued every 21 days (9). The spraying procedure was done three times for both factors; while leaving 21 days between the first, second, and third spraythi plants were sprayed early in the morning until complete wetness using a hand sprayer (2 liters size). Also, a liquid detergent (two drops per liter) was added to the spray solution as a surfactant, taking into account the placement of a barrier between the treatments so as to avoid contamination between the experimental units. A layer of polyethylene was placed under the pots to prevent the growth of weeds in the lath house and to avoid the rise of salts in the experiment pots. Also, thin plastic mulch was placed beneath each pot to maintain moisture in the potting soil.

2.2. First: Vegetative growth indicators

1. Dry weight (gm)

Plant height was measured using a measuring tape from the soil surface of the pots to the highest point at the flower bud emergence stage for each experimental unit, and the rate was calculated for each treatment.

2. Total number of leaves

The number of total leaves and each experimental unit were calculated, from which the average values for each treatment were calculated.

Second: Flower growth indicator

- Number of flowers (flower.plant⁻¹):** The number of plant flowers for each experimental unit was calculated, and the average number of flowers for each treatment was extracted.
- Flower diameter (mm):** Flower diameter was measured using a (vernier caliper) for each experimental unit.

Third: Chemical indicators

- 1Estimation of the total chlorophyll pigment content of leaves (100 mg - ⁻¹) fresh weight.
The chlorophyll pigment content the of leaves was determined according to a previously described method^[15]. Estimation of the leaves' content of total soluble carbohydrates (mg. g⁻¹)
- The carbohydrate content of the leaves was estimated according to the method.^[16]
- Estimation of the nitrogen content of leaves (mg. 100 g⁻¹) is carried out according to the method.^[17]

3. Results

The results shown in Table (3) spraying with tryptophan at a concentration of 30 mg. L⁻¹ led to a significant increase in dry weight, and number of leaves, leaf content of total chlorophyll, leaf content of total soluble carbohydrates, and leaf content of nitrogen, reaching 34.14 gm, 67.15 leaf plant⁻¹, 23.65 mg. 100 g⁻¹, 10.32 mg. g⁻¹ and 5.46 mg. 100 g⁻¹ compared with the control

treatment, which amounted to 20.62 gm., 53.33 leaf plant⁻¹. 22.94 mg. 100 g⁻¹. 9.11 mg⁻¹ and 4.36 mg. 100 g⁻¹, respectively. We conclude from the results of Table (3) that spraying with tryptophan acid at a concentration of 30 mg. L⁻¹ resulted in Number of flowers (plant⁻¹), flower diameter (cm) in the zinnia plant, as it reached 7.00 plant⁻¹, 6.14 cm compared with the comparison treatment amounted to 6.00 (plant⁻¹), 4.20 cm respectively.

The results in the same tables also showed that spraying chelated zinc on the zinnia plant a concentration of 60 mg. L⁻¹ led to a significant increase in dry weight, and number of leaves, leaf content of total chlorophyll, leaf content of total soluble carbohydrates, and leaf content of nitrogen, reaching 21.11gm, 51.66 leaf plant⁻¹, 23.11 mg. 100 g⁻¹, 9.14 mg. g⁻¹ and 4.00 mg. 100 g⁻¹ compared with the control treatment, which amounted to 20.62 gm., 53.33 leaf plant⁻¹. 22.94 mg. 100 g⁻¹. 9.11 mg⁻¹ and 4.36 mg. 100 g⁻¹, respectively.

We conclude from the results of Table (3) that spraying with chelated zinc a concentration of 60 mg. L⁻¹ resulted in Number of

flowers (plant⁻¹), flower diameter cm in the zinnia plant, as it reached 7.00 plant⁻¹, 5.14 cm compared with the comparison treatment amounted to 6.67 (plant⁻¹), 4.20 cm respectively.

The results of Table (3) show that spraying with Tryptophan at a concentration of 30 mg. L⁻¹ and chelated zinc at a concentration of 60 mg. L⁻¹ led to a significant increase in dry weight, and number of leaves, leaf content of total chlorophyll, leaf content of total soluble carbohydrates, and leaf content of nitrogen, reaching 41.77 gm, 70.14 leaf plant⁻¹, 28.13 mg. 100 g⁻¹, 12.88 mg. g⁻¹ and 6.87 mg. 100 g⁻¹ compared with the control treatment, which amounted to 20.62gm., 53.33 leaf plant⁻¹. 22.94 mg. 100 g⁻¹. 9.11 mg⁻¹ and 4.36 mg. 100 g⁻¹, respectively that spraying with tryptophan at a concentration of 30 mg. L⁻¹ with chelated zinc at a concentration of 60 mg. L⁻¹ had a significant effect on Number of flowers (plant⁻¹), flower diameter cm in the zinnia plant, as it reached 9.00 plant⁻¹, 7.00 cm compared with the comparison treatment amounted to 6.67 (plant⁻¹), 4.20 cm respectively.

Growth and flowering response of zinnia plant to spraying with tryptophan and chelated zinc

Tryptophan mg. L ⁻¹	Chelated zinc mg. L ⁻¹	Leaf content of microelements (gm ⁻¹)			Dry weight GM	Number of papers leaf plant ⁻¹	Number of flowers (Plant ⁻¹)	Flower Diameter (cm)
		Chl	CHO	N				
0	0	22.94	9.11	4.36	20.62	53.33	6.00	4.20
	20	22.99	8.97	3.93	30.07	64.00	8.00	5.60
	40	22.92	9.07	4.55	33.73	69.33	9.33	5.76
	60	23.11	9.14	4.00	21.11	51.66	7.00	5.14
10	0	21.02	9.78	4.13	22.13	62.00	8.33	5.60
	20	23.14	9.99	4.00	25.15	67.67	9.33	5.76
	40	23.15	10.14	4.98	28.44	53.00	6.00	5.23
	60	23.46	10.18	5.01	32.44	62.33	8.00	5.89
20	0	23.13	9.18	4.99	33.36	68.67	9.33	5.89
	20	24.00	9.66	5.14	36.47	66.35	6.67	6.61
	40	24.55	10.00	5.66	38.17	64.00	8.00	6.47
	60	24.88	10.89	5.77	39.14	69.33	9.33	6.14
30	0	23.65	10.32	5.46	34.14	67.15	7.00	6.00
	20	25.36	11.13	5.39	38.14	68.14	8.33	6.04
	40	26.12	11.14	6.01	41.11	69.33	9.33	7.00
	60	28.13	12.88	6.87	41.77	70.14	9.78	7.11
L.S.D. (p ≤ 0.05)	Tryptophan	2.010	1.612	1.197	3.922	15.23	1.236	1.18
	Chelated zinc	2.010	1.612	1.197	3.922	15.23	1.236	1.18
	Interaction	4.021	3.224	2.394	7.843	30.46	2.472	2.35

4. Discussion

Table (3) shows that chelated zinc and tryptophan had a remarkable influence on the carbohydrate content of *Zinnia elegans* [18]. Tryptophan initiates auxin biosynthesis the effect of tryptophan supplementation was certainly positive, with the carbohydrate content rising progressively with increasing concentrations and reaching its maximum at 30 mg L⁻¹. The fact that tryptophan the activity of enzymes, and boosting protein development demonstrating that tryptophan is a key player in plant physiological process regulation by recording similar findings As the tryptophan concentration was raised from 0 to 60 mg L⁻¹, it had a significant effect on the concentration of chlorophyll in plants. This can be attributed to the fact that tryptophan is an indole-3-acetic acid (IAA) precursor, that causes cell growth and increases photosynthetic efficiency [19]. Tryptophan initiates auxin biosynthesis, and chelated zinc enhances the photosynthetic machinery. Together, these two produce more pigment to add up to, hence they are synergistic [20]. Confirm that plant growth regulators and chelated zinc synergistically boost photosynthesis and plant productivity over either of them separately. Statistical evidence supports the claim: that application of tryptophan had the most effect on the

chlorophyll content in zinnia plants [21] As the tryptophan concentration was raised from 0 to 60 mg L⁻¹, it had a significant effect on the concentration of chlorophyll in plants. This can be attributed to the fact that tryptophan is an indole-3-acetic acid (IAA) precursor, that causes cell growth and increases photosynthetic efficiency [22]. Tryptophan initiates auxin biosynthesis, and chelated zinc enhances the photosynthetic machinery. Together, these two produce more pigment to add up to, hence they are synergistic. Exogenous tryptophan enhances sunflower reproductive and vegetative development by influencing auxin metabolism. When the concentration of tryptophan increased from 0 to 30 mg L⁻¹, N content increased the most. It slightly declined at 60 mg L⁻¹, though. From this information, it can be seen that the optimum quantity of tryptophan for nitrogen absorption is in the mid-range. Zinc element is considered one of the micronutrients that the plant needs in small quantities, but its deficiency is one of the most important determinants of plant growth [23]. When zinc is severely deficient, the plant may not be able to complete its life cycle, and it also has a significant role in regulating the consumption of sugars, as well as an increase in energy required for the production of chlorophyll, which in turn is reflected

positively on vegetative growth indicators ^[24]Such increment in *Zinnia elegans* chemical composition by spraying zinc could be indicated the role of Zn in the vital reactions related to the formation of chlorophyll, as it contributes to the representation of chlorophyll indirectly through its influence on the formation of carbohydrates and the production of amino acids and energy compounds. Also, increasing the level of zinc may increase the biosynthesis of the chlorophyll molecule ^[25].

5. Conclusion

We conclude that spraying the Zinnia plant with the tryptophan acid and chelated zinc revealed a significant response of the plant in all growth and flowering indicators under study. Further, spraying chelated zinc with high concentration had a positive effect among the other concentrations, which showed the best results in most of the indicators. Also, the plants were characterized by giving the highest mean in vegetative, flowering, and chemical indicators when sprayed with the growth regulator tryptophan acid at 30 mg. L⁻¹ with chelated zinc at a concentration of 40 or 60 mg. L⁻¹.

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