



Stimulation of Vegetative Growth of Gazania Rigens L. By Spraying with Zinc and Ascorbic Acid

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ABSTRACT

An experiment using pots was conducted during the 2024-2025 growing season in a nursery field in Baghdad to study the effect of spraying zinc and ascorbic acid solutions, and their interactions, on the growth indicators of gazania plants. The treatment included four concentrations (0, 50, 75, and 100 mg.L⁻¹) of zinc and three concentrations (0, 100, and 150 mg.L⁻¹) of ascorbic acid, in three replicates using a completely randomized design. Zinc had a significant effect on plant growth and development, and spraying with ascorbic acid also had a significant and effective effect on stimulating plant growth. Spraying gazania plants with zinc and ascorbic acid concentrations led to a clear and significant increase in gazania growth indicators. Furthermore, the interaction between zinc and ascorbic acid resulted in a significant increase in the studied traits. These are plant height, root length, fresh weight of the vegetative and root parts, number of leaves, dry weight of the vegetative part, and dry weight of the root part. The highest values were obtained when treated with a concentration of 100 mg.L⁻¹ of zinc and 150 mg.L⁻¹ of ascorbic acid

1. Introduction

Ornamental plants have great aesthetic, environmental, health, psychological, economic, social, and cultural importance. [1] (Al-Talib, 2021). The other name for the Gazania plant (*G. rigens* L) is the treasure flower. It belongs to the family *Gazania* spp., and is characterized by being a herb with a beautiful floral shape, as the shape of its flowers is interesting. It is a perennial herb, with horticultural appeal. It is characterized by being an evergreen plant, which blooms in three seasons, is dwarf, can be used as a potted ornamental plant, ground cover plant, flower border, etc. [2]. Now it has been widely used in

landscaping in the world [3]. Vegetative growth characteristics are an indicator of the efficiency of physiological processes in the plant. Increased plant height, number of leaves, and other vegetative characteristics are linked to the efficiency of photosynthesis, which increases the carbohydrate content necessary for plant growth and development. This, in turn, affects the plant's ability to flower and bear fruit, as well as the quantitative and qualitative characteristics of the crop. Vegetative growth also serves as an indicator of the plant's stimulation and its response to various treatments[4]. (Taiz, et al., (2018). Plant

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Zinc is a limiting factor for crop production and is an essential trace element required by plants in small amounts [5]. (Duff, 2007). It is a fundamental element that affects many physiological and biochemical pathways in plants [6]. (Hamza et al., 2022). Plant growth processes, such as protein and carbohydrate synthesis and photosynthesis, depend on it [7]. (Vasconcellas et al., 2011). It participates in the synthesis of auxins (indoleacetic acid) and tryptophan and in the activation of several metabolic enzymes, such as alcohol dehydrogenase and carbonic anhydrase. Protein synthesis decreases when zinc is deficient [8]. (Verma & Verma, 2010). It is an antioxidant against peroxide and oxidative damage and regulates free radicals because it enhances the plant's antioxidant system and acts as a stabilizer and protector of living membranes against damage [9]. (Zago and Ottiza, 2001). Zinc spraying has a clear effect on the growth indicators of broad beans [10]. (Thuluth et al., 2005). Treating cowpea plants with zinc resulted in a significant increase in vegetative characteristics such as plant height, leaf area, dry weight, and number of branches [11]. (Kareem and Madeeha, 2009).

Treating zinnia plants with zinc sulfate had a significant effect on their growth characteristics [12]. (Badriet et al., 2026). Ascorbic acid (Vitamin C) is an antioxidant that reduces oxidative damage within the plant and protects plant cells. It protects the photosynthetic system from damage caused by reactive oxygen species and oxidative stress, and regulates oxidation and reduction reactions within the cytoplasm of the plant cell [13] (Smirnoff & Wheeler, 2010). It acts as a cofactor in plant metabolism, including improving plant growth and development by regulating cell division, growth, and elongation, and contributes to the synthesis and regulation of plant hormones (Daniel 2013) [14]. It also acts as a cofactor in the synthesis of hydroxyproline-rich glycoproteins involved in the formation of the plant cell wall, as it participates in the hydroxylation of proline and the synthesis of hydroxyproline, which is important in the synthesis of structural proteins (Smirnoff, 2000) [15]. It protects cell membranes by limiting the effects and accumulation of reactive oxygen species (ROS), and increases plant

resistance to environmental stresses such as drought, salinity, and heat (Akram et al., 2014) [16]

It also increases the efficiency of photosynthesis because it participates in electron transport within the photosynthetic system, protects chlorophyll from reactive oxygen species, and maintains the viability of chloroplasts (Boris, 2014) [17], and protects the photosynthetic system from oxidative damage (Szilvia, 2023) [18]. Ascorbic acid (Vitamin C) is found in high concentrations in the cytoplasm of plant cells and in cellular cytoplasmic organelles such as mitochondria, chloroplasts, and peroxisomes. It plays a vital role within the cell in regulating oxidative balance, due to its ability to reduce free radicals and reactive oxygen species (ROS), which accumulate under environmental stresses such as drought, salinity, and high temperatures.

Ascorbate also functions within one of the most important non-enzymatic defense systems known as the ascorbate-glutathione cycle, which removes hydrogen peroxide (H_2O_2) and protects proteins and cell membranes from oxidation. It also participates in photosynthesis and cell growth (Wu, P., et al. 2024) [19]. Spraying dill plants with ascorbic acid significantly increased vegetative growth indicators such as plant height, number of leaves, and fresh and dry weight (Hassan, et al., 2019) [20]. Spraying corn plants with ascorbic acid also increased plant height [21] (Al-Bazi, 2022). Spraying turmeric plants with ascorbic acid significantly increased vegetative growth indicators such as plant height, number of leaves, and fresh and dry weight (Ali, 2025) [22].

2. Materials and methods

An agricultural experiment was conducted in a nursery in Baghdad.

in pots , during the 2024-2025 growing season.

To find out the role of spraying ascorbic acid and zinc and their interactions on the leaves of the gazania plant. Each pot contained 5 kg of soil. The experiment included 36 experimental units, reflecting the use of four different concentrations of zinc sulfate and three concentrations of

ascorbic acid, with three replicates for each treatment.

I sowed Casania seeds on January 10, 2024, at a rate of 5 seeds per pot. The plants were irrigated at 50% of the field capacity. Two weeks after sowing, the seedlings were thinned to three plants per pot. After the fourth leaf appeared, I used a hand sprayer to spray the plants with zinc (zinc sulfate) solutions at concentrations of 0, 50, 75, and 100 mg.L-1, in addition to three concentrations of ascorbic acid (0, 100, and 150 mg.L-1) in the early morning. Plant samples were taken from both the foliage and root parts after uprooting and cleaning the plant on November 30, 2024. The plant's height was measured using a ruler from the soil surface to its tip. The root length was measured using a graduated ruler, and the foliage was weighed after being separated from the root with a sharp knife. The root was also weighed after separation using a sensitive balance. The number of leaves per experimental unit was counted and recorded. The foliage and root parts were then weighed after being thoroughly dried in an electric oven until a constant weight was reached. According to

method [23], the data were analyzed at a probability level of 0.05% and using the least significant difference (LSD) method.

3. Results

1- Plant Height

Table (1) shows that treating plants with a concentration of 100 (mg.L-1) of zinc led to an increase in average height, reaching 11.30 cm, compared to the control treatment which reached 8.87 cm. The same table also indicates that ascorbic acid at a concentration of 150 parts per million (mg.L-1) had a positive effect on increasing the average plant height, reaching 10.83 cm. These results are consistent with the results of (Ali, 2025) in his study on turmeric. Regarding the interaction between zinc and ascorbic acid, it led to an increase in plant height values. Table (1) shows that treatment with a concentration of 100 mg.L-1 of zinc and a concentration of 150 mg.L-1 of ascorbic acid gave the highest value, reaching 12.47 cm, compared to 8.50 cm at zero concentration for the study factors.

Tab (1) Effect spray the zinc and Ascorbic acid in plant height Gazania plant					
Ascorbic acid(mg.L-1)	zinc concentrations(mg.L-1)				Effect the average Ascorbic aci
	0	50	75	100	
0	8.50	9.52	9.75	10.13	9.45
100	8.91	9.85	10.28	11.29	10.08
150	9.21	10.44	11.21	12.47	10.83
Effect the average zinc	8.87	9.94	10.41	11.30	
LSD (0.05)	zinc=0.350 Ascorbic acid =0.421 The interaction=0.812				

2. Root Length (cm)

The results shown in Table (2) indicate an increase in the average root length when plants were treated with zinc concentrations of 75 and 100 mg.L-1. The increase was 25.57% and 42.63%

for these concentrations, respectively, compared to the control treatment. The results in the same table also show an increase in the average root length with increasing ascorbic acid concentration. The increase was 26.71% for 150

mg.L-1 ascorbic acid compared to the control treatment.

Regarding the interaction between the two study factors, it was significant in increasing root length.

The highest increase, 58.56%, was observed with the zinc treatment at 100 mg.L-1 and the ascorbic acid treatment at 150 mg.L-1, while the lowest increase was observed with the control treatment.

pTab (2) Effect spray the zinc and Ascorbic acid in root length Gazania plant					
Ascorbic acid (mg.L-1)	zinc concentrations (mg.L-1)				Effect the average Ascorbic acid
	0	50	75	100	
0	18.45	19.42	20.50	21.00	19.84
100	19.00	20.75	22.75	29.20	22.92
150	19.56	21.56	28.32	31.10	25.14
Effect the average zinc	19.00	20.58	23.86	27.10	
LSD (0.05)	zinc=0.75 Ascorbic acid =0.89 The interaction=1.58				

3- shoot wet weight

The results in Table (3) indicate a significant increase in the average fresh weight of the vegetative parts of the gazania plant. The increase was 94.51% and 208.12% for zinc concentrations of 75 and 100 mg.L-1, respectively, compared to the control treatment. The table also shows a significant increase in this trait with increasing ascorbic acid concentration, with increases of 13.57% and 38.18% for concentrations of 100 and

150 mg.L-1, respectively, compared to the control treatment. The results were consistent with those of Ali (2025) [21] in his study on turmeric.

The interaction between the two study factors was significant in increasing this trait. The highest value, 19.33 cm., was observed with the treatment of 100 mg.L-1 for zinc and 150 mg.L-1 for ascorbic acid, while the lowest interaction value, 4.11 cm., was observed with the control treatment (zero for both factors).

Tab (3) Effect spray the zinc and Ascorbic acid in shoot fresh weight Gazania plant					
Ascorbic acid(mg.L-1)	zinc concentrations(mg.L-1)				Effect the average Ascorbic acid
	0	50	75	100	
0	4.11	6.21	8.92	13.76	8.25
100	5.33	6.75	9.58	15.82	9.37
150	6.43	7.46	12.36	19.33	11.40
Effect the avrage zinc	5.29	6.81	10.29	16.30	
LSD (0.05)	zinc=0.214 Ascorbic acid =0.242 The interaction=0.520				

4- root wet weight

The results shown in Table (4) indicate a significant increase in the average fresh weight of the root portion of a single plant when plants were sprayed with zinc and ascorbic acid compared to the control treatment. At concentrations of 75 and 100 mg.L-1 of zinc, the average fresh weight was 1.94 g. and 2.73 g. for the two concentrations, respectively, compared to 1.17g for the control treatment. Increasing the ascorbic acid concentration from 0 to 100 and 150 mg.L-1 resulted in a significant increase in the root fresh weight, from 1.38 to 1.82 g. for the 100 mg.L-

1concentration and from 1.38 to 2.18 g. for the 150 mg.L-1concentration.

The interaction effect between the two study factors was also significant. The optimal concentration was 100 mg.L-1 for zinc and 150 mg.L-1 for ascorbic acid, at which the highest root fresh weight was recorded at 3.52 g compared to 1.00 g in the control treatment. The lowest root fresh weight was observed in the treatment with zero concentrations for both factors.

Tab (4) Effect spray the zinc and Ascorbic acid in root fresh weight Gazania plant					
Ascorbic acid(mg.L-1)	zinc concentrations(mg.L-1)				Effect the average Ascorbic acid
	0	50	75	100	
0	1.00	1.26	1.39	1.87	1.38
100	1.21	1.33	1.92	2.81	1.82
150	1.29	1.40	2.50	3.52	2.18
Effect the avrage zinc	1.17	1.33	1.94	2.73	
LSD (0.05)	zinc=0.140 Ascorbic acid =0.123 The interaction=0.301				

5-number of leaves

Table (5) shows a significant increase in the number of leaves after zinc foliar application at concentrations of 75 and 100 mg.L-1, with increases of 55.55% and 88.88%, respectively, compared to the control treatment.

Regarding the effect of ascorbic acid on the number of leaves, the same table shows that concentrations of 100 and 150 mg.L-1 resulted in a significant increase of 15.25 and 17.00 leaf.plant., respectively, compared to 13.5 leaf.plant in the control treatment

The results also show that zinc foliar application at concentrations of 100 and 150 mg.L-1 resulted in a significant increase of 15.25 and 17.00 leaf.plant, respectively. The results of the same table confirmed that the interaction between zinc and ascorbic acid had a significant effect on increasing this trait, and the highest value was 22.00 leaf.plant with treatments of 100 and 150 (mg.L-1) for zinc and ascorbic acid respectively, and the lowest value was 9.00 leaf.plant when no spraying was done to the workers.

Tab (5) Effect spray the zinc and Ascorbic acid in number of leaves Gazania plant					
Ascorbic acid(mg.L-1)	zinc concentrations(mg.L-1)				Effect the average Ascorbic acid
	0	50	75	100	
0	9.00	13.00	15.00	17.00	13.50
100	10.00	14.00	16.00	21.00	15.25
150	11.00	15.00	20.00	22.00	17.00
Effect the avrage zinc	9.00	14.00	17.00		
LSD (0.05)	zinc=3.30 Ascorbic acid =2.11 The interaction=6.28				

6- shoot dry weight

A significant increase in the average dry weight of the vegetative parts was observed when plants were treated with zinc and ascorbic acid, as shown in Table (6). Treatment of plants with zinc at all concentrations (50, 75, and 100 mg.L-1) led to an increase in this characteristic by rates of 0.44, 0.64, and 0.85g., respectively, compared to 0.27g. in the control treatment. Ascorbic acid at concentrations of 100 and 150 mg.L-1 also increased the average dry weight of the vegetative

parts by rates of 0.525g. and 0.649g. for the two concentrations, respectively, compared to 0.465g. in the control treatment. The results of the table showed the significant effect of the interaction of the two study factors on the dry weight of the vegetative part, and the highest percentage increase was in the treatment of 100 for zinc (mg.L-1) and 150 (mg.L-1) for ascorbic acid, where it reached 0.99 compared to 0.23 in the control treatment, and the lowest value was in the treatment of zero for both factors, which reached 0.23g.

Tab (6) Effect spray the zinc and Ascorbic acid in shoot dry weight Gazania plant					
Ascorbic acid(mg.L-1)	zinc concentrations(mg.L-1)				Effect the average Ascorbic acid
	0	50	75	100	
0	0.23	0.35	0.54	0.75	0.465
100	0.25	0.43	0.62	0.80	0.525
150	0.32	0.54	0.75	0.99	0.649
Effect the avrage zinc	0.27	0.44	0.64	0.85	
LSD (0.05)	zinc=0.09 Ascorbic acid =0.04 The interaction=0.13				

7- Root Dry Weight

The results in Table (9) confirmed a significant increase in the average root dry weight when plants were treated with both zinc and ascorbic acid. The increase rates were 214.81% and 39.56%, respectively, compared to the control

treatment. Regarding the interaction between zinc and ascorbic acid, its effect on increasing this trait was significant. The highest values were 0.144g. for the zinc treatment (100 mg.L-1) and the ascorbic acid treatment (150 mM.L-1), while the root dry weight value in the control treatment was 0.039 g.

Tab (7) Effect spray the zinc and Ascorbic acid in root dry weight Gazania plant					
Ascorbic acid(mg.L-1)	zinc concentrations(mg.L-1)				Effect the average Ascorbic acid
	0	50	75	100	
0	0.039	0.065	0.095	0.107	0.077
100	0.054	0.085	0.102	0.135	0.094
150	0.077	0.090	0.132	0.144	0.111
Effect the avrage zinc	0.056	0.080	0.109	0.128	
LSD (0.05)	zinc =0.031 Ascorbic acid =0.025 The interaction=0.061				

4. Discussion

There was a noticeable increase in the growth of gazania plants after treatment with zinc and ascorbic acid. Spraying zinc and ascorbic acid on gazania leaves helped increase the rates and values of plant height, root length, number of leaves, and weight of vegetative parts and roots. This may be attributed to the positive effect of zinc on metabolic processes and biological activity, and

its stimulating effect on enzyme activity and photosynthetic pigments, which in turn stimulates vegetative growth (Mikhail et al., 2004) [24]. Zinc participates in the synthesis of indoleacetic acid (IAA) and the hormone auxin, so it is essential for increasing plant height and fresh and dry weight. Zinc also helps the plant roots absorb the nutrients nitrogen, phosphorus, and calcium, which is why plant and root height increases after

treatment with this element. Nitrogen is an essential component of protein, chlorophyll, DNA, and cytochromes, while phosphorus plays a crucial role in protein synthesis, DNA formation, cell membrane structure, and ATP production (Jain, 2011) [25]. The stimulation of plant growth and the increase in vegetative growth indicators may be attributed to the role of ascorbic acid in promoting plant growth through its function in osmotic balance, regulating water utilization, cell division, and plant hormone synthesis. Furthermore, as a major antioxidant, it protects plant cells from oxidative stress [26] (Author, 2023). It increases the efficiency of photosynthesis by increasing chlorophyll content and leaf area [27] (Dolatabadian et al., 2009). It also activates vital processes and improves nutrient absorption [28] (Khan et al., 2011).

The current study demonstrated the effective role of zinc and ascorbic acid when sprayed on gazania plants, as both promoted plant growth. The study concluded that the application of zinc at a concentration of 100 mg.L⁻¹ and ascorbic acid at a concentration of 150 mg.L⁻¹ showed a significant effect on the studied growth parameters.

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