THE EFFECT OF SPRAYING CHELATED CALCIUM AND CHELATED IRON ON THE VEGETATIVE AND FLOWERING GROWTH CHARACTERISTICS OF (*GAZANIA SPLENDENS* L.)

Sundus A. AL-Rahman[1] **Nawal M. Alwan[2]**
Lecturer **Assist prof.**
[1&2] Dep. of Horti. and Land. Gard. , Coll. of Agric. , University of Baghdad.
[1] sundos.abdallatif@coagri.uobaghdad.edu.iq
[2] nawal.mahmood@coagri.uobaghdad.edu.iq

ABSTRACT

This study was aimed to investigate effect of spraying chelated Calcium and chelated Iron on the vegetative and floral growth characteristics of the Gazania plant , College of Agricultural Engineering Sciences, University of Baghdad in the autumn season 2019-2020 and spring season 2020-2021 . The study was carried out as a factorial experiment in R.C.B.D. Design with three replications. Two factors were included in this study: foliar sprays of chelated Calcium at concentrations of 1, 2, 4 g L^{-1} (Ca_1-Ca_2-Ca_3), respectively, in addition to control treatment, and chelated Iron in concentrations of 1and 2 g L^{-1} (Fe_1-Fe_2) respectively, in addition to control Fe_0. The results showed a significant superiority in all vegetative and floral traits for both autumn and spring seasons. The treatment of spraying with chelated Calcium Ca_4 was superior for most of vegetative and floral traits, as well as treatment of spraying with chelated Iron Fe_2. The treatment combination Ca_4Fe_2 was also superior for plant height (cm), number of leaves (leaf.plant^{-1}), chlorophyll content of leaves (mg.100 g^{-1} fresh weight), leaf area (cm^2), fresh weight (g), dry weight (g), flowering period (days), flowering date (days), number of flowers (flower.plant^{-1}), flower diameter (cm), (fresh weight of flowers, dry weight of flowers (g)).

Keywords: nutrients, herbaceous ornamental, foliar fertilization, life on land, climate action

تأثير رش الكالسيوم المخلبي والحديد المخلبي في النمو الخضري والزهري لنبات (*Gazniaa splendens* L.)

سندس عبد اللطيف عبد الرحمن **نوال محمود علوان**
مدرس **أستاذ مساعد**

المستخلص

هدفت هذه الدراسة إلى معرفة تاثير رش الكالسيوم المخلبي والحديد المخلبي في مواصفات النمو الخضري والزهري لنبات الكزانيا ، في كلية علوم الهندسة الزراعية – جامعة بغداد في الموسم الخريفي 2019–2020 والموسم الربيعي 2020–2021 ، نفذ البحث كتجربة عاملية ضمن تصميم R.C.B.D. بثلاث مكررات ضمت عاملين للدراسة هي الرش الورقي بالكالسيوم المخلبي بالتركيز (1،2،4) غم / لتر(Ca_1–Ca_2–Ca_3) فضلا عن معاملة القياس Ca_0 على الترتيب ،والحديد المخلبي بالتركيز (1و2) غم/ لتر (Fe_1–Fe_2) فضلا عن المعاملة بدون رش Fe_0على الترتيب ، اظهرت النتائج تفوقا معنويا في جميع الصفات الخضرية والزهرية وللموسمين الخريفي والربيعي ، إذ تفوقت معاملة الرش بالكالسيوم المخلبي Ca_4 لمعظم الصفات الخضرية والزهرية وكذلك تفوقت معاملة الرش بالحديد المخلبي Fe_2 ، كما تفوقت معاملة التداخل Ca_4Fe_2 لبعض الصفات ذاتها في ارتفاع النبات (سم) ، عدد الأوراق (ورقة نبات$^{-1}$) ، محتوى الأوراق من الكلوروفيل (ملغم .100 غم–1 وزن طري) ، المساحة الورقية (سم2) ، الوزن الرطب (غم) الوزن الجاف (غم) ، فترة التزهير (يوم) موعد التزهير (يوم) ، عدد الازهار (زهرة. نبات–1) ، قطر الزهرة (سم) ، الوزن الطري للأزهار (غم) والوزن الجاف للأزهار (غم) .

كلمات مفتاحية: العناصر الغذائية ،نباتات الزينة العشبية، التسميد الورقي، الحياة فوق البر، عمل مناخي

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INTRODUCTION

Ornamental plants are one of most popular and widely used plants in world, as they are used to beautify gardens, homes and landscapes, and are characterized by giving an aesthetic and comfortable appearance to soul (12), as they contribute to improving air quality and reducing temperature and pollution (7). Gazniaa (*Gazniaa splendens* L.) is an ornamental plant that belongs to Compositae family, native to South Africa. It is a winter herbaceous perennial plant native to South Africa, plant does not rise above soil surface more than 15 cm, leaves are long oblong ribbon leaves with a full edge.(35 ; 42 ; 32). Foliar feeding is one of methods used nowadays which is used with various plants. If foliar feeding can supply a high percentage of its need for macro and micronutrients when conditions are not favorable in soil and Climate to absorb those nutrients (13). It can also be considered a successful and modern method in alkaline soil with high calcium carbonate content, which reduces the availability of microelements (45). Calcium is one of essential nutrients that plants require in alarge quantities. It is considered as a non-mobile element within plant, and adding it to soil is slow effectiveness. Therefore, foliar spraying is applied, which is an effective and rapid method to directly supply plant with Calcium (28; 27; 16). delays leaf and fruit senescence by reducing respiration rate and ethylene production, and decreases flower or other plant parts abscission (22). Calcium participates in various physiological processes in plants, such as regulating the activity of photosynthetic metabolism enzymes for carbon fixation in Calvin cycle, participating in photosynthetic metabolism reactions, and being involved in light protection mechanisms (41). Additionally, it assists plant in absorbing more nutrients and altering nutritional status of the cell (24 ; 39; 32). Calcium is considered the main component of middle lamella, which connects plant cells together and is found in form of Calcium pectate. This contributes to stability and firmness of plant cells (39). Similarly, Zhang et al. (44) stated that calcium binds to pectic acid present in the cell wall to form calcium pectate, which constitutes the structural framework of the cell wall, providing it with strength and rigidity. Additionally, calcium plays other important physiological roles, including cell expansion, cell division, chromosome stability, mitochondria production, and control of osmotic balance within the cell (11) . Abd-ALLatif (1) observed in a study on effect of foliar spraying with Calcium chloride on Snapdragon (*Antirrinum maju*s) plants and their cultivation in different growth media on vegetative and flowering growth. The following concentrations were used: 0, 1.0, 2.0 g L^{-1} of Calcium. Plants treated with concentration of 1.0 g L^{-1} of Calcium showed significant effects on most vegetative and flowering traits. Abdulhadi *et al.* (3) found in a study on effect of foliar spraying with Calcium and Iron chloride on Snapdragon (*Antirrhinum majus* L.) using following concentrations: 0, 1.5, and 3 g L^{-1} of Calcium chloride, that spraying with a concentration of 3 g L^{-1} was more effective than Iron chloride and recorded best results in vegetative terms. Ali and Majeed (8) conducted a study on impact of foliar spraying with ascorbic acid and Calcium chloride on growth and yield of broccoli plants. They used Calcium concentrations of 0, 1.0, 1.5, 2.0 g L-1. Concentration of 2.0 g L-1 of Calcium yielded the best results . Iron is considered an essential element in chlorophyll synthesis, although it does not directly participate in its composition. It plays a crucial role in formation of enzymes responsible for chlorophyll synthesis (33 ; 45) and is a vital nutrient for plant growth and production. Iron participates in key cellular functions such as photosynthesis and respiration. Disorders in Iron absorption, transport, or storage affect plant growth, crop yield, and quality of plant products. (31; 42). It is preferable to use chelated iron fertilizers that are cost-effective, less stable, and more efficient in foliar absorption (34; 46 ; 18) This represents a promising strategy to mitigate negative effects of drought stress by foliar application of chelated Iron (9). Studies suggest the potential improvement of plant growth through treatment with Iron (21). Mohamadipoor et al. (25) demonstrated that foliar spraying of Iron on *spathiphyllum illusion* plants resulted in a significant increase in leaf number, plant

height, root length, and leaf chlorophyll content. Singh et al. (37) mentioned that Iron spraying on gladiolus plants led to an increase in number of formed corms, flower spikes, as well as dry weight of vegetative and flowering growth. Ramezani et al. (30) found, in a study on effect of foliar application of Iron, Zinc, and Selenium on nutrient uptake and alfalfa productivity. The results also indicated that foliar spraying significantly increased absorption of Iron, Zinc, and Selenium in plants.

MATERIALS AND METHODS

The experiment was conducted in lath house belonging to Horticulture Department, College of Agricultural Engineering Sciences, University of Baghdad, for autumn season of 2020-2019 and spring season of 2021-2020 on *Gazania splendens* plants. The plants were obtained from a private nursery in Baghdad city and were initially planted in plastic pots with a diameter of (20 cm) filled with a growing medium consisting of vermiculite and peat moss at a ratio of 3:1. The plants were planted on 3/12/2019 for autumn season and on 15/4/2020 for spring season. Study included two factors: foliar spraying of plants with chelated Calcium at concentrations of 1, 2, and 4 g L^{-1}, and foliar spraying of plants with chelated Iron at concentrations of 1 and 2 g L^{-1}. Additionally, there was a control treatment where plants were sprayed with distilled water only for both factors. The plants were sprayed with both elements twice, with first spray on 14/1/2021 and 1/5/2021 for autumn and spring, respectively, 40 days after planting. The second spray was applied 21 days after first spray. The control plants were sprayed with distilled water. A 48-hour interval was left between spraying of each element in both sprays. Data were recorded after completion of flowering at the end of June 2021. All plants were fertilized with terra-sorb complex foliar fertilizer every 15 days at a rate of 1.5 ml L^{-1} water. Table (1) shows the fertilizer components.

Table 1. Components of terra-sorb complex foliar fertilizer

Organic N %	Total N %	Amino acid %	Organic materials %	Boron %	MgO %	Fe %	Molybdenum %
5	5.5	20	35	1.5	0.8	1	0.1

Statistical analysis

The study was conducted as a factorial experiment according to a Randomized Complete Block Design (R.C.B.D) with three replications, each replicate containing twelve treatments, and each treatment comprised five plants. Soil analysis was performed before planting to determine chemical and physical properties of soil (analysis was conducted in laboratories of Soil and Water Resources Department, College of Agricultural Engineering Sciences, University of Baghdad).

RESULTS AND DISCUSSION

Vegetative growth traits: The results from Table (2) indicate a significant influence of foliar application of Calcium nitrate on vegetative growth traits in both seasons. The results showed that treatment Ca_2 outperformed in leaf height (cm) and number of leaves (leaf $plant^{-1}$) for the autumn season, at 18.97, 29.39 respectively, compared to control treatment of 18.00 and 25.38 respectively. In addition, treatment Ca_3 outperformed in chlorophyll content (mg/100 g fresh weight), leaf area (cm^2), and fresh and dry weight (g $plant^{-1}$) at 204.69, 10.10, 58.89, 8.76 respectively for autumn season, compared to control treatment at 182.33, 7.92, 48.81, and 5.82 respectively. Moreover, in spring , the same treatment showed good performance in all traits, including plant height (cm), number of leaves (per plant), chlorophyll content (mg/100 g fresh weight); , leaf area (cm^2), . Also that the fresh and dry weights (g $plant^{-1}$), at 23.60, 36.71, 251.77, 15.12, 70.66, 9.88, respectively, as compared to the control also 20.69, 32.21, 200.56, 9.47, 53.45 and 6.4 respectively.

Table 2. Effect of foliar application with chelated Calcium on vegetative traits of Gazania splendens for Autumn and spring seasons

Calcium level	Autumn season						Spring season					
	Plant height (cm)	Leaf number Plant^{-1}	Chlorophyll content (mg/100 g fresh weight)	Leaf area (cm^2)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})	Plant height (cm)	Leaf number Plant^{-1}	Chlorophyll content (mg/100 g fresh weight)	Leaf area (cm^2)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})
Ca_0	18.00	25.38	182.33	7.92	48.81	5.82	20.69	32.21	200.56	9.47	53.45	6.40
Ca_1	18.43	29.29	201.67	9.23	49.64	6.79	22.32	35.49	231.92	12.27	54.85	7.75
Ca_2	18.97	29.39	194.30	9.30	55.72	8.18	23.54	36.21	229.27	13.78	61.85	9.25
Ca_3	18.96	27.75	204.69	10.10	58.89	8.76	23.60	36.71	251.77	15.12	70.66	9.88
$LSD_{0.05}$	0.71	2.68	2.53	0.67	4.27	0.75	0.63	1.954	2.944	0.85	4.83	0.84

The results from Table (3) reveal a significant impact of foliar application of Iron sulfate on vegetative growth traits in both seasons. The findings demonstrate the superiority of treatment Fe_1 in leaf height (cm) and leaf count (per plant) during autumn season, reaching 19.22 and 31.72 respectively, compared to control treatment, which reached 18.1 and 25.12 respectively. In addition, treatment Fe2 outperformed in chlorophyll content (mg/100 g fresh weight), leaf area (cm^2), and fresh and dry weight (g plant^{-1}) at 211.57, 9.74, 59.38, 8.76 respectively for autumn season, compared to control treatment at 183.99, 8.82, 46.99, 6.31 respectively. Moreover, in spring, the same treatment showed good performance in all traits, including plant height (cm), number of leaves (per plant), chlorophyll content (mg/100 g fresh weight); , leaf area (cm^2), . Also that fresh and dry weights (g plant^{-1}), at 24.03, 37.29, 247.04, 13.70, 67.03, 9.92, respectively, as compared to control also 20.76, 32.22, 214.53, 11.47, 53.25, 7.00 respectively.

Table 3. Effect of foliar application with chelated Iron on vegetative traits of *Gazania splendens* for Autumn and spring seasons

Calcium level	Autumn season						Spring season					
	Plant height (cm)	Leaf number Plant^{-1}	Chlorophyll content (mg/100 g fresh weight)	Leaf area (cm^2)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})	Plant height (cm)	Leaf number Plant^{-1}	Chlorophyll content (mg/100 g fresh weight)	Leaf area (cm^2)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})
Fe_0	18.12	25.12	183.99	8.82	46.99	6.31	20.76	32.22	214.53	11.47	53.25	7.00
Fe_1	19.22	31.72	191.68	8.85	53.42	7.09	22.83	35.95	223.57	12.81	60.33	8.03
Fe_2	18.42	27.02	211.57	9.74	59.38	8.76	24.03	37.29	247.04	13.70	67.03	9.92
$LSD_{0.05}$	0.62	2.32	2.19	0.58	3.69	0.65	0.545	1.692	2.55	0.739	4.183	0.732

The result showed a significant interaction in some traits between foliar spray of Calcium nitrate and foliar spray of Iron sulfate on vegetative growth traits of *Gazania splendens* in both Autumn and spring seasons Table (4). Treatment Fe_2Ca_3 excelled significantly in chlorophyll content of leaves (mg 100^{-1} g fresh weight) for the autumn season, at 225.46 mg 100^{-1} g, compared to control treatment, at 180.91 mg 100^{-1} g. Similarly, the same treatment outperformed for spring season in both plant height (cm) and chlorophyll content of leaves (mg 100^{-1} g fresh weight), at 26.53 and 277.32 respectively, compared to the control treatment, which reached 19.2 and 199.0 respectively.

Table 4. Effect of foliar application with chelated Calcium and chelated Iron on vegetative growth traits of Gazania splendens for Autumn and spring seasons

Traits		Autumn season						Spring season					
		Plant height (cm)	Leaf number Plant^{-1}	Chlorophyll (mg/100g fresh weight)	Leaf area (cm^2)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})	Plant height (cm)	Leaf number Plant^{-1}	Chlorophyll (mg/100 g fresh weight)	Leaf area (cm^2)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})
Fa_0	Ca_0	17.50	26.77	180.91	7.50	38.94	5.14	19.02	30.33	199.0	8.73	42.64	**5.65**
	Ca_1	18.60	27.55	187.59	9.00	39.99	5.88	21.43	33.04	215.73	11.47	44.19	**6.71**
	Ca_2	18.60	24.00	171.83	9.00	51.88	6.34	22.2	32.81	202.76	12.1	57.59	**6.98**
	Ca_3	17.80	22.16	195.64	9.80	57.16	7.86	20.37	32.71	240.64	13.57	68.59	**8.65**
Fa_1	Ca_0	18.50	33.22	177.13	8.00	52.11	5.39	21.1	33.1	194.84	9.53	57.06	**5.93**
	Ca_1	19.10	32.00	196.99	8.50	49.65	6.13	22.53	35.77	226.54	12.6	54.87	**6.99**
	Ca_2	19.30	27.00	199.61	9.41	54.27	8.48	23.77	37.37	235.54	14.43	60.24	**9.67**
	Ca_3	19.97	34.66	192.98	9.50	57.63	8.37	23.9	37.55	237.37	14.67	69.16	**9.54**
Fa_2	Ca_0	18.00	28.16	188.95	8.25	55.38	6.92	**21.93**	**33.21**	207.85	10.13	60.64	**7.61**
	Ca_1	17.60	28.33	220.42	10.20	59.27	8.37	**23**	**37.65**	253.48	12.73	65.5	**9.54**
	Ca_2	19.00	25.16	211.45	9.50	61.01	9.73	**24.67**	**38.45**	249.51	14.8	67.72	**11.09**
	Ca_3	19.10	26.44	225.46	11.00	61.87	10.04	**26.53**	**39.86**	277.32	17.13	74.24	**11.44**
$LSD_{0.05}$		N.S	N.s	4.37	N.S	N.S	N.S	1.091	N.S	5.1	N.S	N.S	N.S

Flower growth traits

The results from Table (5) indicate a significant effect of foliar application of Calcium nitrate on floral growth traits in both seasons. The results indicate that treatment Ca_4 showed significant superiority in various parameters during autumn, including flowering time (11.08 days), flowering diameter (7.61 cm), fresh weight (12.23 g plant^{-1}), Dry weight (2.30 g plant^{-1}) , compared to the control, with respective (9.50 days , 6.11 cm, 10.05 g plant^{-1}, and 1.47 g plant^{-1}). values recorded as well as in the spring period treatment Ca_4 in general, with values for flowering time, number of flowers, fresh weight and dry weight, respectively (12.79 days, 7.78 flowers/plant, 14.55 g plant^{-1} and 2.72 g plant^{-1}); , compared to the control treatment of (10 .64 days, 6.80 flowers/ plant, 11.36 g plant^{-1}, and 1.69 g plant^{-1}) respectively. Our results wre in line with (26, 27.

Table 5. Effect of foliar application with chelated Calcium on floral growth of Gazania splendens for Autumn and spring seasons

Calcium level	Autumn season						Spring season					
	flowering time (days)	flowering date (days)	Number of flowers Plant^{-1}	Flower diameter (cm)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})	flowering time (days)	flowering date (days)	Number of flowers Plant^{-1}	Flower diameter (cm)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})
Ca_0	9.50	66.59	5.81	6.11	10.05	1.47	10.64	70.58	6.80	6.66	11.36	1.69
Ca_1	10.72	59.71	6.27	6.70	10.66	1.81	11.20	67.47	7.53	7.31	12.57	2.10
Ca_2	10.59	60.25	7.02	7.09	11.58	2.04	11.84	65.67	7.22	8.58	13.66	2.45
Ca_3	11.08	55.87	6.86	7.61	12.23	2.30	12.79	60.90	7.78	8.29	14.55	2.72
$LSD_{0.95}$	0.46	2.26	0.43	0.61	0.61	0.20	0.505	2.443	0.486	0.682	0.716	0.227

The results of Table (6) show that foliar application of chelated Iron improved all flowering traits of treated gazania plants Fe_2 treatment flowering time (days), number of flowers (flowers plant^{-1}) , Flower diameter(cm) , Fresh weight(g plant-1) and Dry weight (g plant-1) was 11.72 , 7.09 , 7.70 , 11.94 and 2.24 respectively, compared to control treatment of 9.06, 5.67 , 6.10, 10.06, and 1.62 In autumn, the same treatment for the spring season showed higher mean values in all flowering traits of 13.00, 8.00, 8.64, 13.98, and 2.63, respectively, compared to control treatment of 10.67, 6.42, 6.84, 11.78, and 1.90, respectively.

Table 6. Effect of foliar application chelated Iron on flower growth traits of Gazania splendens for Autumn and spring seasons

Fe level	Autumn season						Spring season					
	flowering time (days)	flowering date (days)	Number of flowers Plant^{-1}	Flower diameter (cm)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})	flowering time (days)	flowering date (days)	Number of flowers Plant^{-1}	Flower diameter (cm)	Fresh weight (g plant^{-1})	Dry weight (g plant^{-1})
Fe_0	9.06	64.01	5.67	6.10	10.06	1.62	10.67	69.93	6.42	6.84	11.78	1.90
Fe_1	10.64	61.56	6.72	6.83	11.39	1.86	11.19	67.18	7.58	7.65	13.35	2.19
Fe_2	11.72	56.25	7.09	7.70	11.94	2.24	13.00	61.36	8.00	8.64	13.98	2.63
$LSD_{0.05}$	0.39	1.95	0.37	0.52	0.53	0.17	0.437	2.116	0.421	0.591	0.62	0.197

The interaction effect, as shown in Table (7), between foliar application of chelated Calcium and chelated Iron had a significant superiority in some floral growth traits of *Gazania splendens* plants for both the autumn and spring seasons. Treatment Fe_2Ca_3 outperformed significantly in flowering period (days) , number of flowers (flower plant^{-1}), Flower diameter(cm) and Fresh weight (g plant^{-1}) reaching 12.34,7.83,8.46 and 12.48 respectively for autumn season, compared to control treatment, which reached 7.70, 5.17, 5.15 and 9.38 respectively. Similarly, in the spring season, the same treatment excelled in Number of flowers Plant-^{1} and fresh weight (g plant^{-1}), reaching (8.45, 15.28) respectively, compared to the control treatment, which reached (6.05, 10.60) respectively.

Table 7. Effect of foliar application chelated Calcium and chelated Iron on the floral growth traits of Gazania splendens for Autumn and spring seasons

Treatments		Autumn season						Spring season					
		flowering time (days)	flowering date (days)	Number of flowers Plant^{-1}	Flower diameter (cm)	Fresh weight (g)	Dry weight (g)	flowering time (days)	flowering date (days)	Number of flowers Plant^{-1}	Flower diameter (cm)	Fresh weight (g)	Dry weight (g)
	Ca_0	7.70	65.89	5.17	5.15	9.38	0.87	8.63	69.84	6.05	5.61	10.60	1.02
Fa_0	Ca_1	9.80	65.18	5.80	6.18	8.97	1.27	10.14	73.66	6.96	6.74	10.59	1.45
	Ca_2	9.39	68.75	6.30	6.37	10.47	2.26	11.36	74.94	5.86	7.71	12.36	2.72
	Ca_3	9.35	56.23	5.42	6.70	11.41	2.06	12.56	61.29	6.80	7.31	13.58	2.43
	Ca_0	9.85	67.44	5.78	6.20	9.89	1.47	11.03	71.49	6.76	6.76	11.17	1.68
Fa_1	Ca_1	10.83	58.73	6.29	6.55	11.31	1.80	10.10	66.36	7.55	7.14	13.35	2.10
	Ca_2	10.32	58.98	7.48	6.90	11.93	1.69	11.14	64.29	7.93	8.34	14.07	2.03
	Ca_3	11.55	61.08	7.34	7.66	12.43	2.49	12.48	66.58	8.07	8.35	14.80	2.94
	Ca_0	10.96	66.44	6.50	6.96	10.98	2.07	12.27	70.43	7.60	7.59	12.30	2.36
Fa_2	Ca_1	11.52	55.22	6.73	7.38	11.69	2.36	13.36	62.40	8.07	8.04	13.79	2.76
	Ca_2	12.06	53.02	7.29	8.01	12.33	2.18	13.03	57.79	7.88	9.69	14.55	2.61
	Ca_3	12.34	50.31	7.83	8.46	12.48	2.36	13.32	54.83	8.45	9.22	15.28	2.78
$LSD_{0.05}$		0.79	3.91	0.75	N.S	N.S	0.34	0.874	4.232	N.S	N.S	N.S	0.394

Reason for improvement in vegetative growth indicators of plant may be attributed to its role in process of cell division and differentiation, as it is an important element in cell walls and plays an important role in their elongation (2; 10 ; 23), which was reflected in plant height , number of leaves and leaf area, and has a positive effect on concentration of chlorophyll a and b and carotenoids important in photosynthesis process (17) as well as its effect on the activation of some enzymatic systems that are believed to be related to formation of chlorophyll, which in turn caused an increase in chlorophyll pigment, which increased products of Carbon metabolism and accumulated processed substances in plant such as Carbohydrates and proteins, thus increasing the wet and dry weight of vegetable collection (14; 38). Increase in vegetative growth indicators when spraying with chelated Iron may be due to its vital role in plant, as Iron in composition of oxidative and reductive enzymes, as well as improving enzymatic activities that help enhance physiological processes (20; 19), which reflected positively on vegetative indicators such as plant height, leaf number and leaf area, especially since the Iron used is Fe- chelated Iron EDDHSA, which remains stable in a wide range of pH between 4-6 and is available for absorption to

increase efficiency of its use, as well as its important role in building chlorophyll (6) due to its direct impact on the formation of Amino acids, carbohydrates and energy compounds that improve plant growth and chloroplast functions, enhance rate of photosynthesis (29) and accumulate its products that increase fresh and then dry weight of vegetative group. The positive effect of interaction may be due to role of each element in improving vegetative characteristics, as well as the effect of two factors in various biological processes such as cell division, hormonal balance, and Carbon metabolism, or it may be attributed to growth stimulating effect achieved by these nutrients by directly supplying elements to active centers of biological processes in the plant as well as reducing the energy consumption required for its transport within plant (15). Improvement of vegetative growth indices of Gazniaa plant when sprayed with nutrients, including Calcium and chelated Iron, may be due to their role in many vital activities necessary for plant growth throughout growing season, which is reflected in vegetative growth indices by increasing number of leaves, leaf area, dry weight, and total chlorophyll concentration in leaves Table (3). This leads to an increase in plant's efficiency in photosynthesis process, which increases its primary and secondary products, which improve the flowering indices in terms of early flowering, flower duration, number and diameter of flowers, and ultimately increasing the fresh and dry weight of flowers. The final yield of flowers depends mainly on growth of leaves and is closely related to the efficiency of photosynthesis in the leaf area unit and leaf surface area. Iron works to increase the activity of photosynthesis and respiration, which is reflected in increase in nutrient absorption and increase in average division and elongation of cells, while Calcium contributes to elongation and division of cells as well as encourages the early development and growth of plant (4; 5; 10, 11, 40), or perhaps it is attributed to their role in preparing plant with nutrition, especially in early stages of plant's life, which leads to the formation of a good vegetative growth that makes plant capable of responding to requirements that encourage flowering, as well as increasing products of photosynthesis and carbohydrates, which is reflected in ratio of Carbon to Nitrogen, which has a positive correlation in initiation of flower buds (36). The response of plants to concentrations of chelated Calcium was large and clear. The effect of concentration of 4 mg L^{-1} was more significant in vegetative and flowering growth characteristics compared to other concentrations, and response of plants to spraying with chelated Iron at a concentration of 2 mg L^{-1} was very clear in studied characteristics, both vegetative and florally.and the interaction in studied factors was significant for some vegetative and flowering characteristics.

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