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## **Effect of chelated calcium and iron foliar spraying on growth and flowering of snapdragon (*Antirrhinum majus* L.)**

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**Abstract**--The experiment was carried out in the lath house at the Horticulture and Landscaping Department/College of Agriculture/University of Diyala, during the season 2015-2016 to study the effect of chelated calcium and iron foliar spray on growth and flowering of snapdragon plant (*Antirrhinum majus* L.). The experiment included six treatments: T1 = 0 (Spraying with distilled water only), T2 = 1.5 g.l<sup>-1</sup> chelated calcium, T3 = 3 g.l<sup>-1</sup> chelated calcium, T4 = 1 g.l<sup>-1</sup> chelated iron, T5 = 1.5 g.l<sup>-1</sup> chelated calcium + 1 g.l<sup>-1</sup> chelated iron and T6 = 3 g.l<sup>-1</sup> chelated calcium + 1 g.l<sup>-1</sup> chelated iron. The experiment was carried out using Randomized Complete Block Design (RCBD) with three replications. (Each treatment has six replicates (6 pots), one plant in each pot. The results showed that all the foliar spraying treatments with chelated calcium and iron led to a significant increase in all vegetative and floral growth characteristics studied except for inflorescence diameter in comparison with control treatment. Treatment of 3 g.l<sup>-1</sup> chelated calcium + 1 g.l<sup>-1</sup> chelated iron was surpassed and gave the highest plant height (69.90 cm), number of main branches (5.67 branch.plant<sup>-1</sup>), number of leaves (27.33 leaf.plant<sup>-1</sup>), leaves content of chlorophyll (44.90 SPAD), main stem diameter (3.82 mm), number of inflorescences (5.25 inflorescence.plant<sup>-1</sup>), number of florets (17.80 floret.inflorescence<sup>-1</sup>), length of spike (53.70 cm) and early date of flowering (134.60 days).

**Keywords**---*Antirrhinum majus*, chelated calcium, chelated iron, vegetative growth, floral growth.

## Introduction

*Antirrhinum majus* L. popularly known as snapdragon is an annual flower with magnificent colours and curious shape (Huxley, Griffiths Levy, 1992). Snapdragon can be grown for edging, pots and window boxes, other types of the flowers can be used for hanging baskets (Alchlabi and Alkait, 2005; Alshaib 2005). Recently, there has been increased in the production of this flowers, a flower with a wide range of colors and relatively long vase life and remarkable spike-type form (Shiva and Singh, 2006). The cut flowers was less than 3 billion in 1950s, by 1992 reached 100 billion USA dollars. Recently, the flowers industry is increasing by 0.06 annually and the flower trade reached US\$101.84 billion (Anon, 2010). Foliar application is an alternative method to overcome problems such as nutrient shortage in soils (Sarkar et al., 2007; Cakmak, 2008). Foliar spray can be helpful to solve problems such as soils/growth media fixation of some nutrients especially in a soil with high pH value (El-Naggar, 2009). Another advantage of foliar application is that, it can improve the quality of cut flowers and fruits (Sajid et al., 2009; Khalid et al., 2012). Folia application can enhance the nutrient absorption by the roots to the same nutrients which results in improve plants root and lead to increase in nutrient absorption (Mia, 2015). Kashif et al., (2014) claimed that foliar application can reduce water and soil pollutions.

Calcium is a necessary element to most lives and to develop and growth of plants. Some of calcium functions in plants are, cell wall deposition as the calcium hold together the cell wall of plants, extend the cut flowers lifetime and improve plant resist to diseases. Calcium is immobilize element in plants, thus, it should be supplied regularly (Ruscigno and Larson Meyer, 2019). Torre et al., (1999) stated that the addition of calcium to (type of the plant 500 ppm or less/more) extend plants lifetime, improve buds opening and increase the flowers size. In another study conducted by AbdEl-Gawad et al., (2013) showed that then addition of 750 ppm of chelate calcium mixed with ammonium nitrate increase numbers of leaves, leaf area, dry matter and the chlorophyll index compared to the control treatment. Iron is an essential element for plants but due to its low solubility, iron availability to plants is very low specially in arid regions (Eskandari, 2011). However, iron is one of the micronutrient, it is the most needed element by plants (Taiz and Zeiger, 2010). Iron is an essential element for several important enzymes in plants including synthesize chlorophyll, maintain the structure of chloroplasts, cytochrome that is involved in electron transport chain and enzyme activity (Welch, 2002; Zaharieva and Abadia, 2003; Ziaecian and Malakouti, 2006). The lake of iron in plants lead to decrease in chlorophyll thus a reduction of plants production may be occurred (Mia, 2015). The iron absorption by plants can be improved.

The iron chelate Fe-EDTA is the best form of iron which can be absorbed by plants but the absorption rate can be effected by the soil conditions and specially the pH (Khoshhoy et al. 2005). The chelators prevent the metals ions from being leachate which lead to increasing the ions in the soil (Malakooti and Samar.

1998). It was stated by Amuamuha et al. (2012) that spraying plants with 1 g.L<sup>-1</sup> iron increased the flowers number in the plant as well as aromatic oils in the chrysanthemum petals. From the previous literature, it can be seen that spraying plants with foliar fertilizers improved vegetative and floral growth. It is also showed that spraying plants with a combination of calcium and iron chelate have not been examined on snapdragon, thus, the aim of this research is to investigate the effect of these two elements on snapdragon.

### Material and Methods

The experiment was conducted in the lath house at the Research Station of The Department of Horticultural and Landscape, Agriculture Collage, The University of Diyala in 2018-2019. The seed were saw in cell trays (Tray types Dimensions of a cell 2x2 cm in each try 209 cells) on 03/10/2018. The seedlings were transferred when they reached around 10 cm height to the pots (15 cm Height and 25 cm diameter) contained 2:1 of loamy soil: peat moss. The soil were analyzed at The Soil and Water Resource Department, Agriculture Collage, University of Baghdad as shown in Table 2. The experiment treatments is shown in Table 1. The plants were sprayed three times during the test on a period of two weeks between each spraying time. After four weeks the treatments (spraying) was started as shown in Table 3.

Table 1  
The Experiment Treatments

Treatment s	Fertilizer concentration (g.L <sup>-1</sup> )	Fertilizer type
T1	0	Distilled water only (DW)
T2	1.5	Calcium chelate (CaCh)
T3	3	Calcium chelate (CaCh)
T4	1	Iron chelate (FeCh)
T5	1.5 + 1	Calcium chelate (CaCh) + iron chelate (FeCh)
T6	3 + 1	Calcium chelate (CaCh) + iron chelate (FeCh)

Table 2  
The Experiment Spraying Time

Time/ Weeks	Time/ Days	Treatments					
		T1	T2	T3	T4	T5	T6
Week 5	Day 1	DW	1.5 CaCh	3 CaCh	1 FeCh	1.5 CaCh	3 CaCh
	Day 4					1 FeCh	1 FeCh
Week 7	Day 1	DW	1.5 CaCh	3 CaCh	1 FeCh	1.5 CaCh	3 CaCh
	Day 4					1 FeCh	1 FeCh
Week 9	Day 1	DW	1.5 CaCh	3 CaCh	1 FeCh	1.5 CaCh	3 CaCh
	Day 4					1 FeCh	1 FeCh

The plants were subjected to another 2.5 g.L<sup>-1</sup> foliar fertilizer (Growmore) which was supplied each two weeks to all treatments. Table 4 shows the fertilizer (Growmore) characteristics. The plant vegetative parameters such as plant height, number of brunches, number of leaves, chlorophyll content and the steam dimeter were taken during the test. The flowering growth such as number of inflorescences, the inflorescence height, number of flowers in an inflorescence, inflorescence dimeter and the flowering date.

Table 3  
Soil Physiochemical Characteristics

Characteristics	Values
pH	7.20
EC dS.m <sup>-1</sup>	3.83
Available N mg.kg <sup>-1</sup>	41
Available P mg.kg <sup>-1</sup>	52
Available K mg.kg <sup>-1</sup>	211
Organic matter %	2.50
Sand g.kg <sup>-1</sup>	630
Silt g.kg <sup>-1</sup>	240
Clay g.kg <sup>-1</sup>	46
Soil texture was Sandy Loam	

Table 4  
The percentages of

Total nitrogen	P2O5	K2O	B	Cu	Fe	Mn	Mo	Zn
20%	20%	20%	0.02%	0.05%	0.1%	0.5%	0.0005 %	0.05 %

### Statistical Analysis

The RCBC design was used in this test with three replications of each treatment. Each treatment has six pots and each pot has one plant. The analysis was undertaken using the GenStat and LSD test was performed at a significant level of  $P < 0.05$ .

### Results and Discussion

#### The Impact of Foliar on Plant Vegetative Characteristics

Table 5 shows that the spraying of calcium and iron chelate resulted in a significant increase in plant heights comparing to untreated plants. The highest plant height was 69.70 cm in T6 (3 + 1 g.L<sup>-1</sup>). The number of branch also was significantly increased to be 5.67 branch.plant<sup>-1</sup> in T6 comparing to the control and other treatments. There was also a significant increase in the number of leaves (27.33 leaf.plants<sup>-1</sup>), chlorophyll index (44.90 unit) and the steam dimeter (3.82 mm) in T6.

Table 5  
The Impact of Foliar (Calcium and Iron Chelate) on Plant Vegetative Characteristics

Treatments	Plant height (cm)	Number of branch (branch.plant <sup>-1</sup> )	Number of leaves (leaf.plant <sup>-1</sup> )	Chlorophyll index (unit)	The steam dimeter (mm)
T1	63.70	3.75	23.08	39.40	3.27
T2	65.00	5.08	24.08	40.70	3.28
T3	66.30	5.25	24.25	43.60	3.42
T4	67.80	5.17	24.17	41.80	3.27
T5	69.30	5.25	25.42	44.40	3.64
T6	69.70	5.67	27.33	44.90	3.82
LSD 0.05	4.570	0.185	2.267	1.140	0.486

### The Impact of Foliar on Plant Flowering Characteristics

As illustrate in Table 6, there was a significant impact of spraying plants with 3 g.L<sup>-1</sup> chelated calcium + g.L<sup>-1</sup> chelated iron (T6) on the number of inflorescences (5.25 inflorescence.plant<sup>-1</sup>) comparing to the control treatment. There was also a significant increase in T6 in the number of flowers (17.80 flower.inflorescence<sup>-1</sup>) in inflorescence followed by T5 with 17.70 flower.inflorescence<sup>-1</sup>. Treatment 6 also significantly increased the height of clusters to be 53.70 cm followed by T5 to be 52.70 cm. finally, the T6 significantly increased the inflorescence dimeter as well as flowering date was earlier by (6 days) in T6 comparing to the other treatments.

Table 6  
The Impact of Foliar (Calcium and Iron Chelate) on Plant flowering Characteristics

Treatmen ts	Number of inflorescence (inflorescence.plant <sup>-1</sup> )	Number of flowers (flowers.plant <sup>-1</sup> )	Inflorescence dimeter (cm)	Cluste r height (cm)	Date of flowering (day)
T1	3.33	16.60	6.09	43.80	140.60
T2	3.50	16.97	6.17	44.50	137.20
T3	4.67	17.58	6.63	44.90	137.70
T4	4.33	17.27	6.62	46.30	136.80
T5	4.92	17.70	6.98	52.70	134.80
T6	5.25	17.80	7.52	53.70	134.60
L.S.D 0.05	1.395	1.180	N.S.	9.060	5.890

### Discussion

From the results of this study, it can be seen that treating plants with calcium and iron chelate significantly increased most of snapdragon vegetative and flowering characteristics. Where T6 positively affected the plant height, number of branch, number of leaves, leaf area, chlorophyll index, the main steam dimeter, number of clusters, number of flowers in a cluster, the height of clusters and

flowering date. The positive effect of spraying plants with calcium chelate could be due to that the efficiency of absorbing calcium is higher when calcium applied to the plant in a form of chelated calcium, it also chelate make the nutrient available to the plants for long time (Robichaux, 2008). It also could be due to that the importance of calcium in plant tissues as calcium is a vital component in plant cells, hormonal and enzymatic processes (Poovaiah, 1986). Another reason could be that the iron contribution in the chloroplast structure and their protein (phytoferritin) and the iron roles as a constituent of several enzymes in plants (Oh et al, 1996). In addition, iron is contribution in forming ferredoxin which is Fe/S protein in the protoplast (Abodahy and Alyounis, 1988). In term of improving the vegetative characteristics, this could be a result of improving the photosynthesis and other metabolism activities which lead to improving in the cell growth and division (Hatwar et al, 2003).

### Conclusion

To conclude this work, it can be seen that the most significant effect was accorded by spraying plants with treatment six (T6) which is 3 g.L<sup>-1</sup> of Calcium chelate (CaCh) + 1 g.L<sup>-1</sup> iron chelate (FeCh). Hence, we recommend further investigation on the use of calcium chelate and iron chelate on deferent plants with the same concentration or deferent concentrations. We also recommend investigating the economic effect of using such fertilisers on plants.

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