



Influence of Soaking With Salicylic Acid (SA) and Spraying With Calcium Nitrate (CaNO₃) on Growth, Flowering, and Bulbs of Three *Hyacinthus Orientalis* Cultivars

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Received:11/08/2025

Revised: 13/11/2025

Accepted: 01/03/2026

Published: 10/03/2026

ABSTRACT

This study was conducted out in Pirmam /Erbil Governorate for the period from October 15th 2024 to May 25th 2025. To study the effect of salicylic acid soaking and calcium nitrate spraying on growth, flowering, and bulbs of three *Hyacinthus orientalis* cultivars includes: (Fondant, Carnegie, Blue jacket), bulbs were soaked with different concentrations of salicylic acid primer (0 and 100 mgL⁻¹) for 24 hour. Different concentrations of CaNO₃ (0, 500, 1000) mgL⁻¹ were treated using foliar spray. A field experiment was carried out according to Randomized Completely Block Design (RCBD).

Results indicated that the cultivars had a significant effect the highest values of 37.72 days, 10.77 cm and 50.00 cm³ for sprouting date, length flowers spike and bulb size, respectively, were recorded for Blue jacket cultivar, and the highest values of 27.38 cm, 155.35 cm² 3.39 g and 19.28 days were recorded for plant height, leaf area, leaves dry weight and flower coordination date, respectively, of Fondant cultivar, while Carnegie cultivar recorded the highest value for flowering date 112.11 days. The triple interaction among the levels of the studied factors led to clear significant differences in the averages of the studied traits, as the Carnegie cultivar not soaked in SA and unsprayed with calcium nitrate gave the highest significant values of sprouting date 48.00 days.

The bulbs of the Fondant cultivar soaked in 100 mgL⁻¹ of SA and sprayed with 1000 mgL⁻¹ of calcium nitrate gave the highest values of plant height, leaf area, leaves dry weight and chlorophyll content 29.20 cm, 180.12 cm², 5.33 g and 57.26, respectively. Also, the higher values reaching 113.00 days for the bulbs of Blue jacket cultivar not soaked in SA and sprayed with 1000 mg.l-1 concentration of calcium nitrate. As for the Fondant bulbs cultivar soaked in 100 mgL⁻¹ of SA and sprayed with 500 and 1000 mg.L-1 concentrations of calcium nitrate. They gave the highest significant value of flowering coordination date 21 days, while the lowest value 12.33 days was for the Carnegie cultivar bulbs not soaked in SA and unsprayed with calcium nitrate.

The results of length of flower spikes and bulbs size showed a clear significant difference among treatments, where the highest significant value of 11.97 cm and 57.00 cm³ were recorded in Blue jacket cultivar bulbs soaked in 100 mgL⁻¹ of SA and sprayed with 1000 mg.L-1 of calcium nitrate.

Keywords: Salicylic acid , Calcium nitrate ,Cultivars ,Hyacinthus, Plants.

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INTRODUCTION

Hyacinthus orientalis L., a herbaceous bloom from the Liliaceae family [1], holds significant value due to its use in flower pots and in water gardens within private and public landscapes [2]. This bulbous plant is a known spring-flowering species and is popular as a cut flower [3]. Hyacinth thrives in a Mediterranean climate, favoring cooler temperatures while exhibiting resistance to cold, yet it struggles with high heat and drought conditions. Typically, hyacinths bloom from March to April, marking them as renowned autumn bulb flowers [4, 5]. *Hyacinthus orientalis*, a bulb-producing species, is frequently utilized in floral arrangements and thrives in spring flower beds across green spaces. These hyacinths sprout in spring from stems that emerge from bulbs buried underground in early autumn [6]. [7] Indicated that cultivar response is shaped by both environmental conditions and genetic makeup. In their research, they assessed the growth of four *Gladiolus alatus* cultivars: Florared, Fado, Madriver, and Pietmohlen. The study

revealed significant variances among the cultivars concerning most vegetative and blooming traits, with the Pietmohlen cultivar showing notable superiority in traits such as leaf length, leaf area, flowering length, and both the quantity and size of florets per plant. The Florared cultivar produced the highest leaf count (7.50 leaves per plant) and had the longest vase longevity (5.08 days). Various techniques are employed to treat ornamental species, including bulbs with growth regulators, though the most prevalent methods involve either spraying the plants or soaking the bulbs for a designated period prior to planting. The plant responses to these techniques rely on factors such as the absorption of the growth regulator and the surrounding environmental conditions. The soaking method is utilized to break the dormancy period many bulbs undergo [8].

[9] elucidated that soaking *Gladiolus* corms of varieties Darshan and Dhiraj in 2% Thiourea, 150 ppm Salicylic acid, 150 ppm GA, or 15% Potassium for 12 or 42 hours improved corm germination rates, increased bud counts per corm, and enhanced the corm size and yield of corms produced by the plants. Salicylic acid (SA) is a potent phytohormone with various impacts on plant metabolism, recognized as a phenolic plant growth regulator that affects the growth and productivity of crops [10].

Furthermore, [11] noted that SA at a concentration of 100 mg.L⁻¹ enhanced growth metrics of *gladiolus* plants such as leaf length, leaf count, spike length, as well as overall growth metrics including fresh mass, dry mass, and root length. [12] reported that soaking *Iris hollandica* bulbs in salicylic acid at concentrations of (50, 100, 150) mg.L⁻¹ found that 200 mg.L⁻¹ yielded the maximum height of 78.90 cm, with 8.25 leaves per plant and total chlorophyll content of 66.92 mg/100 g of fresh weight. Floral characteristics were influenced regarding flower quantity (2.92 flowers per plant), flower diameter (10.99 cm), flower stalk length (48.21 cm), and flowering period (100.00 days).

Calcium nitrate plays a crucial role in managing growth and development in plants and is vital for cell wall formation. Proper nutrition is a key element in plant growth and development, with nitrogen serving as an essential component of plant life, typically absorbed in the form of NO⁻³ or, at times, NH⁺⁴. It is integral to amino acids, proteins, nucleic acids, and nucleotides, and stands as one of the most crucial elements in energy compounds like ATP, NADH, NADPH, and chlorophyll pigments [13]. Calcium is pivotal in enhancing performance and quality [14,15]. Additionally, it influences cell wall integrity and acts as the final barrier before cell separation [16]. Ca⁺⁺ serves as a universal second messenger, recognized for its role in various signaling pathways, including those associated with cell wall defense [17].

Calcium serves as a crucial nutrient and plays a significant role in combatting diseases due to its involvement in the protection of cell walls and its critical biochemical functions. It facilitates numerous metabolic activities and activates various enzymatic processes [18].

Calcium is vital for maintaining the integrity of plant cells, enhancing their strength and cohesion by providing stability and consistency to cell membranes. As a result, calcium's influence on improving the quality of flowers during both vegetative and flowering phases is clear. It helps alleviate the impact of salt stress on plants and increases the toughness and thickness of cell walls, fortifying them. The floral stem benefits, as it assists in regulating water balance in the flower, prevents the bending of the flower neck, and ensures the flower opens fully, while also reducing senescence rates and extending flower longevity [19, 20,].

[21] conducted a study to assess how the *gladiolus* variety "Summer Sunshine" responded to foliar applications of calcium nitrate and calcium carbonate. They found that calcium nitrate was more effective in enhancing both vegetative and flowering traits, such as leaf area, the time taken for spikes to emerge, flower diameter, and spike length. [22] reported that *Aechmea fasciata* plants treated with various concentrations (0.25, 2.5, 5, 7.7, 10, 12.5 mmol plant⁻¹) experienced increases in plant height, stem diameter, as well as both wet and dry leaf weight and calcium content in the leaves.

This research was aimed at investigating the effects of soaking with SA primers and foliar applications at different concentrations of CaNO₃ on the vegetative growth, flowering, and bulb development in three cultivars of *Hyacinthus*.

Materials and Methods

A-Materials:

Site:

This study was conducted out in Pirmam /Erbil Governorate for the period from October 15th 2024 to May 25th 2025. The geographical location of the study area is located in the northeastern part of Iraq, at an altitude 1180 m above sea level and at the latitude (36.17-36.32°N) and longitude (44.00-44.24°E) in the city center.

Preparation of *Hyacinthus* cultivars:

To study the effect of salicylic acid soaking and calcium nitrate spraying on growth, flowering, and bulbs of three *Hyacinthus* cultivars includes: (Fondant, Carnegie, Blue jacket), bulbs were soaked with different concentrations of salicylic acid primer (0 and 100 mg L⁻¹) for 24 hour.

Different concentrations of CaNO₃ (0, 500, 1000) mgL⁻¹ were treated using foliar spray, with the initial spray applied

one month after leaves emergence, with a two-week intervals between subsequent sprays. In the early morning, the leaves were sprayed with a hand sprayer until wet. Using PVC pots with a diameter of 17 cm, the pots were filled with a mixture of loamy soil and peat moss with volume (1:1).

Table: Some physical and chemical properties of the medium used.

Soil texture	Soil texture					
	Clay (%)	Silt (%)	Sand (%)			
Sandy clay loam	21.6	20.1	58.3			
O.M (%)	K (ppm)	P (ppm)	N (%)	EC ds.m ⁻¹	pH	
1.13	123.6	16.5	0.15	0.4	7.31	

Design of the experiment:

The experimental treatments were arranged in a Factorial Randomized Complete Block Design (RCBD) experiment consisting of three factors. The study included (18) treatments ($3 * 2 * 3 = 18$ treatments) with three replicates, and each replicate was represented by a pot (17 cm) filled with a growth medium consisting of (loam + peat moss (1:1) as volume) planted with one bulb. Hence, the experiment required 54 bulbs (18 treatments * 3 replicates * 1 pot * 1 bulb = 54 bulbs, 18 bulbs for each cultivars). Studied parameters includes sprouting date (days), plant height (cm), leaf area (cm²), leaves dry weight (g), total chlorophyll content in leaves (SPAD), flowering date (days), coordination date (stay of flowers on plant (day)), length of flower spike (cm), bulbs volume (cm³), and dry weight of bulb (g).

Statistical Analysis of Data: The data were analyzed using SAS Computer Program, and means were compared using Duncan's multiple range test under 5% for determination the significant differences among the studied means as claimed by [23].

Results and Discussion

Effect of salicylic acid and calcium nitrate concentrations on some growth and flowering characteristics of *Hyacinthus cultivars plant*.

The features of sprouting date, plant height, leaf area, leaf dry weight, and chlorophyll content were all significantly impacted by the cultivars, according to the data in Table 1. The Blue Jacket cultivar had the greatest sprouting date of 37.72 days, whereas the Fondant cultivar had the maximum plant height, leaf area, and dry weight of 27.38 cm, 155.35 cm², and 3.39 g, respectively. Additionally, the findings demonstrated that soaking plant bulbs with varying salicylic acid concentrations significantly impacted these traits; the maximum values were noted for plant height of 23.99 cm and leaf dry weight of 3.67 g when soaking with a concentration of 100 mgL⁻¹ of SA. Additionally, research shown that foliar spraying plants with varying calcium nitrate concentrations significantly impacted these traits, with the highest values observed for plant height and leaf area. After being sprayed with a 1000 mgL⁻¹ concentration of calcium nitrate, the leaves' dry weight and chlorophyll content were measured at 24.47 cm, 155.56 cm², 3.67 g, and 55.05, respectively.

Table (1): Effect of salicylic acid and calcium nitrate concentrations on some growth and flowering characteristics of *Hyacinthus cultivars plant*.

Characteristics	Cultivars			Salicylic acid (SA) mg.L ⁻¹		Calcium Nitrate (CaNO ₃) mg L ⁻¹		
	Fondant	Carnegie	Blue jacket	0	100	0	500	1000
Sprouting date (Days).	20.22 c	34.50 b	37.72 a	34.33 a	27.30 b	32.11 a	30.67 ab	29.67 b
	± 2.22	± 3.45	± 3.44	± 3.34	± 3.77	± 3.12	± 3.67	± 3.88
Plant height (cm)	27.38 a	19.81 c	22.46 b	22.44 b	23.99 a	22.01 b	23.17 b	24.47 a

	±	±	±	±	±	±	±	±
	3.88	3.81	3.44	4.14	3.19	2.11	3.17	4.11
Leaf area (cm ²)	155.35 a	117.12 c	134.46	130.37	140.91 a	112.45	138.91 b	155.56 a
	±	±	b	a	±	c	±	±
	3.55	2.44	±	±	6.11	±	6.11	6.15
			4.16	3.17		5.44		
Leaves dry weight (g)	3.39 a	3.00 ab	2.67 b	2.37 b	3.67 a	2.22 b	3.17 a	3.67 a
	±	±	±	±	±	±	±	±
	0.33	0.34	0.35	0.37	0.36	0.31	0.31	0.13
Total chlorophyll content (SPAD)	53.89 a	53.48 a	49.49 b	51.37 a	53.20 a	48.62 b	53.19 a	55.05 a
	±	±	±	±	±	±	±	±
	3.11	3.14	3.16	3.18	3.19	3.17	3.17	3.15

Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Range test.

3.2 Effect of salicylic acid and calcium nitrate concentrations on some growth and flowering characteristics of *Hyacinthus cultivars* plant.

The data in Table 2 showed significant differences between the cultivars in these characteristics, where the Fondant cultivar significantly superior in flower coordination date 19.28 days, while Blue jacket cultivar recorded the highest values for length flowers spike, bulb size and bulb dry weight reaching 10.77 cm, 50.00 cm³ and 28.39 g, respectively, while Carnegie cultivar recorded the highest value for flowering date 112.11 days.

Soaking plant bulbs with different concentrations of salicylic acid had significant effects on these characteristics, with the highest values of 17.93 days, 10.37 cm, 50.48 cm³ and 26.33 g for flower coordination date, length of flowers spike, bulb size and bulb dry weight, respectively, when soaked in 100 mg.l⁻¹ of SA, while the highest value for flowering dates was 112.33 days when not soaked in SA. Foliar spraying with different concentrations of calcium nitrate also had significant effects on the studied characteristics, with the highest values reaching 18.17 days, 10.98 cm, 50.06 cm³ and 28.25 g for flower coordination date, length of flowers spike, bulb size and bulb dry weight, respectively, when sprayed with 1000 mg.l⁻¹ of calcium nitrate, while there was no significant effect on flowering date.

Table (2): Effect of salicylic acid and calcium nitrate concentrations on some growth and flowering characteristics of *Hyacinthus cultivars* plant.

Characteristics	Cultivars			Salicylic acid (SA) mg.L ⁻¹		Calcium Nitrate (CaNO ₃) mg L ⁻¹		
	Fondant	Carnegie	Blue jacket	0	100	0	500	1000
Flowering date (days)	110.50 b	112.11 a	111.61	112.33	110.48	111.94	111.61	110.67
	±	±	a	a	b	a	a	b
	10.12	10.13	±	±	±	±	±	±
			10.14	10.16	10.17	10.18	10.13	10.14
Flowering coordination date (days)	19.28 a	15.00 c	16.28 b	15.78 b	17.93 a	15.33 c	17.06 b	18.17 a
	±	±	±	±	±	±	±	±
	2.11	2.18	2.16	2.14	2.15	2.14	2.16	2.17
Length of flowers spike (cm)	9.91 b	9.41 b	10.77 a	9.69 b	10.37 a	9.16 c	9.95 b	10.98 a
	±	±	±	±	±	±	±	±
	1.14	1.13	1.12	1.14	1.15	1.16	1.17	1.18
Bulbs size (cm ³)	47.72 b	46.94 b	50.00 a	45.96 b	50.48 a	45.89 c	48.72 a	50.06 a
	±	±	±	±	±	±	±	±
	4.16	5.14	5.15	5.15	4.14	5.14	4.14	5.16
Bulb dry weight (g)	23.22 c	24.06 b	28.39 a	24.11 b	26.33 a	21.53 c	25.88 b	28.25 a
	±	±	±	±	±	±	±	±
	3.16	4.14	3.17	5.16	5.47	5.18	5.16	5.19

Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Range test.

3.3 Effect of triple interactions among cultivars, salicylic acid and calcium nitrate concentrations on some growth and flowering characteristics of Hyacinthus plant.

The Carnegie cultivar that was not soaked in SA and unsprayed with calcium nitrate had the highest significant values of sprouting date 48.00 days, indicating that the triple interaction among the levels of the factors under study resulted in clearly significant differences in the averages of the studied traits (Table 3). Significant differences were also shown by the results for plant height, leaf area, dry weight, and chlorophyll content. The bulbs of the Fondant cultivar that were soaked in 100 mgL⁻¹ of SA and sprayed with 1000 mgL⁻¹ of calcium nitrate produced the highest values, which were 29.20 cm, 180.12 cm², 5.33 g, and 57.26, respectively.

Table (3): Effect of triple interactions among cultivars, salicylic acid and calcium nitrate concentrations on some growth and flowering characteristics of Hyacinthus plant.

Cultivars	Salicylic acid (SA) mg.L ⁻¹	Calcium Nitrate (CaNO ₃) mg L ⁻¹	Sprouting Date (Days).	Plant height (cm)	Characteristics			
					Leaf area (cm ²)	Leaves dry weight (g)	Chlorophyll content (SPAD)	
Fondant	0	0	21.00 h	25.83 ab	119.72 d-f	2.00 de	49.77c-g	
			±	±	±	±	±	
		3.11	3.16	3.17	3.19	3.19		
		500	21.33 gh	26.5 ab	154.58 a-d	2.67 cd	52.94 a-f	
			±	±	±	±	±	
		3.17	3.17	3.18	3.18	3.15		
	1000	21.33 gh	27.27 ab	168.80 ab	2.67 cd	54.74 a-e		
		±	±	±	±	±		
	3.15	3.15	3.11	3.16	3.16			
	100	0	0	18.33 h	26.77 ab	140.85 a-e	3.33 b-c	52.25 a-f
				±	±	±	±	±
		3.17	3.16	3.15	3.16	3.17		
500		19.33 h	28.73 a	168.06 ab	4.33 ab	56.35 a-c		
		±	±	±	±	±		
3.18		3.19	3.20	3.15	3.16			
1000	20.00 h	29.20 a	180.12 a	5.33 a	57.26 a			
	±	±	±	±	±			
3.19	3.12	3.13	3.13	3.12				
Carnegie	0	0	48.00 a	18.17 e	79.83 f	2.00 de	47.06 gh	
			±	±	±	±	±	
		3.16	3.17	3.16	3.19	3.18		
		500	36.67 cd	19.17 de	115.21 d-f	2.33 c-e	54.74 a-e	
			±	±	±	±	±	
		3.19	3.11	3.19	3.19	3.16		
	1000	38.00 b-d	19.03 de	129.08 b-e	3.00 b-d	56.45 ab		
		±	±	±	±	±		
	3.11	3.19	3.19	3.18	3.19			
	100	0	0	28.67 ef	20.13 de	103.54 ef	2.67 cd	50.31 b-g
				±	±	±	±	±
		3.19	3.19	3.12	3.19	3.19		
500		27.00 fg	21.13 de	136.04 a-e	3.67 bc	56.74 ab		
		±	±	±	±	±		
3.19		3.19	3.19	3.19	3.15			
1000	28.67 ef	21.20 de	138.99 a-e	4.33 ab	55.57a-d			
	±	±	±	±	±			
3.19	3.19	3.14	3.16	3.19				
0	0	0	43.00 ab	19.70 de	118.60 d-f	1.00 e	45.45 g	
			±	±	±	±	±	
3.17	3.19	3.19	3.19	3.19				
Blue	0	500	42.33 a-c	21.47 de	137.35 a-e	2.67 cd	48.76 e-g	
			±	±	±	±	±	

jacket		±	±	±	±	±
		3.19	3.12	3.19	3.19	3.12
	1000	37.33 b-d	24.87 bc	150.17 a-d	3.00 b-d	52.41 a-f
100		±	±	±	±	±
		3.17	3.11	3.16	3.17	3.19
	0	33.67 de	21.43 de	112.19 d-f	2.33 c-e	46.87 fg
		±	±	±	±	±
		3.19	3.19	3.11	3.19	3.19
	500	37.33 b-d	22.00cd	122.20 c-f	3.33 b-d	49.58 d-g
		±	±	±	±	±
		3.19	3.19	3.19	3.19	3.19
	1000	32.67 d-f	25.27 b	166.23 a-c	3.67 bc	53.84 a-e
		±	±	±	±	±
	3.17	3.16	5.20	3.19	3.16	

Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Range test.

3.4 Effect of triple interactions among cultivars, salicylic acid and calcium nitrate concentrations on some growth and flowering characteristics of Hyacinthus plant.

The data in Table 4 showed that triple interaction among the studied factors had a significant effect on the studied traits, the higher values reaching 113.00 days for the bulbs of Blue jacket cultivar not soaked in SA and sprayed with 1000 mg.L⁻¹ concentration of calcium nitrate. As for the Fondant bulbs cultivar soaked in 100 mgL⁻¹ of SA and sprayed with 500 and 1000 mg.L⁻¹ concentrations of calcium nitrate. They gave the highest significant value of flowering coordination date 21 days, while the lowest value 12.33 days was for the Carnegie cultivar bulbs not soaked in SA and unsprayed with calcium nitrate. The results of length of flower spikes and bulbs size showed a clear significant difference among treatments, where the highest significant value of 11.97 cm and 57.00 cm³ were recorded in Blue jacket cultivar bulbs soaked in 100 mgL⁻¹ of SA and sprayed with 1000 mg.L⁻¹ of calcium nitrate and this value decreased to 8.13 cm and 41.67 cm³ in the bulbs of Fondant cultivar not soaked in SA and unsprayed with calcium nitrate. The Blue jacket bulbs cultivar soaked in 100 mgL⁻¹ of SA and sprayed with 1000 mg.L⁻¹ concentration of calcium nitrate, they gave the highest significant value of bulb dry weight 33.00 g, this value decreased to 13.07 g for the Fondant cultivar bulbs not soaked in SA and unsprayed with calcium nitrate.

Table (4): Effect of triple interactions among cultivars, salicylic acid and calcium nitrate concentrations on some growth and flowering characteristics of Hyacinthus plant.

Cultivars	Salicylic acid (SA) mg.L ⁻¹	Calcium Nitrate (CaNO ₃) mg L ⁻¹	Characteristics				
			Flowering date (days)	Flowering coordination date (days)	Length of flowers spike (cm)	Bulbs size (cm ³)	Bulb dry weight (g)
Fondant	0	0	112.33 a-c	17.00 c-f	8.13 h	41.67 e	13.07 j
		±	±	±	±	±	
		10.12	3.13	1.17	4.17	2.17	
		500	111.67 a-c	18.00 b-d	8.77 f-h	47.67 cd	25.10 f
		±	±	±	±	±	
		10.17	3.12	2.16	5.16	6.16	
	100	1000	111.00 b-d	19.67 ab	9.70 c-h	45.33 de	28.17 c
		±	±	±	±	±	
		10.19	4.16	8.16	6.19	3.16	
		0	110.67 cd	19.00 bc	10.47 a-f	46.67 c-e	25.00 f
		±	±	±	±	±	
		10.18	2.14	1.17	5.17	5.13	
1000	500	109.67 d	21.00 a	11.03 a-d	50.00 b-d	26.00 e	
	±	±	±	±	±		
	10.14	3.18	2.14	6.17	3.16		
	1000	107.67 e	21.00 a	11.37 a-c	55.00 ab	27.00 d	
	±	±	±	±	±		
	10.14	3.18	2.14	6.17	3.16		

Carnegie	0	10.17	2.17	2.14	3.16	3.16	
		112.33 a-c	12.33 h	8.47 gh	45.00 de	20.07 i	
		±	±	±	±	±	
	500	10.16	3.18	2.18	6.19	3.18	
		112.33 a-c	13.67 gh	9.03 e-h	46.33 de	24.10 g	
		±	±	±	±	±	
	1000	10.11	2.15	2.11	6.17	4.19	
		112.33 a-c±	15.00 fg	10.23 a-g	46.67 c-e	26.17 e	
		6.17	±	±	±	±	
	Blue jacket	0	111.67 a-c	15.33 e-g	8.90 e-h	46.67 c-e	20.00 i
			±	±	±	±	±
			10.12	1.16	1.11	1.14	1.19
500		111.67 a-c	16.00 d-f	9.17 e-h	47.67 cd	22.00 h	
		±	±	±	±	±	
		10.14	2.17	2.14	2.16	2.13	
1000		111.00 b-d	17.67 cd	10.67a-e	49.33 cd	27.00 d	
		±	±	±	±	±	
		11.16	3.17	1.18	7.19	4.27	
Blue jacket		0	113.00 a	13.00 h	9.27 d-h	45.67 cd	25.07 f
			±	±	±	±	±
			12.18	3.14	2.19	6.17	4.15
	500	112.67 ab	16.33 d-f	11.63 ab	48.33 cd	27.10 d	
		±	±	±	±	±	
		9.14	3.18	2.11	6.12	4.14	
	1000	112.00 a-c	17.00 c-f	11.67 ab	47.00 c-e	28.17 c	
		±	±	±	±	±	
		9.18	4.15	3.11	5.44	3.11	
	Blue jacket	0	111.67 a-c	15.33 e-g	9.73 c-h	49.67 b-d	26.00 e
			±	±	±	±	±
			10.18	2.11	2.16	6.17	2.14
500		111.00 b-d	17.33 c-e	10.07 b-g	52.33 a-c	31.00 b	
		±	±	±	±	±	
		9.15	2.15	2.11	3.18	2.18	
1000		109.33 d	18.67 bc	11.97 a	57.00 a	33.00 a	
		±	±	±	±	±	
		11.17	3.19	2.17	4.18	7.14	

Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Range test.

Salicylic acid is involved in overseeing physiological, nutritional, and hormonal activities. It affects the process of photosynthesis, boosts cell division, aids in nutrient uptake, and helps sustain cell membranes. Furthermore, it enhances the nitrate reductase enzyme, which promotes nitrate absorption and overall nitrogen levels, thereby enhancing growth traits in both vegetative and flowering stages [24,25,26]. The enhancement of various growth traits from applying Calcium nitrate can be linked to nitrogen, as it is crucial in forming auxins that elevate the rate of cell division and growth. Additionally, nitrogen is vital for chlorophyll production as it is necessary for making porphyrins and enzymes, which are essential for photosynthesis, energy conversion, protein synthesis, nucleic acids, and coenzymes [27,28,29]. Overall, this positively impacted the growth characteristics in both vegetative and flowering stages. Calcium is essential for facilitating photosynthesis, cell division, and growth, and it affects cell membranes, plasma membranes, and the uptake of other nutrients like nitrogen, potassium, zinc, boron, and magnesium, along with its role in metabolic processes. It also works with nitrogen to strengthen and increase the flexibility of cell walls. High levels of calcium can hinder carbohydrate synthesis due to its role in activating oxalate. Calcium also competes with ammonium ions at root uptake sites, and it serves as a signaling molecule in the plant's reaction to hormonal and environmental triggers [21, 30, 22].

The results also indicated that, the type of the cultivars used affecting the characteristics of the growth, flowering, and bulbs of the plant used under the soaking with salicylic acid (SA) and spraying with calcium nitrate (CaNO₃) where the best growth, flowering and bulbs growth of the plants where the results showed that, the higher growth, flowering

and bulbs growth showed a higher level in Blue jacket, followed by Carnegie and Fondant. this results attributed to the differences in the types of the seed used, where there was a differences in the effect of soaking with salicylic acid (SA) and spraying with calcium nitrate (CaNO_3) on the cultivar used, this results agreed with those of [31] where they reported that, the degree of growth, flowering, and bulbs of the plant used under the soaking with salicylic acid (SA) and spraying with calcium nitrate (CaNO_3) differ according to the types of the cultivar used.

Conclusion

This study concluded that, soaking in salicylic acid (SA) and applying calcium nitrate (CaNO_3) enhances the height, leaf area, dry weight of leaves, and chlorophyll levels in *Hyacinthus orientalis* cultivars.

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تأثير النقع بحمض الساليسيليك والرش بنترات الكالسيوم على نمو و ازهار وابصال ثلاثة اصناف من نبات *Hyacinthus orientalis*

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الخلاصة

أجريت هذه الدراسة في منطقة بربام/محافظة أربيل خلال الفترة من 15 تشرين الثاني 2024 إلى 25 أيار 2025. لدراسة تأثير نقع حمض الساليسيليك ورش نترات الكالسيوم على نمو وازهار وابصال ثلاثة اصناف من نبات (*Fondant, Carnegie, Blue jacket*) *Hyacinthus orientalis*، نُقعت الابصال بتركيزات مختلفة من حمض الساليسيليك (0 و 100 ملغم/لتر) لمدة 24 ساعة. كما رُشّت الأوراق بتركيزات مختلفة من أكسيد الكالسيوم (0، 500، 1000) ملغم/لتر. أجريت التجربة الحقلية وفقاً لتصميم القطاعات العشوائية الكاملة (*RCBD*). أشارت النتائج إلى أن الأصناف كان لها تأثير معنوي، حيث سجلت أعلى القيم 37.72 يوماً 10.77 سم و 50.00 سم لموعد الإنبات وطول السنبل الزهرية وحجم البصلة على التوالي لصنف بلو جاكيت، وسجلت أعلى القيم 27.38 سم و 155.35 سم و 3.39 غرام و 19.28 يوماً سجلت لارتفاع النبات ومساحة الورقة ووزن الأوراق الجاف وتاريخ تناسق الأزهار على التوالي لصنف فوندانت، بينما سجل صنف كارنيجي أعلى قيمة لموعد الإزهار 112.11 يوماً. أدى التفاعل الثلاثي بين مستويات العوامل المدروسة إلى فروق معنوية واضحة في متوسطات الصفات المدروسة، حيث أعطى صنف كارنيجي غير المنقوع في المادة وغير المرشوش بنترات الكالسيوم أعلى القيم المعنوية لموعد الإنبات 48.00 يوماً. أعطت أبصال صنف *Fondant*، المنقوعة في 100 ملغم/لتر من حمض الساليسيليك، والمرشوشة بتركيز 1000 ملغم/لتر من نترات الكالسيوم، أعلى قيم لطول النبات، ومساحة الورقة، والوزن الجاف للأوراق، ومحتوى الكلوروفيل، حيث بلغت 29.20 سم و 180.12 سم، و 5.33 غرام و 57.26 غرام على التوالي. كما بلغت أعلى القيم 113.00 يوماً لأبصال صنف *Blue jacket* غير المنقوعة في حمض الساليسيليك، والمرشوشة بتركيز 1000 ملغم/لتر من نترات الكالسيوم. أما أبصال صنف *Fondant*، المنقوعة في 100 ملغم/لتر من حمض الساليسيليك، والمرشوشة بتركيز 500 و 1000 ملغم/لتر من نترات الكالسيوم، فقد بلغت 113.00 يوماً. وأعطت أعلى قيمة معنوية لتاريخ تنسيق التزهير 21 يوماً، في حين كانت أقل قيمة 12.33 يوماً لأبصال صنف *Carnegie* غير المنقوعة في المادة وغير المرشوشة بنترات الكالسيوم. وأظهرت نتائج طول السنابل الزهرية وحجم الابصال فرقا معنوياً واضحاً بين المعاملات، حيث سجلت أعلى قيمة معنوية بلغت 11.97 سم و 57.00 سم في أبصال صنف *Blue jacket* المنقوعة في 100 ملجم/لتر من حمض الساليسيليك والمرشوشة بـ 1000 ملجم/لتر من نترات الكالسيوم.

الكلمات المفتاحية: حمض الساليسيليك، نترات الكالسيوم، الأصناف، نبات الهايسنت، نبات.