Response of two Varieties from *Hyacinthus orientalis* L. to foliar spraying with different organic fertilizer concentrations (Optimus-plus) and salicylic acid

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Abstract:
This study was conducted from November 1st to June 1st, 2023, inside the wooden canopy of the Horticulture and Landscape Architecture Department, College of Agriculture and Forestry, University of Mosul. The objective of the study was to assess how two varieties of *Hyacinthus orientalis* L., called "Carnegie" with white flowers and "Woodstock" with purple flowers, responded to three treatments of Optimus-plus fertilizer (0, 1.5, 3) ml L-1, as well as three treatments of salicylic acid (0, 150, 300) mg. L-1, applied to the vegetative system three times. A randomized complete block design (RCBD) with three replicates and eight plants per treatment was employed in the factorial experiment's implementation within the split plot.
The results indicated the following:
*The white variety (Carnegie) recorded the greatest rates in all of the studied characteristics; plant height, number of leaves, dry weight of leaves, and leaf area.
* Spraying the plants with the organic fertilizer Optimum Plus at a concentration of 3 ml L^{-1} had a significant influence on obtaining the highest values in all of the studies assessed.
* Salicylic acid spraying at a dosage of 300 mg L^{-1} had the highest significant values in all of the characteristics that were assessed.
* The results of the triple interactions between the study factors indicated that the highest significant values for plant height, number of leaves, and leaf area were obtained when the plants (Carnegie white) were sprayed with Optimum-Plus, an organic fertilizer, at a concentration of 3 ml L^{-1}, in addition to 300 mg L^{-1} of salicylic acid.
* Data on the triple interactions between the study factors revealed that spraying purple (woodstock) plants with Optimum-Plus fertilizer at a concentration of 2 ml L^{-1} combined with spraying with salicylic acid at a concentration of 300 mg L^{-1} recorded the highest significant values for leaf length, leaves number, leaf area, and leaf dry weight. in split plot)

Introduction :

Hyacinth bulbs, scientifically known as *Hyacinthus orientalis* L., are a member of the Liliaceae family, the Hyacinthaceae species, and the Hyacinthus genus[1]. It is common in the Mediterranean basin and Central Asia, where it may be found in Iraq, Syria, Minor Asia, and Greece[2] Hyacinth bulbs are planted for their beauty as well as for the production of flowers and bulbs[3]. The hyacinth is distinguished by its ease of cultivation and growth. It blooms in a wide range of soil types as long as they are well-drained and ventilated. It favors light soil and grows in both sunny and shady locations[4],. The soil reaction value must be between (6-7.5), and it is better to be Neutral (pH7)[2], and it is planted in late November[5]. It blooms in March, with some varieties blooming earlier, and it lasts until April. As a result, the best time to plant winter bulbs depends on the flowering date and class type, and they are frequently planted in the autumn to produce flowers in the spring[6].
The plant grows to a height of (30-50) cm[2]. The leaves are (wide, striped) and emerge in a regular ring around the flower stalks from the bulb's axis. In certain varieties, the number of

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leaves ranges from (6 - 12)[7] , During a study on two varieties of Hyacinth plants, [8] noticed that fertilization with the liquid fertilizer Zinmin Sal (Nitrogen with Zinc) at high levels (1.5, 2) ml/L had a significant effect on most of the studied vegetative properties, as it increased the number of leaves/plant. (8.53) leaf/plant versus (7.75) leaf/plant in the comparison treatment, and the leaf area is (219.29) cm^2 versus (153.83) cm^2 in the control treatment. According to[9], while researching three different types of *Gladiolus X hortulanus* L., spraying plants with 250 mg L^{-1} of salicylic acid had a significant impact on recording the largest values for all the studied properties, with the exception of the time between planting and inflorescence emergence, the time between inflorescence emergence and picking, and the number of corms that were significantly reduced. There were no discernible variations found in the weight and size of the corm, the quantity of corms, or the amount of time it took for the basal floret to open.

Materials and Methods

The experiment was conducted inside the wooden canopy of the Department of Horticulture and Landscape Architecture / College of Agriculture and Forestry / University of Mosul, from November 1, 2022 to June 1, 2023, to study the effect of spraying with the organic fertilizer Optimus-plus on the foliage at three concentrations: (0, 1.5, 3) ml L^{-1}, with three sprays on the foliage until the wet stage. The first spray is a month after emergence, with a two-week interval between sprays, and salicylic acid in three concentrations: (0, 150, 300) mg L^{-1}, made by dissolving it in 70% ethanol alcohol, then filling the volume to 1 liter with distilled water and spraying it on the plant three times until it is wet. The first treatment occurred 35 days after germination, and the interval between sprayings was two weeks. Two types of plants have different vegetative growth characteristics *Hyacinthus orientalis* L.

First: the studied characteristics:

1- Number of days required for emergence (day):

2- Emergence percentage :

3- Plant height (cm):

4- leaves number (leaf $plant^{-1}$):

5- Leaf area of the plant (cm^2):

6- Dry Weight of Leaves (g):

7- Leaf content of total chlorophyll

Results and discussion

1- Number of days required for emergence (day): According to Table (1) the class had no significant influence on the number of days required for vegetative growth to emerge, as the purple class emerged after 60,450 days, whereas the white class appeared after 60,992 days

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Table (1): Number of days required for emergence (day) for two varieties of *Hyacinthus orientalis* L.

Duration to emergence (day)	Varieties
a 60.450	Purple
a 60.992	White

*Values with similar letters for each factor individually or their interactions are not significantly different under the 5% probability level, according to Duncan's multinomial test.

2- Emergence Percentage: Table (2) showed that the emergence percentage was 100% in all plants of the purple and white **Varieties**.

ISSN 2072-3857

Table (2): Emergence percentage of two varieties of *Hyacinthus orientalis* L.

Emergence Percentage	Varieties
100 %	Purple
100 %	White

3- Plant height (cm): The statistical analysis in Table (3) indicated that the varieties differed significantly in terms of plant height, with the plants of the white variety being significantly superior to the plants of the purple class, with the white class reaching 38.75 cm compared to 36.29 cm for the purple class. Optimus-Plus organic fertilizer treatment resulted in At a dose of 3 ml. L-1, the value of this feature increased significantly, reaching 38.49 cm compared to 36.50 cm in the comparison treatment. Spraying with salicylic acid at concentrations of 150 and 300 mg L-1 resulted in a substantial increase in plant height, 37.90 cm compared to 37.11 cm for plants in the control treatment. Furthermore, the white class supplied with the organic fertilizer Optimus-Plus had the highest plant height, reaching 39.63 cm compared to 35.02 in the control treatment. The highest values for this characteristic were obtained when plants were treated with salicylic acid at an amount of 300 mg. L-1, which amounted to 39.12 cm for the white variety compared to 35.81 cm for the control treatment. While the plants treated with Optimus-Plus at 3 mL L^{-1} were distinguishable, the plants treated with salicylic acid at 300 mg L-1 recorded the highest significant value of 38.95 cm compared to 35.95 cm for the comparison treatment. In general, the results of the triple interaction of the factors under study indicated that treating the white class plants with the Optimus-Plus fertilizer 3 ml L^{-1} mixed with salicylic acid spraying 300 mg L^{-1} resulted in the highest significant value, which amounted to 40.37 cm, while this value decreased to a minimum of 34.16 cm for plants in the purple class that were not treated with organic fertilizer and salicylic acid.

ISSN 2072-3857

Table (3): Effect of Optimus-Plus and Salicylic acid and their interactions on plant height at flowering (cm) for two varieties of *Hyacinthus orientalis* L.

Varieties	Optimus Plus (ml L^{-1})	Salicylic (mg L^{-1})			variety Interactions X Optimus Plus	Variety response
		0	150	300		
Woodstock Purple	0	34.16 n	35.20 m	35.70 l m	35.02 f	36.29 b
	1.5	36.12 k l	36.58 j k	36.83 I j	36.51 e	
	3	37.16 h i	37.33 h i	37.54 g h	37.34 d	
Carnegie White	0	37.75 f g h	38.00e f g	38.20 d e f	37.98 c	38.75 a
	1.5	38.45 c d	38.66 c d	38.79 c d	38.63 b	
	3	39.04 b c	39.50 b	40.37 a	39.63 a	
Variety Interactions Salicylic	Purple	35.81 e	36.37 d	36.69 c	Effect of Optimus-Plus	
	White	38.41 b	38.72 b	39.12 a		
Optimus-Plus interference Salicylic acid	0	35.95 h	36.60 g	36.95 f g	36.50 c	
	1.5	37.29 e f	37.62 d e	37.81 c d	37.57 b	
	3	38.10 b c	38.41 b	38.95 a	38.49 a	
Effect of Salicylic acid		37.11 c	37.54 b	37.90 a		

* Values with similar letters for each factor individually or their interactions are not significantly different under the 5% probability level, according to Duncan's multinomial test

4- Leaves number (leaf plant^{-1}): Table (4) revealed that the variety had a significant influence on the values recorded for the average number of leaves per plant, with the white class recording the highest significant values, which amounted to (7.05 Leaves Plant^{-1}) versus (6.37 Leaves Plant^{-1}) for purple class. Spraying with Optimus-Plus fertilizer (3 ml L^{-1}) increased the number of leaves to (7.00 leaves Plant^{-1}) versus (6.46 leaves Plant-1) for the control treatment, while treatment with salicylic acid (300 mg L^{-1}) increased the number of leaves to (6.79 leaves Plant^{-1}) versus (6.62 leaves Plant^{-1}) for the comparison treatment, The bilateral interference data between the Varieties and the organic fertilizer Optimus Plus at a concentration of (3 ml L^{-1}) revealed a significant variation in the number of leaves in white class plants, which was (7.50 leave plant^{-1}) against (6.21 leave plant^{-1}). used in comparative treatment for the purple variety. Conversely, the variety-salicylic acid interaction resulted in significant variations in leaves number in the white class plants, reaching (7.18 leaves plant^{-1}) at the concentration (300 mgL^{-1}) as compared to (6.34 leaves plant^{-1}) for purple class plants. also findings demonstrated that the highest significant values (7.12 leaves plant^{-1}) were obtained when plants were treated with the

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organic fertilizer Optimus Plus at a concentration of (3 ml plant^{-1}) along with a salicylic acid spraying at a concentration of 300 mg per plant-1. However, the lowest values (6.40 leaves plant^{-1}) were observed for the plants in the comparison treatment. While the results of the triple interaction of the study factors demonstrated that treating the purple variety plants with the organic fertilizer Optimus-Plus at a concentration of (3 ml L^{-1}) along with spraying salicylic acid at (300 mg L^{-1}) led to the highest significant values in leaf number in the white class plants (7.75 leaves Plant^{-1}), this value decreased to a minimum of (6.15 leaves Plant^{-1}) for comparison treatment plants of the purple class

Table (4): Effect of Optimus-Plus and Salicylic acid and their interactions on leaves number at flowering (leave Plant^{-1}) of two varieties of *Hyacinthus orientalis* L.

Varieties	Optimus Plus (ml L^{-1})	Salicylic (mg L^{-1})			Variety Interactions X Optimus Plus	Variety response
		0	150	300		
Woodstock Purple	0	6.15 j	6.25 i	6.25 i	6.21 f	6.37 b
	1.5	6.37 h	6.37 h	6.50 g	6.41 e	
	3	6.50 g	6.50 g	6.50 g	6.50 d	
Carnegie White	0	6.66 f	6.75 e f	6.75 e f	6.72 c	7.05 a
	1.5	6.83 e	6.95 d	7.04 d	6.94 b	
	3	7.20 c	7.54 b	7.75 a	7.50 a	
Variety Interactions Salicylic	Purple	6.34 e	6.37 d e	6.41 d	Effect of Optimus-Plus	
	White	6.90 c	7.08 b	7.18 a		
Optimus-Plus interference Salicylic acid	0	6.40 h	6.50 g	6.50 g	6.46 c	
	1.5	6.60 f	6.66 e	6.77 d	6.67 b	
	3	6.85 c	7.02 b	7.12 a	7.00 a	
Effect of Salicylic acid		6.62 c	6.72 b	6.79 a		

*Values with similar letters for each factor individually or their interactions are not significantly different under the 5% probability level, according to Duncan's multinomial test**.**

5- Leaf area of the plant (cm^2): The data in Table (5) indicated that the variety had a significant effect on the values recorded for the leaf area of each plant, with plants of the white variety recording the highest significant values of (227.68 leaves plant^{-1}) compared to plants of the purple variety recording the lowest significant values of (122.75 leaves plant^{-1}), Spraying with Optimus-Plus fertilizer at a concentration of (3 ml L^{-1}) resulted in a significant rise in leave number, which was (208.98 leaves Plant^{-1}) compared to (137.72 leaves Plant^{-1}) for the comparator treatment.
While treatment with salicylic acid at a dose (300 mg L^{-1}) resulted in a considerable increase in the number of leaves (187.73 leaves Plant^{-1}) compared to the comparison treatment (164.40 leaves Plant^{-1})
The results of the bilateral interaction between the variety and the organic fertilizer Optimus-Plus at a concentration of (3 ml L^{-1}) found that there were significant differences in the leaf area of the plants of the white variety, amounting to (277.00 leaves Plant^{-1}), while it was recorded (104.27 leaves Plant^{-1}) in purple variety, The interaction between the variety and salicylic acid, on the other hand, contributed to significant changes in the leaf area of white variety, reaching (245.48 leaves Plant^{-1}) at (300 mg L^{-1}). The control treatment, while , had (116.697 leaves Plant^{-1}). For the purple variety The results stated that when the

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plants were treated with the organic fertilizer Optimus-Plus at a dosage of (3 ml L^{-1}), alternating with spraying with salicylic acid at a concentration of (300 mg L^{-1}), the highest significant values (224.95 leaves $Plant^{-1}$).were recorded. whereas the comparison treatment plants demonstrated the lowest values (126.29 leave $Plant^{-1}$). The White variety plants recorded the highest significant values in leaf area (305.50 leave $Plant^{-1}$) , The while comparison treatment plants of the purple variety observed the lowest value (94.67 leave $Plant^{-1}$) based on the triple interaction of the study factors. The purple variety plants were treated with Optimus-Plus fertilizer (3 ml L^{-1}) in conjunction with spraying salicylic acid (300 mg. L^{-1}).

Table (5): Effect of Optimus-Plus and Salicylic acid and their interactions on leaves area (cm^2) of two varieties of *Hyacinthus orientalis* L.

Varieties	Optimus Plus (ml L^{-1})	Salicylic (mg L^{-1})			Variety Interactions X Optimus Plus	Variety response
		0	150	300		
Woodstock Purple	0	94.67 m	103.24 m	114.90 l	104.27 f	122.75 b
	1.5	117.28 l	121.09 k l	130.63 j k	-123.00 e	
	3	138.14 I j	140.37 i j	144.40 i	140.97 d	
Carnegie White	0	157.92 h	168.45 g	187.15 f	171.17 c	227.68 a
	1.5	-223.31 e	237.51 d	243.80 d	234.87 b	
	3	255.07 c	270.42 b	305.50 a	277.00 a	
Variety Interactions Salicylic	Purple	116.697 e	-121.57 e	129.98 d	Effect of Optimus-Plus	
	White	212.10 c	225.46 b	245.48 a		
Optimus-Plus interference Salicylic acid	0	126.29 i	135.85 h	151.02 g	137.72 c	
	1.5	170.30 f	179.30 e	187.22 d	178.94 b	
	3	196.60 c	205.39 b	224.95 a	208.98 a	
Effect of Salicylic acid		164.40 c	173.51 b	187.73 a		

*Values with similar letters for each factor individually or their interactions are not significantly different under the 5% probability level, according to Duncan's multinomial test**.**

6- Dry Weight of Leaves (g): The results in Table (6) illustrate that the varieties differed significantly in the dry weight of leaves, with plants of the white variety recording 7.20 (g) compared to plants of the purple variety recording 3.98 (g), and spraying with Optimus-Plus fertilizer at a rate of (3 ml L^{-1}) proved a significant difference in the dry weight of leaves, reaching 6.22 (g) compared to 5.05 (g) for the comparison treatment. Treatment with salicylic acid at a dosage of 300 mg. L-1 resulted in a considerable increase in leaf dry weight, reaching 5.87 (g) compared to 5.36 (g) for the comparator treatment. The binary interaction between the variety and the Optimus -Plus (3 ml L^{-1}) revealed significant differences in the dry weight of leaves for plants of the white

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variety, amounting to 8.01 (g) compared to 3.58 (g) for plants of the purple variety's comparison treatment.

Table (6): Effect of Optimus-Plus and Salicylic acid and their interactions on Dry Weight of Leaves (g) of two varieties of *Hyacinthus orientalis* L.

Varieties	Optimus Plus (ml L^{-1})	Salicylic (mg L^{-1})			Variety Interactions X Optimus Plus	Variety response
		0	150	300		
Woodstock Purple	0	3.40 j	3.60 I j	3.74 h I j	3.58 f	3.98 b
	1.5	3.85 g j	3.92 g h i	4.00 g h i	3.92 e	
	3	4.10 g h	4.22 g	5.01 f	4.44 d	
Carnegie White	0	6.30 e	6.53 e	6.73 d e	6.52 c	7.20 a
	1.5	7.01 d	7.05 d	7.13 c d	7.06 b	
	3	7.52 b c	7.87 b	8.64 a	8.01 a	
Variety Interactions Salicylic	Purple	3.79 d	3.91 d	4.25 c	Effect of Optimus-Plus	
	White	6.94 b	7.15 b	7.18 a		
Optimus-Plus interference Salicylic acid	0	4.85 g	5.06 f g	5.23 e f	5.05 c	
	1.5	5.43 d e	5.49 d e	5.57 c d	5.49 b	
	3	5.81 b c	6.04 b	6.82 a	6.22 a	
Effect of Salicylic acid		5.36 b	5.53 b	5.87 a		

*Values with similar letters for each factor individually or their interactions are not significantly different under the 5% probability level, according to Duncan's multinomial test**.**

However, there were notable variations in the dry weight of leaves for the white variety plants when the variety and salicylic acid (300 mg L^{-1}) were combined; the white variety plants' dry weight was 7.18 (g) as opposed to 3.79 (g) for the control treatment plants. Results demonstrated that when the plants were sprayed with 300 mgL^{-1} of salicylic acid in between treatments with Optimus-Plus fertilizer at a concentration of 3 ml L^{-1}, the dry weight of the leaves showed the highest significant value of 6.82 (g), while the plants in the control treatment showed the lowest values of 4.85 (g).

7- Total chlorophyll: Table (7) presents the data, which indicates that the white variety's total chlorophyll content in the leaves achieved 20.24%, whereas the purple variety's percentage was 13.13%. There was an increase in the percentage of total chlorophyll in leaves after applying Optimus-Plus fertilizer (3 ml L^{-1}). Relative to the control treatment plants, leaves increased significantly to 19.43% from 13.85%. In contrast, plants receiving 300 mg L^{-1} of salicylic acid showed a considerable rise in this proportion, reaching 17.71%, as as compared to 15.74% in the control treatment. Considering the outcomes of the bilateral interaction between the variety and Optimus-Plus fertilizer, it turns out that when the two varieties under investigation were treated independently with Optimus-Plus (3 ml L^{-1}) concentration, the white variety's total chlorophyll percentage in the leaves reached the highest significant values, getting 23.23%, while the purple variety's control treatment only reached 10.63%. While the total chlorophyll percentage in the leaves of the white variety when sprayed with salicylic acid (300 ml L^{-1}) concentration was found to

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be at its highest values of 21.27%, it was observed that this percentage significantly decreased to 12.02% for the purple variety's comparison treatment.

According to the results of the interaction between salicylic acid and Optimus-Plus fertilizer, plants sprayed with Optimus-Plus (3 ml.L-1) mixed with 300 mg.L-1 of salicylic acid showed a significant difference in total chlorophyll percentage, reaching 20.48% as opposed to 12.75% for the plants in the control treatment.

The results of the triple interaction of the factors under investigation indicated that treating the white variety plants with Optimus-Plus fertilizer (3 ml L^{-1}) mixed with spraying salicylic acid (300 mg L^{-1}) led to recording the highest significant values in the estimation of total chlorophyll percentage of leaves, which amounted to 24.50% for the white variety plants, while this value decreased to a minimum of 8.90% in the comparison treatment of the purple variety. Therefore, it can be said that the two varieties under study differed significantly in their responses to the various treatments.

Table (7): Effect of Optimus-Plus and Salicylic acid and their interactions on total chlorophyll of two varieties of *Hyacinthus orientalis* L.

Varieties	Optimus-Plus (ml L^{-1})	Salicylic (mg L^{-1})			Variety Interactions X Optimus-Plus	Variety response
		0	150	300		
Woodstock Purple	0	8.90 n	11.08 m	11.90 l	10.63 f	13.13 b
	1.5	12.39 k l	12.90 k	14.11 j	13.13 -e	
	3	14.77 i	15.65 h	16.46 g	15.63 d	
Carnegie White	0	16.59 g	16.91 g	17.70 f	17.07 c	20.24 a
	1.5	19.45 -e	20.24 d	21.61 c	20.43 b	
	3	22.36 b	22.84 b	24.50 a	23.23 a	
Variety Interactions Salicylic	Purple	12.02 f	13.21-e	14.16 d	Effect of Optimus-Plus	
	White	19.47 c	19.99 b	21.27 a		
Optimus-Plus interference Salicylic acid	0	12.75 i	13.99 h	14.80 g	13.85 c	
	1.5	15.92 f	16.57- e	17.86 d	16.78 b	
	3	18.56 c	19.24 b	20.48 a	19.43 a	
Effect of Salicylic acid		15.74 c	16.60 b	17.71 a		

*Values with similar letters for each factor individually or their interactions are not significantly different under the 5% probability level, according to Duncan's multinomial test.

conclusions

The results on vegetation shoot growth show that varieties perform a role in influencing the characteristics of vegetative growth, as the white variety superior to the purple variety in most of the characteristics listed in tables (3, 4, 5, 6), including plant height, leaf number, leaf area, and dry weight of the leaves. The explanation might be because of These are genetic distinctions across kinds based on which genes each variety carries10 [10]. The results also demonstrate a definite influence of organic fertilizer on vegetative growth if the organic fertilizer concentration is high enough to increase the vegetative growth parameters. The reason could be due to fertilizer content from amino acids, which play a major role in production of proteins and then

enzyme formation, both of which are important in plant essential processes, as well as the role of the amino acid tryptophan, which is the basic substance in the biosynthesis of auxin (IAA), which plays an important role in cell division and elongation. It resulted in an increase in cell number and elongation, which was reflected in these features, in addition to the function that amino acids play in delivering the nitrogen element needed to produce the energy unit ATP, which is required for critical processes. Furthermore, in the synthesis of nucleic acids that contain nitrogenous bases that have been included in their composition. also In the generation of cytokines, which have an essential role in enhancing cell division and elongation as well as activating enzymes that result in favorable vegetative development [11] ،[12] . The results also demonstrate that salicylic acid has an advantageous effect on vegetative growth properties as concentration increases. The reason for this could be due to the role salicylic acid plays in cell division and elongation as a result of the participation of Auxin and phenol [13], as well as salicylic acid has role in increasing some Plant hormones such as Auxins and Cytokines, which lead to a rapid and significant increase in cell division in meristematic tissues, as well as Auxin role in expanding the cell wall by breaking the bonds that bind the wall components together, thus increasing the leaf area, Salicylic acid may additionally enhance the plant's ability to improve biological functions by increasing the efficiency and effectiveness of photosynthesis in the plant, which is reflected in plant growth and development, and increasing the efficiency of water use, which results in increased nutrient absorption, which is reflected in increased root growth[14].

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