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INFLUENCE OF FOLIAR SPRAY WITH AMINO ACIDS AND SEAWEED EXTRACT COMBINED WITH MICROELEMENTS AND CALCIUM ON GROWTH, FLOWERING AND YIELD OF *HYMENOCALLIS SPECIOSA* L.

M.A. Barsoom, Nermeen E. Abdul-Moneem, Evon A. Khella
Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., ARC, Egypt

ABSTRACT: The present study aimed to investigate the beneficial effects of foliar spraying with amino acids and seaweed extract each at concentrations of 1.0, 1.5, and 2.0 ml/l alone or with the addition of a mixture of microelements at 0.5 g/l and calcium at 0.25 ml/l on vegetative growth, flowering, bulb production, and chemical components of *Hymenocallis speciosa* L. The current study was conducted at the Ornamental Plants and Landscape Gardening Res. Dept. Nursery, Hort. Res. Inst., ARC, Giza, Egypt, during the 2022 and 2023 seasons. Plants were treated with amino acids as a biostimulant at concentrations of 2 ml/l, which gave an increase in most growth characteristics as well as the same effect when using seaweed extract compared with the control. Also, when plants were treated with amino acids at 2.0 ml/l with a mixture of microelements at 0.5 g/l, it led to a significant increase in the values of morphological parameters included plant height, fresh weight of vegetative growth, number of leaves/plant, leaf area, root length, fresh weight of roots, spike length, flower diameter, flower weight, fresh weight of bulb and bulb circumference. It also led to an increase in the content of chlorophylls and carotenoids in leaves and total carbohydrates and N, P and K in new bulbs. Likewise, spraying the plant with seaweed extract at a rate of 2.0 ml/l with the addition of a mixture of microelements at a rate of 0.5 g/l led to an increase in most plant characteristics. However, the treatment with amino acids was superior in some of the studied plant characteristics compared to treatment with seaweed extract.

Keywords: spider lily, flowering bulbs, biostimulant, microelements

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Corresponding author:
Evon A. Khella
evonatef681@gmail.com

INTRODUCTION

Hymenocallis speciosa L., the green-tinged spider lily is a flowering bulb plant. This species of the genus *Hymenocallis* is native to the eastern Caribbean's northward islands. It is grown as an ornamental plant and belongs to the Amaryllidaceae family. It forms bulbs when cultivated under Egyptian environmental conditions. Spike can grow as high as fifty centimeters. The lanceolate leaves are narrow and can reach length of up to 50 cm and width of 10 cm. The number of leaves is 20 or less. Up to twenty white flowers can be produced by one umbel. At the time of flowering, the petals reflex (curl backward), resulting in white flowers with a hint of green. Very fragrant flowers that hold their fragrance when desiccated. Flowers bloom in summer (Bailey, 1963). *Hymenocallis speciosa* is used as a pot plant.

Amino acids have functional groups that are both carboxylic and amino in nature (Nelson and Cox, 2005) that are both carboxylic and amino in nature. Despite the fact that nature contains over 500 amino acids, the 22 α-amino acids found in proteins are by far the most significant, (Areski *et al.*, 2020). Amino acids have been shown in numerous studies to improve plant quality and yield when sprayed at various growth stages, particularly the crucial ones like the growing and flowering stages (Baqir *et al.*, 2019). Amino acids, primarily found in the chloroplast and mitochondria of organisms, also play a role in the assimilation of carbohydrates produced by carbon assimilation during the Krebs cycle, thereby facilitating the availability of ketonic acids. (Beavers, 1991). It is thought that amino acids are involved in the production of plant pigments, higher contents of proteins, division of cells, and natural hormones like ethylene, GA_3, and IAA, and as a result, raising the yield and plant quality (Ahmed *et al.*, 2014; Baqir *et al.*, 2019; Madian and Refaai, 2011). Gladiolus plant sprayed with amino acids (150 mg/l) showed a significant improvement in the qualities of flowering growth as well as vegetative growth traits (Number of leaves, leaf area, plant height) also, the chlorophyll content of leaves, as reported by Abed Edan *et al.* (2022). Treating plants with threonine (150 ppm) lead to an enhancement in growth of *Lilium longiflorum* (Abdel-Said *et al*., 2019).

In addition, seaweed extract (SWE) is obtained from marine plants such as *Fucus* (brown algae), *Ecklonia* (kelp), and *Ascophyllum* brown algae species. Applications of seaweed benefits encompass promoting growth, preventing diseases and pests, and enhancing the quality of products. Plant hormones, primarily cytokinins, amino acids, many vitamins, and trace nutrients found in the extracts are likely what give the extracts their effectiveness, (Arioli *et al*. 2024).

Seaweed extract are applied to plants in a variety of ways, such as through soil treatment, foliar spraying, and seed treatment, to protect and enhance plant growth. Because seaweed extract is non-toxic, biodegradable, and environmentally friendly, it is more preferable than chemical fertilizers, (Mukherjee and Patel, 2020). Seaweed extract applied to *Narcissus tazetta* L. increased quality and quantity of growth, enhanced characteristics of flowering, production of blubs, and chemical composition. (Rizk and Barsoom, 2020). The application of seaweed extracts had a significant effect on *Allium ascalonicum* L. with respect to plant height, fresh weight of herb, and fresh weight (Yusuf *et al*., 2016).

Microelements are actually as important as macroelements for enhancing growth, yield and quality in plants, (El- Sherbeny *et al*., 2024). Plant nutrients and the growing medium are the two most crucial factors in the healthy growth and development of ornamental plants; flowering crops are particularly vulnerable to nutrient deficiencies in plants, and ornamental plants rarely show signs of microelement deficiencies, (Atal *et al*., 2021).

Meanwhile, calcium Ca^{2+} is an important macronutrient for plant growth and flowering as it takes part in many metabolic and physiological processes. In various abiotic stress situations, calcium also functions as a second messenger to create intracellular stimulation and provide protection, (Parvin *et al.*, 2019). The vital role of calcium in the growing and development of plants is highlighted by its significance in biological processes like signaling, metabolism, and cell growth. Furthermore, plant diseases and alterations in the soil's microbiome are caused by a deficiency in calcium, (Jing *et al.*, 2024).

The main objective of the current study was therefore to investigate the effect of foliar spray of amino acids and seaweed extracts with microelements and calcium on growth, flowering, producing bulbs, and chemical constituents of *Hymenocallis speciosa* L. plants.

MATERIALS AND METHODS

This work was carried out at the Ornamental Plants and Landscape Gardening Research Dept., Hort. Res. Inst., ARC. Giza, Egypt, through the two seasons of 2022 and 2023 to investigate the effect of foliar spray of amino acids and seaweed extract with microelements and calcium on growth, flowering, bulb production, and chemical constituents.

Transplants of *Hymenocallis speciosa* L. (bulbs) were individually planted in plastic pots 30 cm in diameter filled with a mixture of clay and sand (1:1, v/v) of about 5.5 kg, as well as one bulb per pot. The bulbs used were 100-105 g in weight and 16-18 cm in circumference. The physical and chemical properties of the used soil are presented in Table (1).

Treatments:

The bulbs were planted on April 19th in pots under open field in both seasons and received the following treatments till the end of the experiment:

1. An amino acid (AA) complex consisting of (tryptophan + methionine 24% + cytokinin 1% + gibberellin 0.5 % + folic acid 8% + zinc 1.5% + manganese 1% + iron 2%) was used in concentrations of 1.0, 1.5 and 2.0 ml/l.
2. Seaweed extract (SWE) complex consisting of amino acids + vitamins + auxins + cytokinin 24% + organic acids 21% + trace elements 6% was used in concentrations of 1.0, 1.5 and 2.0 ml/l.
3. The microelements (ME) consisting of chelated iron 5.1%, chelated manganese 5.1%, chelated zinc 5.1%, chelated copper 0.25%, chelated boron 1.38%, amino acids 11.43%, magnesium 3.6% was used at a concentration of 0.5 g/l and calcium (Ca^{2+}) was used at 0.25 ml/l.

Treatments were as follows:

1. Control without any treatments
2. AA at 1.0 ml/l
3. AA at 1.5 ml/l
4. AA at 2.0 ml/l
5. AA at 1.0 ml/l + 0.25 ml Ca/l
6. AA at 1.0 ml/l + 0.5 g/l ME
7. AA at 1.5 ml/l + 0.25 ml Ca/l
8. AA at 1.5 ml/l + 0.5 g/l ME
9. AA at 2.0 ml/ l + 0.25 ml Ca/l
10. AA at 2.0 ml/l + 0.5 g/l ME
11. SWE at 1.0 ml/l
12. SWE at 1.5 ml/l
13. SWE at 2.0 ml/l
14. SWE at 1.0ml/l + 0.25 ml Ca/l
15. SWE at 1.0 ml/l + 0.5 g/l ME
16. SWE at 1.5ml/l + 0.25 ml Ca/l
17. SWE at 1.5 ml/l + 0.5 g/l ME
18. SWE at 2.0 ml/l + 0.25 ml Ca/l
19. SWE at 2.0 ml/l + 0.5 g/l ME

These treatments were applied as foliar spraying every two weeks. Everywhere if it was necessary, routine agricultural tasks like weeding and watering were completed.

Data recorded:

Plant height (cm), fresh weight of vegetative growth (g), number of leaves/plant, leaf area (cm^2), root length cm, fresh weight of roots (g), spike length (cm), spike diameter (cm), flower diameter (cm), flower weight (g), number of days from planting to flowering, fresh weight of bulb (g), bulb circumference (cm) and number of the new bulbs/plant.

Chemical constituents:

Photosynthetic pigments in fresh leaf samples (chlorophyll a, b, and carotenoids mg/g f.w.) were determined according to Lichtenthaler and Wellburn (1985). Dubois *et*

Table 1. Characteristics of growing media, both physically and chemically.

Mixture of clay and sand (1:1, v:v)			pH	EC (ds/m)	S.P.	Elements (ppm)						
Clay	Sand	Silt				N	P	K	Fe	Mn	Zn	Cu
45.80%	30.1%	22.25%	7.50	2.80	33.8	90.7	19.1	254	5.2	9.0	5.6	3.2

Cations (meq/l)				Anions (meq/l)		
Na^+	Ca^{++}	Mg^{++}	K^+	HCO_3^-	Cl^-	SO_4^{--}
7.9	5.15	3.1	2.40	2.71	5.95	5.42

al. (1956) was followed with the aim to calculate the total carbohydrate % in dry bulb samples. Additionally, the percentages of nitrogen (N) (Pregle, 1945), phosphorus (P) (Luatanab and Olsen, 1965), and potassium (K) (Jackson, 1973) were determined.

Statistical analysis:

The experimental design was a one-factor randomized complete block design (RCBD) with three replicates; each replicate contained five plants. After that, the data were tabulated and statistically analyzed using the MSTAT-C software according to Gomez and Gomez (1984) and the L.S.D. method described by Snedecor and Cochran (1980) was used to compare the means of the treatments at the 0.05 level of probability.

RESULTS

Parameters of growth:

Plant height (cm):

Data shown in Table (2) indicated that plant height was gradually increased by increasing amino acids or seaweed extract concentrations at 1.0, 1.5 and 2.0 ml/l compared with control in both seasons. The maximum values were recorded in plants treated with amino acid at 2.0 ml/l + 0.5 g/l microelements and seaweed extract at 2.0 ml/l + 0.5 g/l microelements.

Fresh weight of vegetative growth (g):

Fresh weight of vegetative growth (g) gave significantly the highest values for plants treated with amino acid at 2.0 ml/l + 0.5 g/l microelements, followed by seaweed extract 2.0 ml/l + 0.5 g/l microelements, as well as all treatments produced heavier values of fresh weight of vegetative growth when compared to the control in the two seasons, as exhibited in Table (2).

Number of leaves/plant:

Data registered in Table (2) demonstrated an increase in values of the number of leaves/plant compared to control in the two seasons in plants treated with amino acids and seaweed extract. Meanwhile, the effect of amino acid 2.0 ml/l + 0.5 g/l microelements or seaweed extract 2.0 ml/l + 0.5 g/l microelements led to the highest significant values in number of leaves/plant.

Leaf area (cm^2):

Leaf area (cm^2) of *Hymenocallis* plants showed a gradual increase in both seasons due to the gradual increase in the concentration of either amino acids or seaweed extract as shown in Table (3). In both seasons, all biostimulant treatments produced larger leaf areas compared to the control treatment. The foliar treatment of amino acids (2.0 ml/l) + 0.5 g/l of microelements produced the largest leaves (280.3 and 353.4 cm^2) in the first and second seasons, respectively. A significant increase in leaf area was observed in plants treated with the combined treatment of 0.5 g/l of microelements + amino acids at 2.0 ml/l.

Root length (cm):

Negligible differences were noticed for root length (cm) resulting from using amino acid or seaweed extract treatments in both seasons, as shown in Table (3). Meanwhile, the significant highest values were resulted from either applying amino acids (2.0 ml/l) + 0.5 g/l of microelements or seaweed extract (2.0 ml/l) + 0.5 g/l of microelements.

Fresh weight of roots (g):

Data executed in Table (3) showed that fresh weight of roots (g) was progressively increased by increasing the concentration of amino acids or seaweed extract in the two seasons. The amino acid treatments gave higher values than the seaweed treatments. Foliar spraying with amino acids (2.0 ml/l) + 0.5 g/l of microelements recorded the highest significant values.

Parameters of flowering:

Spike length (cm):

Data registered in Table (4) indicated that treating plants with amino acids or seaweed extract at 2.0 cm/l recorded the significantly longest spike (cm) compared with the untreated plants (control) in both seasons. Meanwhile, treatments with either amino acids or seaweed extract at 2.0 ml/l + 0.5 g/l

Table 2. Effect of amino acids, seaweed extract, microelements and calcium on plant height (cm), fresh weight of vegetative growth (g) and number of leaves/plant of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

Treatments		Plant height (cm)		Fresh weight of vegetative growth (g)		Number of leaves/plant	
AA and SWE	Ca and ME	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	**0**	38.0	43.2	81.4	95.5	7.3	9.0
AA 1.0 ml/l	**0**	44.1	55.0	99.7	141.1	9.0	10.3
	Ca 0.25 ml/l	45.2	56.1	115.6	132.8	9.60	14.5
	ME 0.50 g/l	46.1	59.2	125.3	149.8	10.3	16.0
AA 1.5 ml/l	**0**	47.0	59.0	120.6	151.0	10.0	11.6
	Ca 0.25 ml/l	47.4	60.1	120.5	156.1	10.7	15.0
	ME 0.50 g/l	48.7	62.0	127.6	162.9	11.0	15.3
AA 2.0 ml/l	**0**	49.2	62.0	144.8	170.0	9.30	13.0
	Ca 0.25 ml/l	49.3	64.5	145.5	180.4	11.0	15.3
	ME 0.50 g/l	56.3	69.5	188.2	225.3	12.5	17.0
SWE 1.0 ml/l	**0**	43.5	50.5	114.0	111.2	9.0	10.1
	Ca 0.25 ml/l	43.5	50.2	107.7	112.5	9.0	12.0
	ME 0.50 g/l	45.3	53.2	116.9	132.2	9.3	9.0
SWE 1.5 ml/l	**0**	45.5	53.2	118.8	133.5	9.0	11.2
	Ca 0.25 ml/l	46.0	54.0	121.2	141.1	9.3	10.3
	ME 0.50 g/l	48.9	59.0	129.9	151.0	10.7	11.6
SWE 2.0 ml/l	**0**	48.1	60.5	131.4	175.1	11.0	11.5
	Ca 0.25 ml/l	49.5	60.0	148.4	170.0	10.5	13.0
	ME 0.50 g/l	55.4	65.1	174.8	210..0	11.3	15.5
LSD at 0.05		5.230	6.411	11.710	13.852	1.601	1.550

AA: Amino acids; SWE: Seaweed extract; ME: Microelements; Ca: Calcium= Ca

Table 3. Effect of amino acids, seaweed extract, microelements and calcium on leaf area (cm^2), root length (cm) and fresh weight of roots (g) of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

Treatments		Leaf area (cm^2)		Root length (cm)		Roots fresh weight (g)	
AA and SWE	Ca and ME	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	**0**	158.6	217.7	27.0	35.0	69.0	94.5
AA 1.0 ml/l	**0**	175.7	232.5	27.5	37.2	87.4	103.5
	Ca 0.25 ml/l	187.9	245.6	29.0	35.1	93.2	145.7
	ME 0.50 g/l	205.8	267.6	31.5	41.1	101.5	157.6
AA 1.5 ml/l	**0**	184.9	258.2	30.0	38.2	96.8	116.0
	Ca 0.25 ml/l	210.3	293.4	30.8	39.3	98.5	166.7
	ME 0.50 g/l	216.5	295.1	32.1	45.4	119.9	185.7
AA 2.0 ml/l	**0**	207.5	273.3	34.0	40.5	102.4	123.5
	Ca 0.25 ml/l	212.3	303.6	34.1	42.5	103.1	201.8
	ME 0.50 g/l	280.3	353.4	42.5	56.5	133.2	213.5
SWE 1.0 ml/l	**0**	178.2	210.2	28.1	36.1	76.0	94.5
	Ca 0.25 ml/l	180.7	234.1	30.3	40.0	77.5	122.4
	ME 0.50 g/l	200.0	250.4	31.5	44.2	79.1	91.2
SWE 1.5 ml/l	**0**	193.8	225.0	30.8	40.3	80.4	178.5
	Ca 0.25 ml/l	210.0	257.3	32.5	42.5	81.7	100.1
	ME 0.50 g/l	226.3	278.6	33.3	44.6	85.9	141.0
SWE 2.0 ml/l	**0**	214.5	243.2	32.2	45.1	82.6	116.7
	Ca 0.25 ml/l	219.7	288.6	35.5	45.0	90.0	133.2
	ME 0.50 g/l	237.3	305.1	38.0	51.5	115.9	161.2
LSD at 0.05		29.271	33.653	4.550	5.292	14.810	18.282

AA: Amino acids; SWE: Seaweed extract; ME: Microelements; Ca: Calcium= Ca

Table 4. Effect of amino acids, seaweed extract, microelements and calcium on spike length (cm), spike diameter (cm) and number of flowers/plant of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

Treatments		Spike length (cm)		Spike diameter (cm)		Number of flower/Spike	
AA and SWE	Ca and ME	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	**0**	29.8	42.1	1.17	1.65	7.0	7.0
AA 1.0 ml/l	**0**	33.6	45.7	1.27	1.81	8.0	8.2
	Ca 0.25 ml/l	35.8	45.0	1.69	1.90	8.0	9.5
	ME 0.50 g/l	36.8	46.2	1.44	1.93	9.0	10.6
AA 1.5 ml/l	**0**	37.7	48.0	1.45	1.92	8.0	9.6
	Ca 0.25 ml/l	37.5	48..8	1.66	1.99	9.5	11.2
	ME 0.50 g/l	39.4	50.7	1.70	2.10	9.9	13.0
AA 2.0 ml/l	**0**	38.7	51.8	1.53	2.10	9.7	10.0
	Ca 0.25 ml/l	40.3	52.3	1.67	2.14	10.0	13.7
	ME 0.50 g/l	48.1	58.4	2.00	2.39	12.0	14.8
SWE 1.0 ml/l	**0**	31.5	45.9	1.30	1.61	7.1	7.5
	Ca 0.25 ml/l	33.2	46.5	1.39	1.60	7.5	9.1
	ME 0.50 g/l	36.7	47.9	1.40	1.74	8.2	9.5
SWE 1.5 ml/l	**0**	34.4	47.6	1.47	1.72	7.5	9.0
	Ca 0.25 ml/l	35.7	50.1	1.55	1.71	10.0	9.7
	ME 0.50 g/l	38.8	51.4	1.60	1.77	10.1	10.3
SWE 2.0 ml/l	**0**	37.6	49.8	1.50	1.80	8.0	9.5
	Ca 0.25 ml/l	39.3	53.4	1.65	1.79	10.3	10.5
	ME 0.50 g/l	44.1	56.6	1.77	2. 25	11.0	12.3
LSD at 0.05		4.615	5.817	0.523	0.672	2.621	2.604

AA: Amino acids; SWE: Seaweed extract; ME: Microelements; Ca: Calcium= Ca

of microelements resulted in the longest flowering spikes in both seasons.

Spike diameter (cm):

Either the amino acids and/or seaweed extract at 2.0 ml/l + 0.5 g/l of microelement treatments significantly increased spike diameter to the highest values in both seasons, as shown in Table (4). Spike diameter showed a gradual increment in both seasons with increasing either amino acid or seaweed extract concentrations.

Number of flowers/spike:

Data on number of flowers/spike shown in Table (4) revealed that in the successive growing two seasons, the foliar treatments with either amino acids or seaweed extract at 2.0 ml/l + 0.5 g/l of microelements significantly increased the formation of flowers/spike compared to control. A similar effect resulted from using amino acids or seaweed extract at 2.0 ml/l + 0.25 ml Ca/l.

Flower diameter (cm):

Data presented in Table (5) indicated that the flower diameters (cm) resulting from all of the applications either amino acid or seaweed extract treatments in both seasons were insignificantly different. It was noticed that, in comparison to the control, there were not any significant differences between all treatments.

Flower weight (g):

The results listed in Table (5) showed that spraying plants with amino acids at the two concentrations used (1.5 and 2.0 cm/l) significantly increased flower weight (g) compared to control. However, foliar spraying of seaweed extract at 2 cm/l and seaweed extract at 2 ml/l + 0.5 g/l of microelement significantly increased this value. The amino acids or seaweed extract at 2.0 ml/l + 0.5 g/l of microelement led to a significant increase in flower weight.

Number of days from planting to flowering:

Data given in Table (5) indicated that applying either amino acids or seaweed extract at 2.0 ml/l + 0.5 g/l of microelement induced the earliest flowering in both seasons.

Table 5. Effect of amino acids, seaweed extract, microelements and calcium on flower diameter (cm), flower weight (g) and number of days from planting to flowering of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

Treatments		Flower diameter (cm)		Flower weight (g)		Number of days from planting to flowering	
AA and SWE	Ca and ME	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	**0**	22.1	22.9	8.0	10.9	120.0	120.1
AA 1.0 ml/l	**0**	22.5	24.5	9.5	11.4	111.1	116.0
	Ca 0.25 ml/l	23.0	23.5	9.9	12.1	114.0	116.5
	ME 0.50 g/l	23.0	25.1	10.0	12.9	112.0	112.3
AA 1.5 ml/l	**0**	22.7	24.6	10.0	12.4	112.4	114 .0
	Ca 0.25 ml/l	24.1	25.4	11.2	14.85	113.5	116.5
	ME 0.50 g/l	24.4	25.3	14.0	15.4	113.0	115.7
AA 2.0 ml/l	**0**	23.9	25.2	10.4	16.0	112.2	114.7
	Ca 0.25 ml/l	24.5	25.1	11.6	16.2	114.0	116.2
	ME 0.50 g/l	24.6	25.4	17.9	19.9	105.3	106.2
SWE 1.0 ml/l	**0**	21.2	22.1	9.5	10.1	115.0	117.5
	Ca 0.25 ml/l	23.1	22.3	12.1	10.8	114.3	116.9
	ME 0.50 g/l	24.0	25.0	12.6	11.5	116.0	112.0
SWE 1.5 ml/l	**0**	21.3	23.7	10.0	12.0	113.5	116.9
	Ca 0.25 ml/l	21.3	24.1	9.4	12.1	115.1	117.8
	ME 0.50 g/l	22.5	24.7	11.7	13.2	115.5	112.7
SWE 2.0 ml/l	**0**	23.8	24.9	11.0	13.7	114.0	115.4
	Ca 0.25 ml/l	24.0	23.5	12.8	12.7	117.5	116.0
	ME 0.50 g/l	24.8	25.7	15.8	17.6	112.5	110.7
LSD at 0.05		N.S.	N.S.	2.383	4.172	11.051	11.530

AA: Amino acids; SWE: Seaweed extract; ME: Microelements; Ca: Calcium= Ca

There were negligible differences in the earliest flowering when amino acid or seaweed extract treatments were used in the two seasons.

Parameters of bulbs:

Bulbs fresh weight (g):

All of treatments when compared to control (untreated plants) were successfully increased the bulbs fresh weight in both seasons as a shown in Table (6).

Bulb circumference (cm):

Bulb circumference (cm) in both seasons was progressively increased by increasing concentrations of amino acids or seaweed extract, as exhibited in Table (6). Spraying amino acids gave significantly higher values, followed by seaweed extract at 2.0 ml/l + 0.5 g/l of microelement.

Number of bulbs/plant:

Data exhibited in Table (6) indicated that number of bulbs/plant was gradually increased by the gradual increase in treatments with either amino acids or seaweed extract at 2.0 ml/l + 0.5 g/l of microelement. Treating plants with amino acids or seaweed extract mixed with 0.5 g/l of microelement recorded significantly higher values in both seasons than other treatments.

Chemical constituents of the plant:

1. Pigment contents of leaves:

a. Chlorophyll a (mg/g f.w.):

Data illustrated in Fig. (1) demonstrated that the fertilizer treatments improved chlorophyll (a) content in leaves compared with control in both seasons, the superiority was of using both amino acids 2.0 ml/l+ microelements 0.5 g/l and seaweed extract 2.0 ml/l+ microelements 0.5 g/l.

b. Chlorophyll b (mg/g f.w.):

The recorded data in Fig. (2) show that treating plants with amino acids at 2.0 ml/l+ microelements at 0.5 g/l gave the highest values of chlorophyll b (mg/g f.w.) content in the two seasons. However, seaweed extract at 2.0 ml/l + microelements 0.5 g/l in the first

Table 6. Effect of amino acids, seaweed extract, microelements and calcium on bulb fresh weight (g), bulb circumference (cm) and number of bulbs/plant (bulbs yield) of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

Treatments		Bulbs fresh weight (g)		Bulb circumference (cm)		Number of bulbs/plant	
AA and SWE	Ca and ME	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	**0**	52.8	64.9	14.1	14.9	0.91	0.95
AA 1.0 ml/l	**0**	65.8	77.5	15.5	16.5	0.97	0.99
	Ca 0.25 ml/l	64.5	75.4	14.9	18.0	0.98	1.00
	ME 0.50 g/l	68.7	87.1	15.5	18.3	0.99	1.00
AA 1.5 ml/l	**0**	73.1	94.4	16.5	17.1	0.99	1.00
	Ca 0.25 ml/l	74.2	95.3	13.5	18.3	1.00	1.14
	ME 0.50 g/l	79.4	104.2	13.0	19.0	1.00	1.15
AA 2.0 ml/l	**0**	89.2	110	17.6	18.1	1.12	1.15
	Ca 0.25 ml/l	93.2	101.9	14.5	19.3	1.01	1.17
	ME 0.50 g/l	99.1	112.3	16.1	19.5	1.23	1.29
SWE 1.0 ml/l	**0**	63.8	77.3	14.0	20.6	0.96	0.96
	Ca 0.25 ml/l	65.5	73.4	13.8	19.0	0.98	1.00
	ME 0.50 g/l	68.8	79.9	15.0	15.9	0.99	1.01
SWE 1.5 ml/l	**0**	75.9	86.2	14.5	14.2	0.98	0.99
	Ca 0.25 ml/l	76.4	85.1	14.5	16.1	1.05	1.12
	ME 0.50 g/l	80.2	88.7	14.5	17.5	1.15	1.17
SWE 2.0 ml/l	**0**	78.7	94.5	15.0	17.8	1.10	1.10
	Ca 0.25 ml/l	82.2	90.4	14.3	18.5	1.09	1.13
	ME 0.50 g/l	89.1	97.7	15.1	20.5	1.31	1.28
LSD at 0.05		7.444	8.123	3.486	2.797	0.173	0.157

AA: Amino acids; SWE: Seaweed extract; ME: Microelements; Ca: Calcium= Ca

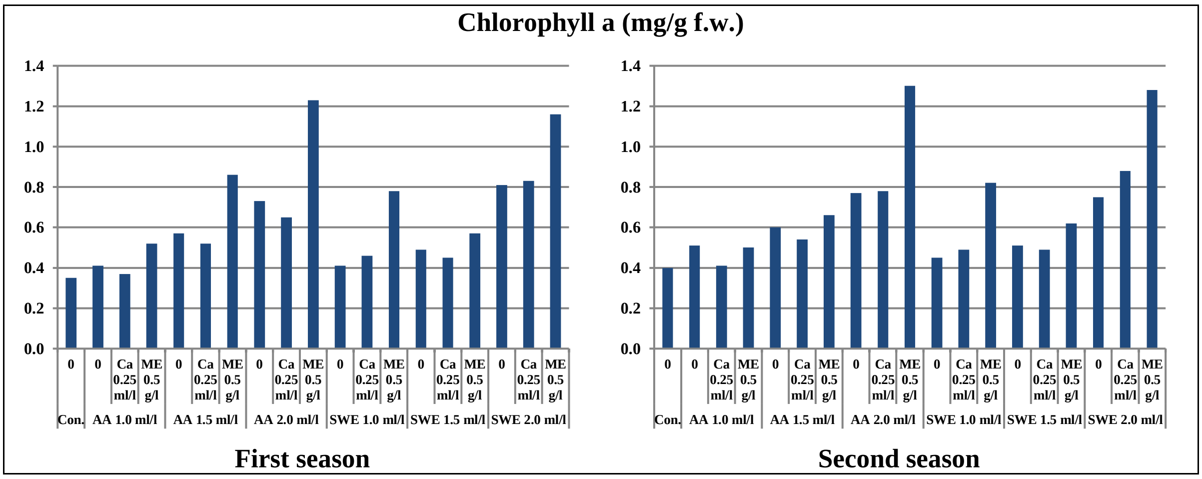

Fig. 1. Effect of amino acids, seaweed extract, microelements and calcium on chlorophyll a (mg/g f.w.) of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

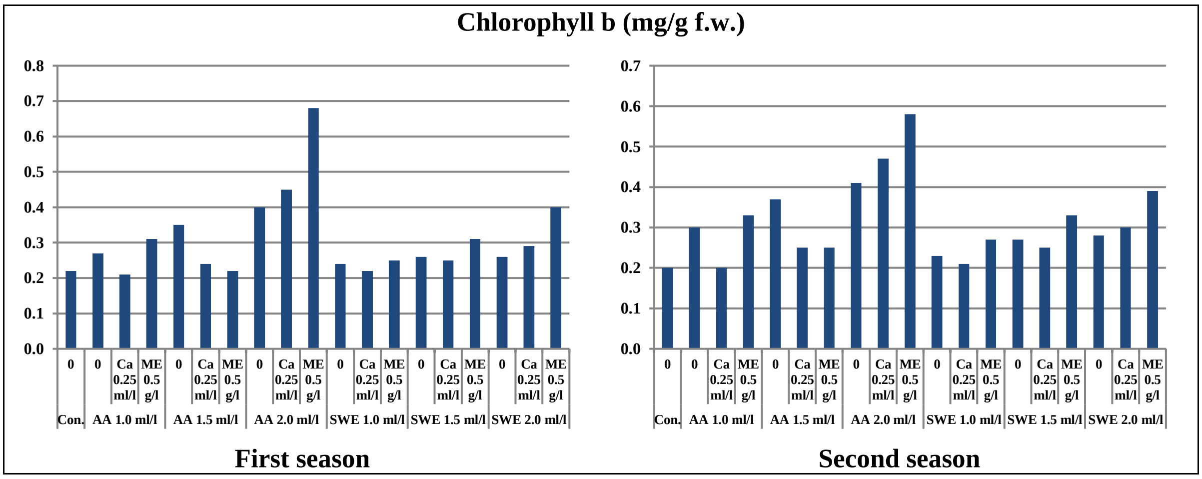

Fig. 2. Effect of amino acids, seaweed extract, microelements and calcium on chlorophyll b (mg/g f.w.) of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

and second seasons proved also the superiority in increasing chlorophyll b content.

c. Carotenoids (mg/g f.w.):

Data shown in Fig. (3) displayed that treating plants with amino acids 2.0 ml/l, amino acids 1.0 ml/l + microelements 0.5 g/l, amino acids 2.0 ml/l + microelements 0.5 g/l, seaweed extract 1.5cm/l and seaweed extract at 2.0 ml/l + microelements 0.5 g/l recorded the highest values of carotenoids content in the first season. On the other side, the superiority was to treating plants with amino acids 2.0 ml/l, amino acids 2.0 ml/l + microelements 0.5 g/l, seaweed extract 1.5 ml/l, seaweed extract 1.5 cm/l and seaweed extract 2.0 ml/l + microelements 0.5g/l in the second one.

Total carbohydrates (%):

Data presented in Fig. (4) demonstrated a decrease in total carbohydrate percentage in both seasons when amino acids and seaweed extract were treated with calcium at a concentration of 0.25 ml/l. Meanwhile, negligible differences were noticed as total carbohydrates % in bulbs resulted from using amino acids seaweed extract treatments in both seasons.

Nitrogen (%):

Data registered in Fig. (5) revealed that nitrogen % in bulbs was progressively increased by raising the concentrations of amino acids and seaweed extract, giving the utmost highest values by receiving plants amino acids at 2.0 ml/l + microelements at 0.25 g/l, then seaweed extract at 2.0 ml/l + microelements at 0.25 g/l in both seasons.

Phosphorus (%):

Data illustrated in Fig. (6) showed that phosphorus % in bulbs was progressively increased as a result of increasing the concentrations of amino acids and seaweed extract in the two seasons. Moreover, all treatments caused increments in the phosphorus % compared with the control plant. The treatment of amino acid 2.0 ml/l+ microelements (0.25 g/l) gave a superior rank in both seasons.

Potassium (%):

Data outlined in Fig. (7) indicated that amino acids followed by seaweed extract caused an increment in potassium %, in bulbs compared with the control in both seasons. Meanwhile, negligible differences were noticed in potassium % content resulting from all treatments used, except amino acid 2.0 ml/l + microelements 0.25 g/l, which was superior in both seasons.

DISCUSSION

Growth and development of plants are influenced by amino acids because they are

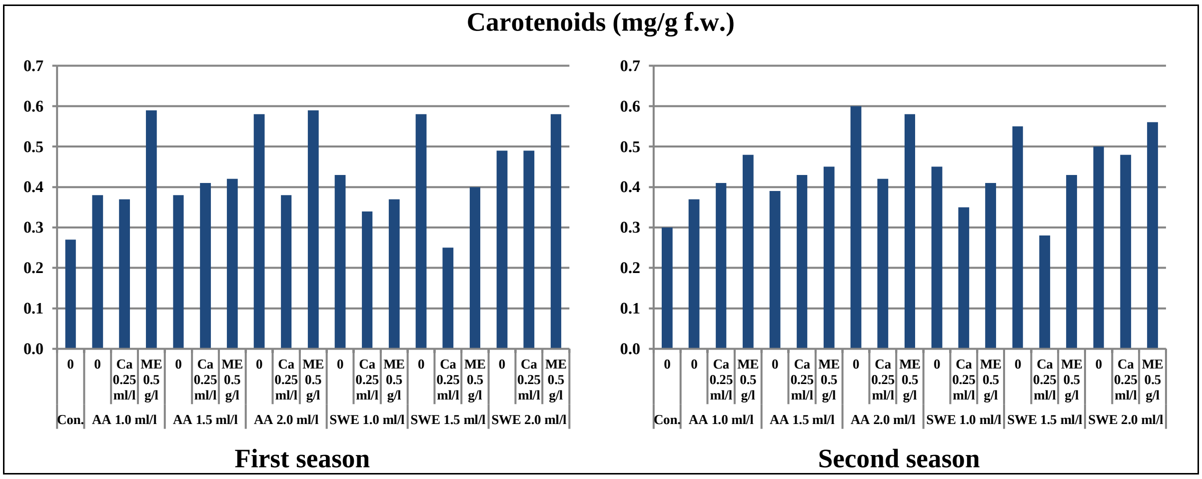

Fig. 3. Effect of amino acids, seaweed extract, microelements and calcium on carotenoids (mg/g f.w.) of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

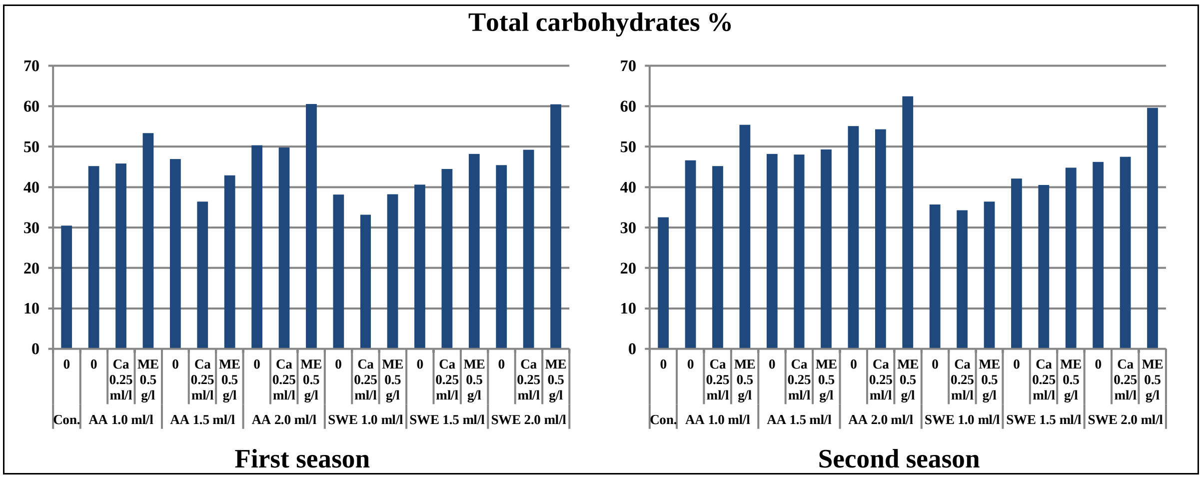

Fig. 4. Effect of amino acids, seaweed extract, microelements and calcium on total carbohydrates % of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

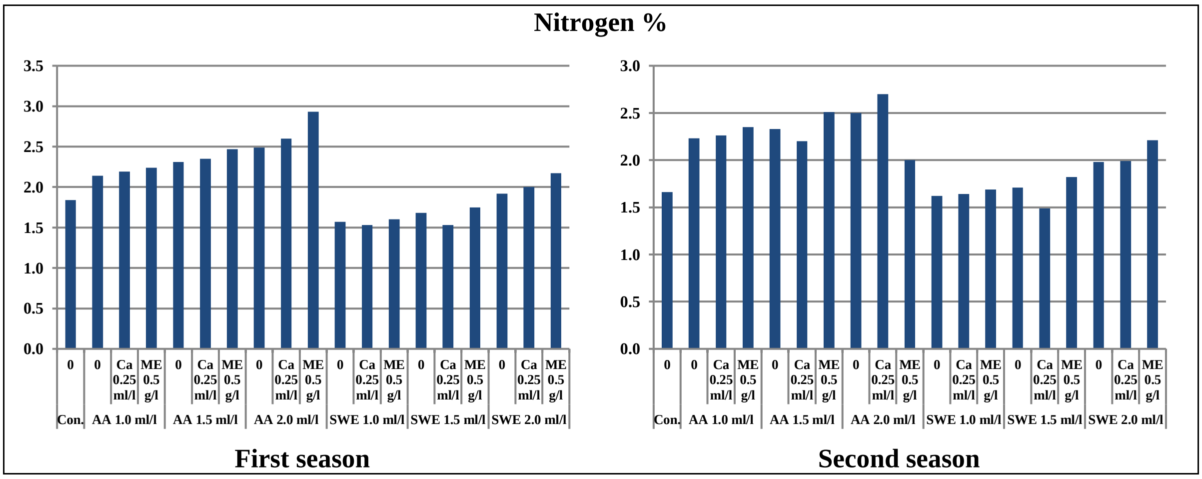

Fig. 5. Effect of amino acids, seaweed extract, microelements and calcium on total nitrogen % of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

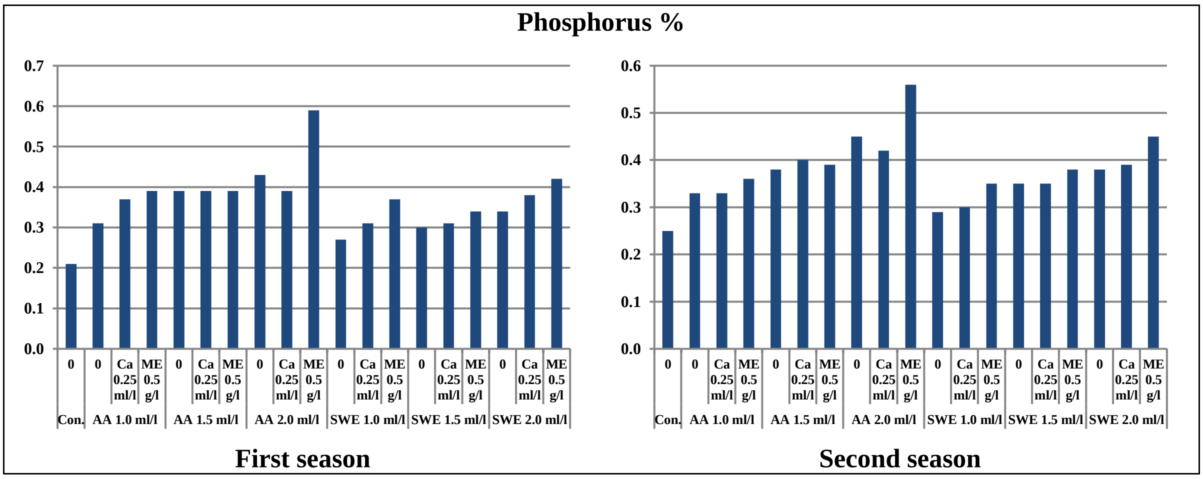

Fig. 6. Effect of amino acids, seaweed extract, microelements and calcium on total phosphorus % of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

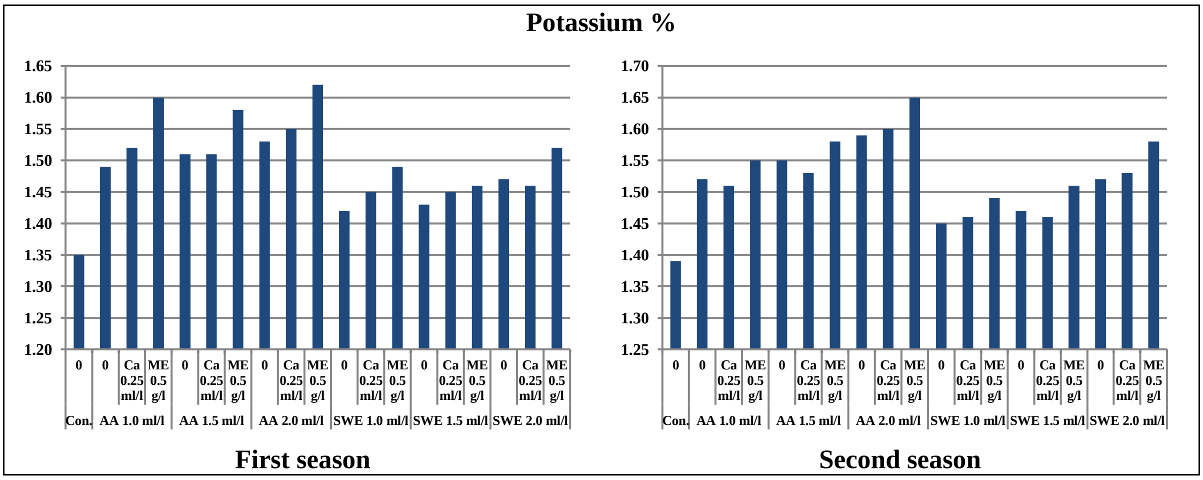

Fig. 7. Effect of amino acids, seaweed extract, microelements and calcium on total potassium % of *Hymenocallis speciosa* L. in two seasons of 2022 and 2023.

necessary for the synthesis of proteins, phytohormones, and other organic compounds like vitamins, amines, alkaloids, and enzymes (Batista-Silva *et al*., 2019). The development of amino acid foliar spray programs is the focus of recent researches. The nitrogenous substance that makes up the foundation of every living cell is amino acid. It is exogenously absorbed by leaves. (Stiegler *et al*., 2013). Previous studies on ornamental flowers such as Gladiolus (Mustafa and Al-Saad, 2020) spraying treatments with amino acid significantly increased the number of leaves, plant height, leaf area, early flowering date and diameter of new corms. Studies on *Polianthes tuberosa* (Afifipour and Khosh-Khui, 2015), *Gerbera jamesonii* (Abd-Elkader *et al*., 2020), *Eustoma grandiflorum* (Mondal *et al*., 2015) showed that foliar applications with some amino acids increased the fresh and dry weights of leaves and roots, total leaf area, number of leaves, chlorophylls a, b and total, total carbohydrates, and leaf N, P and K contents. El-Naggar *et al.* (2013) recorded that spraying plants with amino acid (2.0 ml/l) gave the highest significant increase in flower diameter and flower fresh weight, bulb circumference and fresh weights of bulbs of lilium cultivars.

Amino acids are considered important bio-stimulants for plants because they increase the concentration of pigments in the leaf, carbohydrates, and minerals. Many studies have been conducted on the effect of amino acids on various plants. Shafie *et al*. (2021) on yarrow (*Achillea millefolium* L.)

found that the foliar sprays of amino acids at 3 ml/l led to increasing chlorophyll content, carotenoids, N, P, and K in the leaves. Naggar and Abd El-Hafez (2011) showed that foliar spray of amino acid (tryptophan) at 200 ppm led to the highest values of chlorophyll a, b, and mineral contents in the leaves, as well as carbohydrates in the new corms of gladiolus plants. Treating lilium bulbs by foliar spraying of amino acid and 2.0 ml/l) gave the highest significant value of chlorophyll (a, b), total carbohydrates and N, P and K in the leaves (El-Naggar *et al.* 2013). On gladiolus plant, the treatment with amino acids at 150 mg /l, significantly enhanced the contents of chlorophyll, nitrogen, phosphorus, and potassium in the leaf, (Abed Edan *et al.*, 2022). Amino acids are the building blocks of proteins and have a number of vital functions. For example, glutamine and ornithine, which are precursors for nucleotides and polyamines, respectively, can function as coenzyme components or as precursors for biosynthesis (Alcázar *et al*., 2010).

Seaweed extracts have many growth benefits when applied to plants. Abd Al-Karimjassim and Radhi (2019) found that the spraying treatment with seaweed extract at 6 ml/l concentration gave increases in plant height, leaves area, number of flowers, and number of corms on freesia plant. Kanbe, (2022) on *Gladiolus hybrida*, stated that foliar application of seaweed extract at 1 g /l gave a significant increase in the total number of leaves /plant and corms and their fresh weights. Seaweed extract promoted flowering traits and significantly gave earliest flowering. (Nofal *et al.*, 2022). On *Zinnia elegans* the foliar spraying of seaweed extract at 2.0ml/l significantly influenced the quality of flower production (Ahmed, 2024).

Numerous studies worked on various plants revealed the vital role of foliar spraying seaweed extract in increasing the content of chlorophyll a and b and carotenoids in leaves as well as N, P and K (%), as reported by El-Alsayed *et al.* (2018) on dahlia plant, Khalaf and Saeed (2020) on the freesia, Shehata *et al.* (2011) on the celeriac plant, and Shafie *et al*. (2021) on yarrow (*Achillea millefolium* L.). Seaweed extracts, which naturally supply nutrients and plant growth hormones (auxins, cytokines, and gibberellins) along with other plant biostimulants, such as vitamins and amino acids, may have a positive impact on these results. These extracts could improve plant resistances, delay plant senescence, and regulate cell division (Crouch and Van Standen, 1993).

A lot of workers agreed that micronutrients improve the growth and yield of plants. Foliar treatment of micronutrients mixture significantly increased plant height, fresh weights, root length, chlorophyll, carotenoids, N and K contents as compared to the control on *Majorana hortensis* plants, (Hanafy *et al*., 2018). Spraying microelement resulted in the largest values of chlorophyll, leaf area, number of leaves, bulb weight, bulb diameter, and number of bulbs/plant on *Polianthes tuberosa* L. (Al-Dur and Al-Atrakchii, 2021). Micronutrients are important for plant nutrition because they affect the growth, development, and quality of plants. Also, the use of some biostimulants and micronutrient mixtures and their interactions led to an increase in vegetative growth, yield, and chemical compositions (Ahmed *et al*., 2024).

RECOMMENDATION

From the above-mentioned results, it could be concluded that foliar spraying treatment of amino acids and seaweed extract at 2.0 ml/l could be successfully utilized to increase vegetative growth, flower parameters, significantly enhanced chlorophyll, total carbohydrates, N, P, and K of *Hymenocallis speciosa* L. Furthermore, foliar spraying treatment of amino acids at 2.0 ml/l + microelements at 0.5 g/l significantly increased the parameters of growth, flowering, producing new bulbs, and chemical content results, followed by seaweed extract at 2.0 ml/l + microelements at 0.5 g/l.

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تأثير الرش الورقي بالأحماض الأمينية ومستخلص الأعشاب البحرية مع العناصر الصغرى والكالسيوم على نمو وإزهار وإنتاجية ألابصال لنبات الهيمنوكاليس

مجدى عزمى برسوم، نرمين السيد عبد المنعم، إيفون عاطف خلة
قسم بحوث نباتات الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، مصر

تهدف الدراسة الحالية إلى دراسة التأثيرات المفيدة للرش الورقي بالأحماض الأمينية و مستخلص الأعشاب البحرية بتركيزات ١ و١,٥ و٢ مل/لتر منفردة أو مع إضافة خليط من العناصر الصغرى بتركيز ٠,٥ جم/لتر والكالسيوم بتركيز ٠,٢٥ مل/لتر على النمو الخضري والإزهار وإنتاجية البصيلات والمكونات الكيميائية. عوملت النباتات بالأحماض الأمينية كمحفز حيوي بتركيز ٢ مل/لتر أعطى زيادة فى معظم صفات النمو كما أعطي مستخلص الأعشاب البحرية نفس التأثير. وايضا عند معاملة النباتات بالأحماض الأمينية بتركيز ٢ مل/لتر مع العناصر الصغرى بتركيز ٠,٥ جم/لتر، أدى إلى زيادة كبيرة في قيم الصفات الخضرية ارتفاع النبات، الوزن الطازج للمجموع الخضري، عدد الأوراق/نبات، مساحة الورقة، طول الجذر، الوزن الطازج للجذور، طول الحامل الزهري، قطر الزهرة، وزن الزهرة، الوزن الطازج للبصيلة ومحيط البصيلة. كما أدى إلى زيادة محتوى الكلوروفيل والكاروتينات في الأوراق والكربوهيدرات الكلية والنسبة المئوية لعناصر النيتروجين والبوتاسيوم والفسفور في البصيلات الجديدة. وقد أدى رش النبات بمستخلص الأعشاب البحرية بمعدل ٢ سم/لتر مع إضافة خليط من العناصر الصغرى بمعدل ٠,٥ جم/لتر إلى زيادة معظم صفات النبات. ولكن معاملة الأحماض الأمينية تفوقت فى بعض صفات النبات المدروسة مقارنة بالمعاملة بمستخلص الاعشاب البحرية.