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Inas Majid Takleef
Faculty of Agriculture, University of Kufa, Republic of Iraq, Iraq

Aziz Kamil Nahi Aljaifari
Faculty of Agriculture, University of Kufa, Republic of Iraq, Iraq

Mohammed Jassim Mohammed Ganaweyi
Faculty of Agriculture, University of Kufa, Republic of Iraq, Iraq

Corresponding Author:
Aziz Kamil Nahi Aljaifari
Faculty of Agriculture, University of Kufa, Republic of Iraq, Iraq

Response of *Catharanthus roseus* to fertilization with humic acid and spraying seaweed extracts in vegetative, floral and chemical growth indicators

Inas Majid Takleef, Aziz Kamil Nahi Aljaifari and Mohammed Jassim Mohammed Ganaweyi

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Abstract
The experiment was conducted at the research station of the College of Agriculture, University of Kufa, during the 2024-2025 growing season, to evaluate the effect fertilization with humic acid and spraying with seaweed extracts on vegetative, floral and chemical on *Catharanthus roseus*. seeds of *Catharanthus roseus* L. plant were planted on February/20/2025. the treatments of fertilizing with hiumic acid four concentrations 0, 10, 20 and 30 mgL.-1 and foliar treatment with seaweed extracts four concentrations 0, 100, 200 and 300 mg L-1. humic acid compost was added three times at transplanting in 26 cm dia. pots while seaweed extracts was sprayed three times apply the experiment period. the treatments were applied in a factorial experiment with two factors and three replications and the experiment was implemented using a complete randomized block design (R.C.B.D) 4×4×3 = 48. were analyzed using analysis of variance (ANOVA) and comparisons were made. According to the Least Significant Difference test (L.S.D) at a probability level (0.05).the results showed that soil treated with 30 mg L^{-1} hiumic acid and with seaweed extracts at 300 mg. L^{-1} resulted in higher values of in plant height, number ofv leaves, number of flowers, flower diameter, leafrs content of total chlorophyll, and total soluble carbohydrates and the flower content of anthocyanin pigment. the interaction was 30 mg.L^{-1} humic acid and 300 mg.L^{-1} seaweed extracts, which did not differ from the interaction of humic acid at the same concentration with 200 mg.L^{-1} seaweed extracts. the mentioned interaction treatments differed significantly from the individual treatments and was also significantly different from the control treatment in all the studied parameters.

Keywords: *Catharanthus roseus,* humic acid, seaweed extracts, fertilization

Introduction
The Al-Wonka plant, *Catharanthus rosens* L., is a member of the apocynaceae family. It is a perennial, evergreen, flowering ornamental plant. It is grown in Arab and Islamic countries as an ornamental plant in flower beds for the beauty of its multi-colored flowers and its long flowering period [20]. It is recommended as a perennial semi-shrub plant with single, cylindrical, erect stems, and many branches at the top. The leaves are simple, opposite, oval, oblong, smooth, and entire. The inflorescences are terminal or axillary. The flowers are layered and arranged in groups without a stalk, ranging in number from 2 to 7. Its original habitat is the island of Madinah [23] and. It is considered an important medicinal plant, as it contains many alkaloid compounds, the most important of which are Vincristine and Vinblastine, which are produced by the Al-Wonka plant, and are used in the treatment of cancer and reducing the number of white blood cells It also contains The plant two compounds, serpentine and ajmalicine, which are used to treat high blood pressure [27]. have been reported to contain many alkaloids with therapeutic efficacy. These are used to treat several diseases, such as diabetes, and also aid wound healing in diabetic patients [17]. the process of correct and balanced nutrition that provides the plant with all its nutritional needs, is important in increasing the rate of plant growth, completing the formation and improvement of flowers and their quality, and producing flowers with standard specifications, by adding organic fertilizers to the soil because they play a major role in improving plant growth [24]. among these organic fertilizers is humic acid, is an organic fertilizer that improves plant growth by regulating the carbon cycle and releasing nutrients such as

nitrogen, phosphorus, and sulfur. It also increases the absorption of elements and improves soil fertility [3]. humic acid has been shown to stimulate plant growth by affecting mechanisms involved in photosynthesis, cellular respiration, water and nutrient uptake, membrane permeability, enzyme activity, and biomass activation [22]. the effect of humic acid on plant growth and crops is both direct and indirect. The indirect effect of humic acid is on soil fertility, increasing the number of soil microorganisms, improving soil structure and cation exchange capacity, and regulating soil pH. As for the direct effect, humic acid may have various physiological effects in plants, including on the cell wall and cell membrane layer, or in the cytoplasm, such as increasing photosynthetic activity, improving protein synthesis, and hormone-like activities [8]. Seaweed extracts are organic sources that, when added in small concentrations, stimulate plant growth and do not leave any negative residues on the plant or soil due to their non-toxic biological nature. Seaweed extracts also contain many nutritional elements and some plant growth regulators such as auxins, gibberellins, and amino acids that stimulate vegetative growth [13]. seaweed extracts play a role in improving the absorption of nutrients by plants, which stimulates growth and increases the efficiency of nutrient use by plants. They also play a role in stimulating root growth, increasing stem thickness, and increasing vegetative growth by increasing the efficiency of photosynthesis, in addition to protecting the plant from stress conditions such as drought, aging, and salinity by supporting the plant cell [11].

Materials and Methods

The experiment was carried out at the Agricultural research station of the College of Agriculture - University of Kufa, in a Plastichouse covered with green netting, with a shade rate of 25% during the 2024-2025 agricultural season, to demonstrate the effect of humic acid and Seaweed extracts on the growth and flowering of the Al-Wonka. The seeds have been planted of the "Local variety on febraury/20/2025, into plastic pots with a diameter of (25 cm) and a height of (28 cm) containing a culture medium consisting of soil and peat moss at a ratio of 1:3. Samples of the soil used in agriculture were analyzed and their chemical and physical properties and suitability [12] Table (1).

Table 1: Physiochemical composition analyses of the potting soil.

The texture of potting soil (Sandy soil)	**Profile**	**(%)**
	Clay	16.28
	Silt	7.85
	Sand	74.18
Chemical analysis	**Unit**	**Value**
pH	----------	7.60
EC	$Ds.M^{-1}$	3.70
N	$mg.L^{-1}$	30.90
P	$mg.L^{-1}$	12.30
K^+	$mg.L^{-1}$	14.70
$CaCO_3$	%	12.56
Orange matter (OM)	%	2.20

Table 2: Physiochemical composition analyses of potting-peat moss.

Chemical analyses	Unit	Value
pH	----------	***7.86***
EC	$Ds.M^{-1}$	2.69
N	$mg.L^{-1}$	140
P	$mg.L^{-1}$	160
K^+	$mg.L^{-1}$	180
Mg++	$mg.L^{-1}$	100
S	$mg.L^{-1}$	120

The experimental treatments included two factors the first factor was add humic acid four concentrations (0, 10, 20 and 30) $mg.L^{-1}$, and the second factor was spraying Seaweed extracts four concentrations: (0, 100, 200 and 300) $mg.L^{-1}$ three times. with three replications as Complete Randomized Block Design (RCBD) the experiment data were collected and subjected to data analysis, where analysis of variance ANOVA was performed using the computing statistical program GenStat 12th Differences among the treatment's means were compared according to the least significant difference (L.S.D) at a probability level of 0.05**.** the first and second factors were applied (after the appearance of 4-5 true leaves), and treatments continued every 21 days [9]. The add and spraying procedure was done three times for both factors; while leaving 21 days between the first, second, and third treatment plants were sprayed early in the morning until complete wetness using a hand sprayer (2 liters size). Also, a liquid detergent (two drops per liter) was added to the spray solution as a surfactant, taking into account the placement of a barrier between the treatments so as to avoid contamination between the experimental units. A layer of polyethylene was placed under the pots to prevent the growth of weeds in the and to avoid the rise of salts in the experiment pots. Also, thin plastic mulch was placed beneath each pot to maintain moisture in the potting soil.

First: Vegetative growth indicators

1. Plant height (cm)

Plant height was measured using a measuring tape from the soil surface of the pots to the highest point at the stage of flower bud emergence for each experimental unit, and the rate was calculated for each treatment.

2. Total numbere of leavese

The number of total leaves and each experimental unit were calculated, from which the average values for each treatment were calculated.

Second: Flower growth indicator

1. Number of flowers ($flower.plant^{-1}$) The number of plant flowers for each experimental unit was calculated, and the average number of flowers for each treatment was extracted.
2. Flower diameter (mm). Flower diameter was measured using a (vernier caliper) for each experimental unit.

Third: Chemical indicators

1. Estimation of the total chlorophyll pigment content of leaves (100 mg - ^{1}) fresh weight.
   The chlorophyll pigment content of leaves was determined according to the method of [16].
   Estimation of the leaves' content of total soluble carbohydrates ($mg.g^{-1}$)
2. The carbohydrate content of the leaves was estimated according to the method [14].
3. Estimation of the anthocyanin pigment content of flowers (mg. 100 g^{-1}) is carried out according to the method [2].

Results

It is noted from the results in table (3) add with humic acid at a concentration of 30 $mg.L^{-1}$ led to a significant increase in plant height, number of leaves, leaf content of total chlorophyll, leaf content of total soluble carbohydrates, and flower content of anthocyanin pigment, as it reached 24.57cm. 71.74 leaves $plant^{-1}$ 41.57 mg.100 g^{-1}, 7.33 $mg.g^{-1}$ and 6.21 mg.100 g^{-1} compared with the control treatment, which amounted to 16.56 cm., 62.39

leaves.plant^{-1}. 23.47 mg.100 g^{-1}. 4.70 mg^{-1} and 4.53 mg.100 g^{-1}, respectively. we conclude from the results of table (3) that spraying with humic acid at a concentration of 30 mg.$^{-1}$ resulted in number of flowers It did not affect the diameter of the flowers of the, as it reached 35.49. (floret.plant^{-1}), compared with The comparison treatment amounted to 15.07(floret. plant^{-1}).

The results of the same tables also showed that spraying Seaweed extracts on the Al-wonka plant a concentration of 300 mg.L^{-1} led to a significant increase in the height of the plant, the number of leaves, the leaf content of total chlorophyll, the leaf content of total soluble carbohydrates, and the flower content of anthocyanin pigment, as it reached 19.06 cm, 66.71 leaves. Plant^{-1} 35.64 mg.100 g^{-1}, 6.25 mg.g^{-1}, 6.09 mg.100 g^{-1} compared to the measurement treatment, which amoun ted to 17.15 cm, 62.16 leaf.plant^{-1}, 32.37 mg. 100g^{-1}, 4.92 mg.g^{-1}, 5.28 mg.100 g^{-1} sequentially.

It is noted from the results of Tables (3) that spraying Seaweed extracts at a concentration of 300 mg.l^{-1} on the Al-wonka led to a significant increase in the in number of flowers and flower diameter (mm).of the *Catharanthus rosens*, as it reached 28.03 (floret.plant^{-1}), 3.33 mm compared to the measurement treatment, which amounted to 24.66 (floret.plant^{-1}) and 2.28 mm, respectively.

The results of Table (3) show that add with humic acid at a concentration of 30 mg.L-^{1} with Seaweed extracts at a concentration of 300 mg.L-^{1} led to a significant increase in plant height, number of leaves, total chlorophyll content of leaves, total soluble carbohydrates, and flower content of anthocyanin oide pigment reached 24.57 cm, 71.74 leaf.plant^{-1}, 44.08mg.100 g^{-1}, 8.16 mg.g^{-1}, 6.55 mg.100 g^{-1}. compared to the measurement treatment, which amounted to 14.08 cm, 59.04 leaf.plant^{-1}, 22.51mg.100 g^{-1}, 4.50 mg.g^{-1}, 4.12 mg.100 g^{-1} respectively [3]. that add with humic acid at a concentration of 30 mg.l^{-1} with The seaweed extracts at a concentration of 300 mg.l^{-1} had a significant effect on the number of number of flowers and flower diameter (mm).of the Al-wonka, as it reached 38.00 (floret.plant^{-1}), 4.66 mm compared with the comparison treatment amounted to 12.60(floret plant^{-1})and2.00mm respectively.

Response of *Catharanthus roseus* to fertilization with humic acid and spraying seaweed extracts in vegetative, floral and chemical growth indicators

Humic acid (JA) mg.L^{-1}	Seaweed extracts mg.L^{-1}	Leaf content of macroelements (gm^{-1})			Number of flowers. Plant^{-1}	Flower diameter (mm)	Plant height(cm)	Numbe r of papers leaf. planT_1^-
		Chl	CHO	Anthocyanin				
0	0	22.51	4.50	4.12	12.60	2.00	14.08	59.04
	100	22.94	4.72	4.35	12.87	2.00	15.38	60.35
	200	22.37	4.59	4.73	17.13	2.33	16.55	63.11
	300	26.06	5.00	4.91	17.57	2.33	20.23	67.08
10	0	29.33	4.42	5.20	21.07	2.00	21.22	67.17
	100	29.96	4.73	5.31	23.23	2.33	18.41	63.34
	200	30.45	5.48	5.56	25.37	2.66	15.49	60.19
	300	32.06	5.76	5.82	29.37	3.00	16.07	66.16
20	0	35.85	4.80	5.73	25.37	3.00	18.20	61.63
	100	36.37	5.77	5.84	32.50	3.33	20.59	66.66
	200	38.40	6.58	5.56	30.37	3.00	21.86	67.63
	300	40.37	6.09	7.08	27.17	4.00	15.38	61.86
30	0	42.97	5.96	6.09	34.23	3.33	15.11	60.78
	100	36.08	6.99	6.13	35.33	4.00	17.22	61.67
	200	43.16	8.22	6.06	34.40	4.00	20.26	67.18
	300	44.08	8.16	5.56	38.00	4.66	24.57	71.74
L.S.D. (P≤0.05)	Humic acid	2.729	1.612	5.82	3.922	15.23	4.236	12.18
	Seaweed extracts	2.729	1.612		3.922	15.23	4.236	12.18
	Interaction	5.457	0.836	0.150	1.359	0.629	2.864	5.504

Discussion

It has been shown that humic acid has an important effect on physiological processes through encouraging the work of enzymes and transferring the products of the photosynthesis process, as well as affecting cell division and elongation [22], which leads to increased growth, which may be represented by the number of leaves and Plant height [18, 19]. where it was shown that adding humic acid gave significant increase in vegetative growth indicators. and that the by the number of leaves and Plant height growth parameters of the plants were increased when humic acid levels increased, these may be attributed to the increase in seedling height, which appears in the accumulation of the products of this process in storage centers and thus increasing the dry weight of the plant, or it may be attributed to its physiological role in the plant through stimulating the format ion of auxins and cytokinins in the growing tips, which affects the growth of the plant and then i number of leaves and Plant height leavesof [25]. adding humic acid to the soil also increased the porosity of the soil, which led to improved aeration, root respiration, and penetration into the soil. This can reflect increasing root growth and thus increase the leaves and Plant height [15].

The results also showed that spraying with SWE significantly affected all indicators of vegetative and floral growth according to the table above, especially at a concentration of 300 mg.L-1, as this treatment outperformed all other treatments in in increase plant height and number of leaves formed on plants, stem diameter, number of branches, and higher leaf area, and shoot and dry weight [5]. the reason for this may be due to the increase in leaf area and photosynthesis leading to an increase in the amount of carbohydrates manufactured in the leaves as a result of the increase in the amount of chlorophyll in the plant leaves [26]. which is used in growth processes, Different conditions or the reason may be due to the use of increased concentrations of marine algae extract, which leads to providing the necessary nutrients within its composition in a ready form for the plant, especially the major elements (N P K) [7]. which have an effective role in physiological processes, as nitrogen has an

important role in building organic compounds such as proteins, nucleic acids, amino acids, plant hormones, and enzymes [1]. Nitrogen is also involved in the synthesis of amino acids, including tryptophan. Tryptophan is the main precursor of indole acetic acid (IAA) [24]. Nitrogen also plays a very important and significant role in plant growth, as it is the most important element for the proper growth and development of plants, which greatly increases and enhances the crop and its quality through its essential role in the biochemical and physiological functions of the plant [11]. In addition, it is playing a major role in the process of photosynthesis, stimulating the roots and their development [10]. Thus improving water use and the efficiency of absorption of nutrients [4]. The role of the fertilizer used in improving growth is mostly by improving the nutritional status as a result of increasing the efficiency of photosynthesis and carbohydrate accumulation in the leaves [21]. This was reflected positively in stimulating the growth of buds and thus increasing growth. humic acid and marine alga' content of some plant hormones also have positive impact on cell division and encourage rapid growth of roots and an increase in stem diameter and the efficiency of photosynthesis due to vitamins and stimulating, thus enzymes increasing the vegetative growth of the plant This is positively reflected on floral growth [6].

Conclusion:

Results showed that spraying the the *Catharanthus roseus* with the growth regulator humic acid and seaweed extracts revealed a significant response of the plant in all growth and flowering indicators under study. Further, spraying seaweed extracts with high concentration had a positive effect among the other concentrations, which showed the best results in most of the indicators. Also, the plants were characterized by giving the highest mean in vegetative, flowering, and chemical indicators when sprayed with the growth regulator humic acid at 40 mg. L^{-1} with seaweed extracts at a concentration or 300 mg. L^{-1}.

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