



Impact of marine algae extract and balanced fertilizer(NPK) on *Hibiscus sabdariffa*.L growth, quotient, and vitamin C content.

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Received: June 29, 2024	Abstract A field experiment was conducted in one of the experimental fields affiliated to Ibn Al-Bitar Vocational Preparatory School located in Al-Hussainiyah District - Karbala Governorate during the 2023 agricultural season with the aim of studying the impact of adding different concentrations of marine algae extract, balanced fertilizer in the growth qualities, yield and vitamin C in the roselle plant. The experiment was carried out according to a randomized complete block design (RCBD) with factorial arrangement and three replications. The experiment included two factors. The first factor included spraying with marine algae extract in concentrations (0, 0.25, 0.5 and 0.75 ml L ⁻¹). The second factor included spraying with balanced fertilizer (NPK) in concentrations (0, 2.5 and 5 ml L ⁻¹). The results showed that spraying with marine algae extract (0.75 ml L ⁻¹) has a significant superiority in the vegetative growth qualities and vitamin C content of the roselle plant compared to other agile agreements, and the spraying with balanced fertilizer at a concentration of (5 ml L ⁻¹) It significantly excelled in all study indicators. The interaction between the two study factors, The spray treatment superiority (0.75 ml L ⁻¹) of algae extract with the of balanced fertilizer (5 ml L ⁻¹), and gave the highest averages for all the studied qualities., giving the highest Means for all the studied qualities.
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Introduction

Hibiscus sabdariffa L Which belongs to the marshmallow family Malvaceae of medically important plants [1]. Of course, its medical importance is concentrated in its coronary calyx leaves as a source of Hibiscin, as it is rich in Vitamin C and also contains Protocatehnic acid (PCA), which is an important antioxidant because of its role in the treatment of some cancerous [2]. It also contains anthocyanin dye and organic acids, so it is used in the coloring of medicines for the pharmaceutical industries. In the food industry, sweets and jelly are prepared from it in addition to jams. It is also used industrially as the fibers extracted from its stems are used in the manufacture of ropes [3].

Due to the medical importance of the plant, it was necessary to increase its productivity of leaves and the active substance in addition to making an effort to improve its quality through several mechanisms and means, including foliar feeding, Sprinkle marine algae extracts, which are an important source because they are used in many applications on economic crops, where they have been used recently because they reduce chemical fertilizers, and at the applied level, we find that they have an important impact on improving production in quantity and quality [4], and they are also a good source of nutrients and many important growth stimulants (oxine, cytokine, and betanine) In addition to their content of organic and amino acids and some vitamins that affect the plant's vital activities [5], not to mention the role of marine algae extracts in increasing growth, as they stimulate the growth of roots, vegetable branches, increase the leaf content of chlorophyll, early flowering, thus increasing the plant's yield [6]. [7] indicated that spray four concentrations of marine algae extract (0, 1, 2 and 3ml L⁻¹) gave. It was noted that the use of marine algae extract at a concentration of (3 ml L⁻¹) a increase In some of the vegetative growth traits studied, from the trait of plant height with an Mean of (126.83) cm to the trait of the number of main branches with an Mean of (83.08) branch plant⁻¹, In the same regard, the same treatment outperformed the dry weight of the vegetative total with an Mean of (505.00)g plant⁻¹, In comparison to by the control treatment without spraying, which recorded the lowest Means with a value of (74.29)cm and (32.08)branch plant⁻¹ (278.58) g plant⁻¹ respectively. In another study, found [8], spraying the roselle plant with three concentrations of marine algae extract (0, 4 and 8ml L⁻¹), a significant increase in the traits of yield, which studied the number of nuts and the total yield of the calyx with Mean of (157.44) plant nuts⁻¹ (1188.79) kg h⁻¹ at a concentration of (8 ml L⁻¹) Compared with the comparison treatment that gave the lowest average for the two traits (105.90) plant nuts⁻¹ and(918.93) kg ha⁻¹,respectively.

Spraying with balanced fertilizer, which contains NPK, as nitrogen, phosphorus and potassium are major nutrients and have great importance in the growth and development of the plant, and adding them in a balanced manner and not individually is an urgent necessity to avoid the pollution of nutrients as well as the economic cost as a result of increasing their addition. From this standpoint, we explain the role of nitrogen (N) in promoting the growth of both stems and leaves, as this element is the most important element needed by crops. Phosphorus (P) supports the formation of roots and fruit development. It also accelerates the process of crop maturation because it is an essential element for growth, while potassium (K) plays an important role in enhancing the strength of the plant and its resistance to harsh environmental conditions. It is also an essential element for many important physiological activities and processes [9]. Badry [10] found in its experience about the impact of the date of planting and spraying with NPK fertilizer on some growth qualities, the effective crop and components of the fenugreek plant (*Trigella foenicum* – Lm.) In two concentrations of marine algae extract (1,2) g L⁻¹ It had a significant impact on the studied qualities compared to plants that were not sprayed with fertilizer, plants that were sprayed with a concentration of



2 g L⁻¹ recorded the highest Mean plant height of (64.87 cm) and for the number of branches (6.06 branches of the plant⁻¹) and for dry weight (2,000 g) and vitamin C (2,933 mg 100g⁻¹).

Given the importance of the roselle plant pharmacologically and economically, in addition to the lack of field and pharmaceutical studies on it, this research aimed to: - find safe natural alternatives to the chemical compounds used to increase the growth and yield of the roselle and study the effect of different concentrations of seaweed extract and balanced fertilizer in some vegetative and yield growth qualities and the vitamin C content of the roselle plant resulting from the physiological processes that accompany the spraying.

Materials and Methods

A field experiment was carried out in the summer season 2023 in one of the experimental fields of Ibn Al-Bitar Vocational Preparatory School located in Al-Hussainiyah District - Karbala Governorate in order to find out the response of the roselle plant to different concentrations of marine algae extract and balanced fertilizer(NPK) the experiment was carried out according to a randomized complete block design (RCBD) with factorial arrangement and three replication, the experiment included two factors. The first factor included spraying with marine algae extract in concentrations of (0, 0.25, 0.5 and 0.75 ml L⁻¹) were symbolized as A0, A1, A₂, and A3, respectively. The second factor included spraying with balanced fertilizer(NPK) in concentrations of (0, 2.5 and 5 ml L⁻¹) were symbolized as F0, F1, and F2, respectively. The spraying process was carried out when the plant reached a height of (10-15 cm).

After the soil service operations of plowing, smoothing, settling and then dividing into experimental units (5×3m), the seeds of the local variety (*Hibiscus sabdruff L.*) were planted on (23/3/2023) In each hole at the upper third of the meadow and the distance between one hole and another is (50 cm) and alternately on both sides of the meadow by 3 seeds in the hole and a depth of (3-5 cm), then it was reduced to one plant, in addition to conducting all crop service operations from weeding and irrigation and according to the need of the crop, and the soil was fertilized according to the fertilizer recommendations with nitrogen fertilizer in the form of urea 200 kg h⁻¹ (N46%) in two batches (11). Ten plants were randomly taken from the middle of the experimental unit, at 50% flowering stage to study the following traits:

Plant height (cm)

Plant height was measured from the soil surface level to the highest apex of the marked plants using a meter tape for ten plants from each experimental unit and from the two middle lines.

Number of branches of the plant(branch plant⁻¹)

The number of main branches of plants whose height was measured was calculated, and then the Mean number of branches per plant was taken.

Dry weight of vegetative total (g plant⁻¹)

The plants were dried air-dried at room temperature for a month until the weight was stable. Then the dry weight was estimated using a sensitive electric balance, after which the Means were calculated.

The nut no.per plant (plant nut⁻¹)

The number of nuts set in five plants of the experimental units for each replicator was calculated, then the Mean number of nuts per plant was taken after 75% of the flowers had opened.

The total yield of the calyx is(Mg h⁻¹)

The total yield of a hectare area was calculated according to the law: Total yield of nuts = yield of nuts per plant x plant density

In the covered papers content of Vitamin C

Vitamin C (Ascorbid Acid) was estimated according to the method [12]. The data were collected and analyzed statistically according to the aforementioned design and the arithmetic Means of the transactions were compared using the least significant difference (L.S.D) test at a probability level of (0.05) using the statistical analysis program

Results and Discussion

Plant Height (cm)

It is clear from Table 1 that the spraying with seaweed extract and the balanced fertilizer(NPK) and the interaction between them have a significant impact on the height of the plant, superiority concentrations A3(0.75ml L⁻¹)lexcelled over the rest of the concentrations, which gave the highest Mean of the plant height characteristic of (130.21 cm), while gave A0 (comparison) lowest Mean of this (100.22 cm), with an increase of (29.92%), and the treatment with a concentration of A2 did not differ from the treatment with a concentration of A3. The clear effect of seaweed extract concentrations is attributed to its role in improving the nutritional and physiological status of some growth regulators and hormones, as these hormones interfere with the hormones in the plant to perform their physiological action, causing an increase in cell division, thus increasing the lengths of vegetative growths [13].

As for the spraying with NPK fertilizer, it has a moral impact on this trait, as shown in the same table, As the length of the hibiscus plant increased to reach the concentration F2 (5 ml L⁻¹), as it gave the highest Mean of (142.47 cm) compared to the treatment F0, which gave the lowest Mean of this trait of (89.92cm). The transactions differed among them , that the superiority that emerged may be due to the vital role of foliar feeding, where the balanced fertilizer works to the plant's need for the necessary mineral elements NPK and promote healthy and balanced plant growth, and it also works to increase the efficiency of the carbon representation process through the role of the elements NPK in increasing cell division, and this is positively reflected on the height of the plant [14].

As for the interaction between the concentrations, it was significant in this trait, and despite the fact that the response is direct except for the treatment with concentration A3F0, in which there was a decrease, but it is not significant, and in general the increase in the characteristic is similar when increasing the concentrations of seaweed extract and at the same concentrations of balanced fertilizer, and that the difference in the percentage of increase is relatively large in the characteristic studied, as when increasing the concentration of seaweed extract to 0.75 ml L⁻¹ (A3) and at the treatment of 5 ml L⁻¹ (F2) to (40.95%), while the increase was (79.4%) at the same concentration of seaweed extract with the treatment of non-addition of balanced fertilizer F0, as the treatment A3 F2 gave the highest Mean of (164.07 cm), compared to the treatment A0 F0, which gave the lowest Mean of (86.20 cm).

Table (1): Effect of sea algae extract concentrations and balanced fertilizer and the interaction between them on the height of the roselle plant (cm)

marine algae extract (ml L ⁻¹)	Balanced fertilizer(NPK) (ml L ⁻¹)			Mean
	F0	F1	F2	
A0	86.20	98.07	116.40	100.22
A1	88.27	102.20	124.80	105.09
A2	94.87	118.47	164.06	125.98
A3	90.33	136.23	164.07	130.21
Mean	89.92	113.74	142.47	
L.S.D. (0.05)	marine algae extract	Balanced Fertilizer	Interaction	
	8.172	7.077	14.155	

Number of main branches of the plant (plant branch⁻¹)

The results in Table 2, indicated that there is a significant impact of spraying with marine algae extract on the number of main branches, as the treatment of spraying A3 (0.75 ml L⁻¹) achieved the highest Mean number of main branches, which reached 20.69 branch plant⁻¹, with a significant difference from all spraying treatments (A0, A1, A2), which gave Means of 12.48 , 13.23, 18.58, and the branch plant⁻¹ in succession, as the treatments A0 and A1 did not differ between them, this increase can be attributed to the content of marine algae extract from growth regulators, which have a catalytic role by creating woody tissues for buds and stems and thus the growth of lateral buds [15].

The results of the same table indicate that the spraying of balanced fertilizer has a significant impact on the number of main branches, as its maximum Mean at the sprayinf with concentration of spraying F2 (20.23 branch plant⁻¹), while the lowest Mean for this trait at the treatment F0 amounted to (11.25 branch plant⁻¹) and an increase of (79.82%). This increase may be due to the role of the nutrients constituting



the balanced fertilizer composition, such as nitrogen and phosphorus, as they enter into the synthesis of proteins, enzymatic accompaniments, RNA, DNA, and a product that increased photosynthesis rates. As for the role of the potassium element affecting the opening and closing of the stoma as an osmotic regulator, it results in an increase in water and absorbed nutrients that activate photosynthesis and increase its outputs, thus increasing the vegetative growth rate of the plant, such as the height of the plant, accompanied by an increase in the number of plant branches [16].

The interaction of marine algae extract spraying and balanced fertilizer achieved a significant effect on the number of branches, as the interaction treatment A3F2 gave the highest Mean of the trait of (27.13 branch plant⁻¹), while the interaction treatment A0F0 gave the lowest Mean of this trait of (9.97 branch plant⁻¹).

Table (2): The effect of concentrations of marine algae extract and balanced fertilizer and the interaction between them in the number of branches of roselle (branch plant⁻¹)

marine algae extract (ml L ⁻¹)	Balanced fertilizer(NPK) (ml L ⁻¹)			Mean
	F0	F1	F2	
A0	9.97	12.63	14.83	12.48
A1	11.27	13.20	15.23	13.23
A2	11.23	20.27	23.73	18.58
A3	12.53	22.40	27.13	20.69
Mean	11.25	17.12	20.23	
L.S.D. (0.05)	marine algae extract	Balanced Fertilizer	Interaction	
	1.426	1.235	2.470	

Dry weight of vegetative total (g plant⁻¹)

The results in Table 3 showed that there were significant differences between the Foliar spray treatments with marine algae extract in the dry weight of the vegetative total. the concentration of spraying A3 was (0.75ml L⁻¹) achieved the highest Mean dry weight of (386.1 g plant⁻¹) and a significant difference from all spraying concentration (A2, A1 and A0), which was gave (379.6, 308.7 and 270.0 g plant⁻¹), respectively. As we note, the concentration of spraying A0 gave the lowest Mean for this trait. The superiority of the highest concentration is attributed to the role of the extract in increasing the nutrient and chlorophyll content of the roselle plant in addition to protein, which increases the efficiency of photosynthesis of the manufacture of foodstuffs and their accumulation in the plant, which is reflected in the increase in dry matter [17].

As for the effect of balanced fertilizer, we note the moral superiority of the concentration of spraying F2 which was (398.3 g plant⁻¹), While F₀ gave the lowest mean of (279.7) gm plant⁻¹. From the above results, it is clear that the addition of NPK balanced

fertilizer spraying on the vegetative total of the roselle plant caused a moral increase with the increase in the level of addition to physiological characteristics, including the dry weight of the vegetative total and the reason is due to the effective role of balanced fertilizer, as it increases the readiness of the major elements of the plant, which represent essential components that contribute to promoting vegetative and root growth of the plant, which is positively reflected on the dry weight of vegetative hunger [18]. The interaction of marine algae extract spraying and balanced fertilizer achieved a significant effect on dry weight, as the interaction treatment A3F2 gave the highest Mean of (474.8 g plant⁻¹), while the interaction mean A0F0 gave the lowest Mean of (251.7 g plant⁻¹).

Table (3): Effect of concentrations of marine algae extract and balanced fertilizer and their interaction on the dry weight of the vegetative total of roselle(g plant⁻¹)

marine algae extract (ml L ⁻¹)	Balanced fertilizer(NPK) (ml L ⁻¹)			Mean
	F0	F1	F2	
A0	251.7	271.1	287.2	270.0
A1	271.6	292.4	362.0	308.7
A2	290.6	373.5	469.3	379.6
A3	305.0	383.9	474.8	386.1
Mean	279.7	330.2	398.3	
L.S.D. (0.05)	marine algae extract	Balanced Fertilizer	Interaction	
	12.74	11.03	22.06	

Number of nuts (plant walnut⁻¹)

The results of Table 4 indicate the moral impact of marine algae extract in increasing the number of flowering calyces of the roselle plant, as it achieved the treatment of spraying A3 (0.75 ml L⁻¹), the highest Mean of 190.8 nut plant⁻¹, while the of concentration A0 achieved the lowest Mean of 122.9 nut plant⁻¹. the concentration A₂ and A₃ did not differ significantly between them in this trait. The moral impact of spraying with seaweed extract is attributed to the nutrients it contains that stimulated vegetative growth represented by the height of the plant and the number of branches Table 2 and 3, which led to an increase in the processed foodstuffs in the leaves, thus moving them to the effective growth areas. This encourages the formation of the maximum possible number of flower buds, which results in an increase in the number of nuts [19].

The results of the same table also indicated the significance effect of spraying with balanced fertilizer, of the impact of the balanced fertilizer spraying transactions towards increasing the level of concentrations used and with significant differences between all transactions. The treatment of spraying F2 (5 ml L⁻¹) gave the highest Mean of this trait of 179.2 nut plant⁻¹ compared to other spraying transactions, while the treatment F0 (comparison) gave the lowest number of flower cups of 143.3 nut plant⁻¹ with



an increase of 25.05%. This moral impact may be due to the superiority of the treatment in the height of the plant and the number of branches (Table 1 and 2) in succession , or the superiority may be due to the fertilizer content of NPK elements in a balanced amount, thus increasing growth rates and the accumulation of dry matter, especially during the pre-flowering period, and all this affects the weight of the dry vegetative total [20] .

The interaction of marine algae extract spray and balanced fertilizer achieved a significant impact on the number of nuts, as the interaction treatment A3F2 gave the highest Mean of 232.9 nut plant⁻¹, while the interaction treatment A0F0 gave the lowest Mean of 98.3 nut plant⁻¹ .

Table (4): Effect of sea algae extract concentrations and balanced fertilizer and their interaction on the number of nuts of roselle (nut plant⁻¹)

marine algae extract (ml L ⁻¹)	Balanced fertilizer (NPK) (ml L ⁻¹)			Mean
	F0	F1	F2	
A0	98.3	128.7	141.6	122.9
A1	118.7	141.4	160.6	141.3
A2	121.4	145.1	181.5	149.3
A3	121.4	196.2	232.9	190.8
Mean	143.3	152.8	179.2	
L.S.D. (0.05)	marine algae extract	Balanced Fertilizer	Interaction	
	8.57	7.42	14.84	

The total yield of the nuts is (mica g h⁻¹)

The results of Table 5 Showed that there are significant differences in the total yield of the coronal calyx leaves by the effect of Foliar spray treatments with marine algae extract Spraying with concentration A₃ was significantly superior to the rest of the concentrations, which amounted to (2.168) Mg ha⁻¹, while A₀ gave the lowest average, amounting to (1.360) Mg ha⁻¹, with a percentage increase (%59.41). The moral superiority appeared may be due to the fact that marine algae extract contains high proportions of major and minor elements, as they are important elements for the biosynthesis of the plant in addition to its role in activating photosynthesis and manufacturing carbohydrates in the leaves and then transporting and storing them in nuts, thus increasing the yield of one plant and the total production, or this increase in quantity may be due to the role of marine algae extracts in increasing the number of branches and the number of nuts table 4, thus increasing the dry weight [21].

The results of the same table showed significant superiority when spraying with the F₂ concentration, which amounted to (1.911) Mg ha⁻¹ and an increase rate of (18.62%

) compared to the F0 concentration, which gave the lowest average for this characteristic, which amounted to (1.611) $Mg\ ha^{-1}$, respectively. The superiority may be attributed to the role of balanced fertilizer in increasing the height of the plant and the paper area, thus increasing the area exposed to light, and this results in an increase in dry matter, which was positively reflected in the increase in the total yield of cup leaves [22].

The interaction of marine algae extract spraying and balanced fertilizer achieved a significant effect in the studied trait as the interaction treatment A3F2 gave the highest Mean of 2.435 $Mg\ ha^{-1}$ While the treatment A0F0 gave the lowest Mean of 1.306 $Mg\ ha^{-1}$.

Table (5): Effect of sea algae extract concentrations and balanced fertilizer and their interaction on the total yield of coronal leaves of roselle ($mg\ ha^{-1}$)

marine algae extract (ml L ⁻¹)	Balanced fertilizer(NPK) (ml L ⁻¹)			Mean
	F0	F1	F2	
A0	1.306	1.395	1.377	1.360
A1	1.466	1.520	1.724	1.570
A2	1.795	2.195	2.106	1.970
A3	1.875	2.195	2.435	2.168
Mean	1.611	1.780	1.911	
L.S.D. (0.05)	marine algae extract	Balanced Fertilizer	Interaction	
	0.05752	0.04982	0.09963	

Vitamin C content of leaves calyces ($mg\ g^{-1}$)

The results of Table 6 showed: There is a significant difference in the vitamin C content of calyx leaves when sprayed with seaweed extract if the spray concentration A₃ was significantly higher and achieved the highest average which was (62.89).) $mg\ g^{-1}$, followed concentrations A₂ and A₁, which reached (59.22 and 50.78) $mg\ g^{-1}$, respectively, while concentration A₀ achieved the lowest average for this trait, reaching (45.00) $mg\ g^{-1}$. The moral superiority may be attributed to the efficiency of the marine algae extract in activating the growth of roots, which increases the absorption of nutrients from the soil. This has an impact on the energy-rich compounds needed by the plant in order to build various compounds contributing to the stimulation of its diverse activities, thus increasing the concentration of secondary compounds produced by the plant, including Vitamin C, which is found in the calyx leaves of the plant of roselle [23].

The results of the same table showed significant superiority when spraying with the F2 concentration, which amounted to (65.58) $mg\ g^{-1}$, and an increase rate of (45.47%) compared to the F0 concentration, which gave the lowest average for this characteristic, which amounted to (45.08) $mg\ g^{-1}$. The superiority of the treatment F2 may be

attributed to its content of important NPK elements in the vegetative growth of the plant and the efficiency of carbon representation, which in turn works to form many compounds such as amino acids and secondary metabolites in addition to vitamins (24). The Interaction of seaweed extract spraying and balanced fertilizer achieved a significant effect in the studied trait as the treatment A3F2 gave the highest mean of (87.58) mg g⁻¹, Which was significantly superior to the rest of the treatments, While the treatment A0F0 gave the lowest mean of (38.67) mg g⁻¹.

Table (6): The effect of concentrations of marine algae extract and balanced fertilizer and the interaction between them in the content of calyx leaves of Vitamin C (mg g⁻¹)

marine algae extract (ml L ⁻¹)	Balanced fertilizer (NPK) (ml L ⁻¹)			Mean
	F0	F1	F2	
A0	38.67	43.67	52.67	45.00
A1	43.00	51.33	58.00	50.78
A2	48.67	58.00	71.00	59.22
A3	50.00	58.00	87.58	62.89
Mean	45.08	52.75	65.58	
L.S.D. (0.05)	marine algae extract	Balanced Fertilizer	Interaction	
	2.087	1.808	3.615	

It seems that by increasing the concentrations of seaweed extract and balanced fertilizer, the response of each of the studied qualities such as plant height, number of branches, dry weight, number of nuts , total yield of cup leaves and content of cup leaves of Vitamin C ‘The response of the traits under the influence of the interaction between the two study factors was better than their response to any of the study factors individually, and the significance of this response is the result of the difference in the size of the response .

References

- 1) Ajithadoss, K., Pandian, T., Rathinkumar, S., Edwin, R., Sekar, T., Sakar, P., & Munusamy, S. (2006). *Botany: Higher secondary second year* (1st ed.). Government of Tamil Nadu Textbook Corporation.
- 2) Kiliç, C. S., Aslan, S., Kartal, M., & Coskun, M. (2011). Fatty acid composition of *Hibiscus trionum* L. (Malvaceae). *Records of Natural Products*, 5(1), 65.
- 3) Nzikou, J. M., Bouanga-Kalou, G., Matos, L., Ganongo-Po, F. B., Mboundou-Mboussi, P. S., Moutoula, F. E., ... & Desobry, S. (2011). Characteristics and nutritional evaluation of seed oil from roselle (*Hibiscus sabdariffa* L.) in Congo-Brazzaville. *Current Research Journal of Biological Sciences*, 3(2), 141-146.



- 4) Khan, W., Rayirath, U. P., Subramanian, S., Jithesh, M. N., Rayorath, P., Hodges, D. M., ... & Prithiviraj, B. (2009). Seaweed extracts as biostimulants of plant growth and development. *Journal of Plant Growth Regulation*, 28, 386-399.
- 5) Sharma, H. S., Fleming, C., Selby, C., Rao, J. R., & Martin, T. (2014). Plant biostimulants: A review on the processing of macroalgae and use of extracts for crop management to reduce abiotic and biotic stresses. *Journal of Applied Phycology*, 26, 465-490.
- 6) Elansary, H. O., Skalicka-Woźniak, K., & King, I. W. (2016). Enhancing stress growth traits as well as phytochemical and antioxidant contents of *Spiraea* and *Pitosporum* under seaweed extract treatments. *Plant Physiology and Biochemistry*, 105, 310-320.
- 7) Said, A., Rabo, B. S., Mustapha, A. B., Simon, S. Y., & Hamma, I. L. (2015). Influence of NPK fertilizer on the performance of roselle (*Hibiscus sabdariffa* L.) in Samaru, Zaria. *Nigerian Journal of Agriculture, Food and Environment*, 11(3), 61-64.
- 8) Al-Hamidi, B. H. M. (2023). *The effectiveness of concentrations of seaweed extract and nano-organic fertilizer on some growth characteristics, yield, and medically active compounds of two types of gujarat* (Master's thesis). University of Middle Euphrates Technology, Faculty of Agriculture.
- 9) Fahmy, A. A., & Hassan, H. M. S. (2019). Influence of different NPK fertilization levels and humic acid rates on growth, yield, and chemical constituents of roselle (*Hibiscus sabdariffa* L.). *Middle East Journal of Agriculture Research*, 8(4), 1182-1189.
- 10) Badry, N. A.-H. S. (2023). *Autumn and spraying with NPK fertilizer affects some growth characteristics, components, and unknown components of the plant (Trigonella foenum-graecum L.)* (Master's thesis). University of Karbala, Faculty of Agriculture.
- 11) Al-Dabin, M. A.-K. S. (2022). *The response of the Gujarati plant Hibiscus sabdariffa L. to nitrogen and potassium fertilization and the interaction between them in growth characteristics, yield, and medically active substance* (Master's thesis). University of Karbala, Faculty of Agriculture.
- 12) Hussain, N., Khan, A. Z., Akbar, H., Bangash, N. G., Hayat, Z., & Idrees, M. (2007). Response of maize varieties to phosphorus and potassium levels. *Sarhad Journal of Agriculture*, 23(4), 881.
- 13) Al-Tai, A. S. H. (2017). *The effect of salicylic acid and marine algae extract on the growth and yield of several varieties of the roselle plant and its content of some medicinal active compounds* (Master's thesis). Faculty of Agriculture, Middle Euphrates Technical University.
- 14) Said, A., Rabo, B. S., Mustapha, A. B., Simon, S. Y., & Hamma, I. L. (2015). Influence of NPK fertilizer on the performance of roselle (*Hibiscus sabdariffa* L.) in Samaru, Zaria. *Nigerian Journal of Agriculture, Food and Environment*, 11(3), 61-64.
- 15) Al-Obaidi, O. M. A.-Z., & Khairallah, H. S. E.-D. M. (2017). The role of some growth regulators in the multiplication of *Stevia* plant branches ex vivo. *Iraqi Agricultural Sciences Journal*, 48(5), 1158-1168.



- 16) Dahmardeh, M. (2012). Effect of mineral and organic fertilizers on the growth and calyx yield of roselle (*Hibiscus sabdariffa* L.). *African Journal of Biotechnology*, 11(48), 10899-10902.
- 17) Saleh, L. M. S. M., & Taha, S. M. (2012). The effect of spraying marine extract (15 Matrix) on the vegetative and root growth qualities of two varieties of *Fragaria × ananassa* Duch L. *Journal of Kirkuk University of Agricultural Sciences*, 3(2), 34-42.
- 18) Janmohammadi, M., Navid, A., Segherloo, A. E., & Sabaghnia, N. (2016). Impact of nano-chelated micronutrients and biological fertilizers on growth performance and grain yield of maize under deficit irrigation conditions. *Biologija*, 62(2).
- 19) Al-Falahi, T. H. R., & Abdullah, F. H. (2017). The effect of spraying with antioxidants and KELPAK marine algae extract on some growth characteristics and mineral content of tangerine seedlings of Clementine variety. *Anbar Journal of Agricultural Sciences*, 15(1), 290-297.
- 20) Ramadan, A. F., & Jamil, S. M. (2010). The effect of spraying with some nutrients on the growth and yield of the gujarat plant (*Hibiscus sabdariffa* L.). *Anbar Journal of Agricultural Sciences*, 8(4).
- 21) Al-Tai, A. S. H. (2017). *The effect of salicylic acid and marine algae extract on the growth and yield of several varieties of the roselle plant and its content of some medicinal active compounds* (Master's thesis). Faculty of Agriculture, Middle Euphrates Technical University.
- 22) Ingestad, T., & Ågren, G. I. (1995). Plant nutrition and growth: Basic principles. *Plant and Soil*, 168, 15-20.
- 23) Hasson, A. S., Ramadan, E. L., & Hussain, M. H. (2017). Effect of salicylic acid and seaweed extract on the content of sepals of some active medical compounds for several varieties of roselle (*Hibiscus sabdariffa* L.). *International Journal of STEM Education*, 4(4), 7068-7073.
- 24) Gomaa, A. O., Youssef, A. S. M., Mohamed, Y. F. Y., & AbdAllah, M. S. (2018). Effect of some fertilization treatments on growth, productivity, and chemical constituents of roselle (*Hibiscus sabdariffa* L.) plants. *Scientific Journal of Flowers and Ornamental Plants*, 5(2), 171-193