Volume 3, Issue 11, November - 2025
ISSN (E): 2938-3781

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

EFFECT OF SEAWEED EXTRACT AND ATONIC SPRAY ON SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF (MORINGA OLEIFERA)

G. Z. K. AL-RIKABI
Department of Horticulture, College of Agriculture and Marshes,
University of Thi Qar, Iraq
*Corresponding author's emails: ghufran.z@utq.edu.iq

Abstract
The experiment was conducted at a research station affiliated with the Ministry of Agriculture during the 2023-2024 fall season. We used a randomized complete block design (RCBD) and compared treatment means using the Least Significant Difference (LSD) test at a 0.05 probability level. Moringa oleifera trees were treated with auxin amino acid and seaweed extract. The experiment consisted of two factors and three replicates, examining the interaction between auxin and seaweed extract at concentrations of 0-, 1-, and 2-ml L-1. Plants were sprayed three times at 10-day intervals. This study aimed to investigate the effects of auxin and seaweed extract on some physical and chemical properties of Moringa oleifera and identify the optimal concentration for best results in the southern region, particularly in Dhi Qar Governorate. The results can be summarized as follows: Foliar application of auxin significantly affected some vegetative growth traits and chemical characteristics in leaves, with the highest values recorded for stem diameter, plant height, number of leaves, chlorophyll content, carotenoids, and carbohydrates, which were (0.611 and 96.39) cm plant-1, (242.3 leaves plant-1), and (0.541, 27.203, and 83.39) mg 100g-1, respectively. Seaweed extract fertilization showed a significant effect on some vegetative growth traits and chemical characteristics in leaves, with the highest values recorded for stem diameter, plant height, number of leaves, chlorophyll content, carotenoids, and carbohydrates, which were (0.617 and 96.83) cm plant-1, (231.2 leaves plant-1), and (0.560, 29.108, and 85.30) mg 100g-1, respectively. The interaction between auxin and seaweed extract had a significant effect on some vegetative growth traits and chemical characteristics, particularly in the number of leaves, chlorophyll content, carotenoids, and carbohydrates, which recorded (296.5 leaves plant-1), (0.632, 36.437, and 88.84) mg 100g-1, respectively.

Introduction

Moringa oleifera Lam. is a gift from God to humanity, belonging to the genus Moringa within the flowering plant family Moringaceae, which possesses high nutritional and medicinal value. This tree is mainly grown in tropical and subtropical regions and is one of the most popular plants in Southeast Asia, particularly in the Philippines. It is found worldwide, thriving best in dry sandy soils and tolerating poor soils, including coastal areas. Moringa oleifera is a fast-growing, drought-tolerant tree native to the southern foothills of the Himalayas in northwest India (Premi and Sharma, 2013; Radovich, 2010). It can be said that this plant has saved more lives in developing countries than any other thing (Paliwal et al., 2011). The plant is characterized by its rapid growth and high economic value, with every part having its own specific uses. Different parts of the plant can be used as a source of food and medicine, such as antihypertensive, anticancer, antispasmodic, anti-asthmatic, and anti-inflammatory agents, as well as for treating various other diseases. It is described as a "miracle tree" due to its use in treating over 300 diseases (Mani et al., 2007; Ashfaq et al., 2012; Arora et al., 2013).

Moringa oleifera leaves are a rich source of unsaturated fatty acids, including omega-3 and omega-6 in the form of alpha-linolenic acid and linoleic acid, respectively. They are also a source of saturated fatty acids, such as stearic and palmitic acids, and various vitamins like alpha-tocopherol and ascorbic acid (Saini et al., 2014). Extracts from leaves and other parts of the plant are used to treat malnutrition and hyperthyroidism (Omotesho et al., 2013; Saini, 2013). The seed oil can be used to treat rheumatism, gout, and skin conditions, and is also used in cosmetics, lubricants, and as a blood purifier and heart tonic (Gopalakrishnan et al., 2016).

Moringa plants require essential nutrients for growth. Chemical fertilizers have negative environmental and health impacts due to their non-biodegradable nature, soil alkalization, and high costs (Al-Timimi, 1998). This has led to a shift towards organic fertilization, which reduces these adverse effects. The use of humic substances, auxins, plant extracts, and seaweed extracts is considered a type of organic nutrition (Al-Bayati, 2011; Al-Timimi and Azzeddin, 2014).

Auxin is crucial for plant growth, as it contains essential nutrients that are often immobile in plants. Its importance in plant physiological activities has led to its use in providing plants with necessary nutrients that roots cannot supply (Al-Sahaf, 1989). Seaweed extracts are a valuable resource that can be added to plants and soil to provide essential nutrients, including macro- and micronutrients, hormones, and growth regulators like auxins, gibberellins, and cytokinins (O'Dell, 2003).

The study aims to investigate the response of Moringa to the effect of auxin and seaweed extracts on vegetative growth traits and some chemical characteristics. Due to the scarcity of research in this field on Moringa, it was decided to conduct this experiment.

Materials and Methods

The experiment was conducted in the wooden shade of the research stations affiliated with the Ministry of Agriculture during the fall season 2023-2024. Moringa trees were selected and treated with auxin amino acid and seaweed extract. The plants were treated with different concentrations of auxin and seaweed extract according to the experimental units, three times: the first application was on April 18, 2023, the second application was 10 days later on April 28, 2023, and the third application was 10 days after that on May 7, 2023. The plants were irrigated with seaweed extract and sprayed with auxin amino acid in the early morning using a 1-liter hand sprayer.

3-4: Studied Traits

3-4-1: Vegetative Growth Indicators

All pots were measured for the required traits, including:

3-4-1-1: Plant Height (cm plant-1)

Plant height was measured using a metric tape from the point of connection between the stem and the soil surface to the growing tip of the plant.

3-4-1-2: Stem Diameter (cm plant-1)

Stem diameter was measured using a Vernier caliper at a height of 1 cm from the point of connection between the main stem and the soil surface, and the average was calculated.

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

3-4-1-3: Number of Leaves and Leaflets (leaf plant-1)

The total number of leaves and leaflets was counted at the end of the season for each selected plant, and the average was calculated.

3-4-2: Chemical Traits in Leaves

3-4-2-1: Estimation of Total Chlorophyll Content (mg 100g-1 fresh weight)

Total chlorophyll was extracted from a known weight of fresh leaves (0.5 g) with 20 ml of 80% acetone and left for 24 hours. The absorbance was measured using a spectrophotometer at wavelengths of 663 nm and 645 nm (Bajracharya, 1999).

3-4-2-2: Percentage of Total Carbohydrates in Leaves

Total soluble carbohydrates were estimated using the phenol-sulfuric acid method (Dobiose et al., 1956). 0.5 g of dried and ground leaves were placed in a 100 ml volumetric flask with 75 ml of distilled water. The mixture was heated in a water bath at 70°C for 1 hour, cooled, and filtered. 5 ml of the filtrate was mixed with 25 ml of distilled water, and 1 ml of this solution was mixed with 1 ml of 5% phenol and 5 ml of 95% sulfuric acid. The absorbance was measured at a wavelength of 490 nm using a spectrophotometer. Carbohydrate content was estimated using a standard glucose curve.

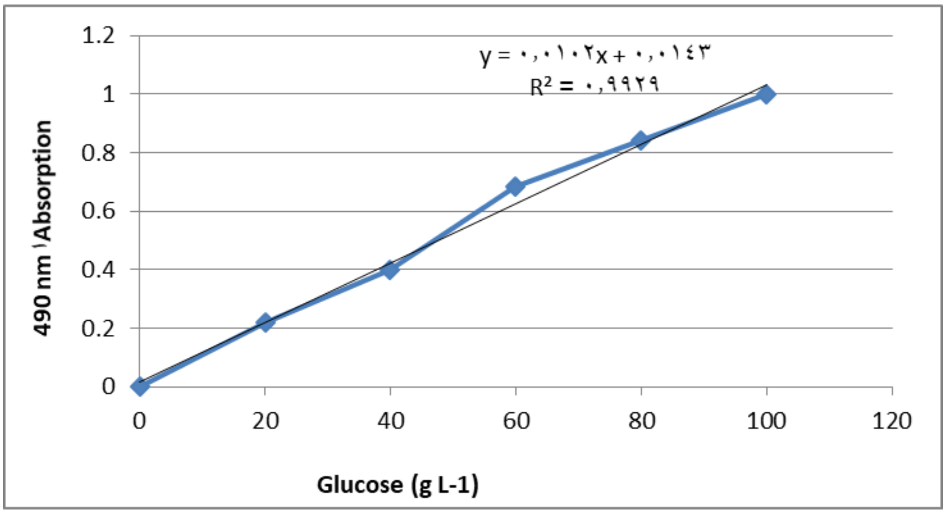

Figure (1) Standard curve of glucose

According to the following equation:

Total carbohydrates = (Amount of carbohydrates in the standard curve × Final volume of extract (ml) × Dilution factor) / Sample weight (g)

The unit (mg 100g^-1) is then converted to percentage

Results and discussion

4-1 Effect of Auxin and Seaweed Extract on Vegetative Growth Traits

4-1-1 Stem Diameter (cm plant^-1)

The results in Table 1 show the effect of auxin and seaweed extract on stem diameter (cm plant-1). The auxin treatment at a concentration of 1 ml L-1 resulted in the highest stem diameter (0.611 cm plant-1) compared to 0.594 cm plant-1 for the 2 ml L-1 concentration. The same table shows that the seaweed extract treatment had a significant effect on stem diameter, with the 1 ml L-1 concentration outperforming the 2 ml L-1 concentration, which recorded 0.617 and 0.594 cm plant-1, respectively. The interaction between the study factors had a significant effect on stem

Volume 3, Issue 11, November - 2025
ISSN (E): 2938-3781

diameter, with the combination of auxin and seaweed extract at 1 ml L-1 resulting in the highest mean (0.683 cm plant-1). In contrast, the treatment with 1 ml L-1 auxin and 2 ml L-1 seaweed extract resulted in the lowest mean stem diameter (0.550 cm plant-1). However, there were no significant differences between some treatments

Table 1: Effect of Atonic and Seaweed Extract on Stem Diameter (cm plant-1) of Moringa Plants

Atonic acid 1ml	Seaweed Extract 1 ml-1 liter			Effect of Atonic acid
	0	1	2	
0	0.600	0.583	0.633	0.606
1	0.600	0.683	0.550	0.611
2	0.600	0.583	0.600	0.594
LSD 0.05	NS			NS
Effect of Seaweed Extract	0.600	0.617	0.594	
LSD 0.05	NS			

4-1-2 Plant Height (cm plant-1)

The results in Table 2 show the effect of auxin and seaweed extract on plant height (cm plant-1). The auxin treatment at a concentration of 1 ml L-1 resulted in the highest plant height (96.39 cm plant-1) compared to 92.67 cm plant-1 for the comparison treatment, which gave the lowest height. The same table shows that the seaweed extract treatment had a significant effect on plant height, with the 1 ml L-1 concentration outperforming the comparison treatment, which recorded 96.83 and 92.94 cm plant-1, respectively. The interaction between the study factors had a significant effect on plant height, with the combination of auxin and seaweed extract at 1 ml L-1 seaweed with 2 ml L-1 auxin resulting in the highest mean (99.83 cm plant-1). In contrast, the treatment with 0 ml L-1 auxin and 1 ml L-1 seaweed extract resulted in the lowest mean plant height (91.00 cm plant-1). However, there were no significant differences between some treatments.

Table 2: Effect of Atonic and Seaweed Extract on Plant Height of Moringa Plants (cm plant-1)

Atonic acid 1ml	Seaweed Extract 1 ml-1 liter			Effect of Atonic acid
	0	1	2	
0	94.00	91.00	93.00	92.67
1	92.67	99.67	96.83	96.39
2	92.17	99.83	94.50	95.50
LSD 0.05				NS
Effect of Seaweed Extract	92.94	96.83	94.78	
LSD 0.05	NS			

4-3-1 Number of Leaflets (leaflets plant-1)

The results in Table 3 show the effect of auxin and seaweed extract on the number of leaflets (leaflets plant-1). The auxin treatment at a concentration of 2 ml L-1 resulted in the highest number of leaflets (242.3 leaflets plant-1) compared to 181.6 leaflets plant-1 for the comparison treatment, which gave the lowest number of leaflets, with a significant effect. The same table shows that the seaweed extract treatment had a significant effect on the number of leaflets, with the 2 ml L-1 concentration outperforming the comparison treatment, which recorded 296.5 and 157.3 leaflets plant-1, respectively, with no significant differences between some treatments. The interaction between the study factors had a significant effect on the number of leaflets, with the combination of auxin and seaweed extract at 2 ml L-1 seaweed with 2 ml L-1 auxin resulting in the highest mean (296.5 leaflets plant-1). In contrast, the comparison treatment resulted in the lowest mean number of leaflets (157.3 leaflets plant-1), with significant differences between treatments.

Table 3: Effect of Atonic and Seaweed Extract on Number of Leaflets (leaflets plant-1)

Atonic acid 1ml	Seaweed Extract 1 ml-1 liter			Effect of Atonic acid
	0	1	2	
0	157.3	186.2	201.2	181.6
1	242.8	271.5	195.7	236.7
2	213.5	217.0	296.5	242.3
LSD 0.05	60.88			35.15
Effect of Seaweed Extract	204.6	224.9	231.2	
LSD 0.05	NS			

Discussion of vegetative growth

The results in Tables 1 and 2 show no significant differences between treatments in terms of stem diameter and plant height. However, the results in Table 3 show significant differences between treatments in the number of leaflets, with the auxin treatment at 2 ml L^-1 resulting in the highest number of leaflets (242.3 leaflets plant^-1) compared to the comparison treatment. The interaction between auxin and seaweed extract also showed significant differences, with the highest mean number of leaflets (296.5 leaflets plant^-1) recorded at the interaction between 2 ml L^-1 auxin and 2 ml L^-1 seaweed extract.

The significant effect of auxin can be attributed to its role in improving soil chemical and physical properties, fertility, and biological activity. Auxin also affects the cation exchange capacity, increasing nutrient availability and improving soil structure and aeration, which facilitates root growth and development (Al-Timimi, 1998). This increased root growth leads to a larger vegetative growth, resulting in a higher number of leaflets due to increased nutrient uptake and physiological activity (Al-Rukabi and Al-Zubaidi, 2021).

The increase in vegetative growth traits can also be attributed to the ability of auxin to provide an acidic environment and chelate cations, forming complexes that increase the availability of micronutrients (Al-Rukabi and Al-Zubaidi, 2021). Auxin also serves as a source of nitrogen, increasing nutrient availability and positively affecting plant growth.

The increase in vegetative growth traits of Moringa plants may also be due to the presence of auxins in seaweed extract, which play a crucial role in cell division and expansion, leading to increased vegetative growth and leaf area (Gollan and Wright, 2006). Seaweed extracts also contain cytokinins, which promote physiological activity and increase total chlorophyll, positively affecting photosynthesis and plant growth (Thomas, 1996).

The positive effect of seaweed extracts may also be due to their content of macro- and micronutrients, such as iron, which plays a crucial role in activating oxidation-reduction enzymes and chlorophyll synthesis (Al-Sahaf, 1989). Additionally, zinc in seaweed extracts contributes to the synthesis of tryptophan, a precursor to auxin, which promotes cell division and expansion, leading to increased vegetative growth (Lopez et al., 2008).

4-2 Effect of Auxin and Seaweed Extract on Chemical Traits in Leaves

4-2-1 Total Chlorophyll Content in Leaves (mg 100g-1)

The results in Table 4 show the effect of auxin and seaweed extract on total chlorophyll content in leaves (mg 100g-1). The auxin treatment at a concentration of 1 ml L-1 resulted in the highest chlorophyll content (0.541 mg 100g-1) compared to 0.451 mg 100g-1 for the 2 ml L-1 concentration, which gave the lowest chlorophyll content, with a significant effect. The same table shows that the seaweed extract treatment had a significant effect on chlorophyll content, with the 1 ml L-1 concentration outperforming the comparison treatment, which recorded 0.560 and 0.402 mg 100g-1, respectively, with significant differences between treatments. The interaction between the study factors had a significant effect on chlorophyll content, with the combination of auxin and seaweed extract at 2 ml L-1 seaweed with 1 ml L-1 auxin resulting in the highest mean (0.632 mg 100g^-1). In contrast, the treatment with 2 ml L-1 auxin and 1 ml L-1 seaweed extract resulted in the lowest mean chlorophyll content (0.209 mg 100g-1), with significant differences between treatments.

Table 4: Effect of Atonic and Seaweed Extract on Chlorophyll content of Moringa leaves (100 mg/g-1).

Atonic acid 1ml	Seaweed Extract 1 ml-1 liter			Effect of Atonic acid
	0	1	2	
0	0.593	0.532	0.438	0.521
1	0.527	0.464	0.632	0.541
2	0.559	0.209	0.584	0.451
LSD 0.05	0.006			0.003
Effect of Seaweed Extract	0.402	0.560	0.551	
LSD 0.05	0.003			

4-2-2: Carotene Content in Leaves (mg 100g-1)

The results in Table 5 show the effect of auxin and seaweed extract on carotene content in leaves (mg 100g-1). The auxin treatment at a concentration of 1 ml L-1 resulted in the highest carotene content (27.203 mg 100g-1) compared to 21.120 mg 100g-1 for the comparison treatment, which gave the lowest carotene content, with a significant effect. The same table shows that the seaweed extract treatment had a significant effect on carotene content, with the 2 ml L-1 concentration outperforming the 1 ml L-1 concentration, which recorded 29.108 and 21.386 mg 100g-1, respectively, with significant differences between treatments. The interaction between the study factors had a significant effect on carotene content, with the combination of auxin and seaweed extract at 2 ml L-1 seaweed with 2 ml L-1 auxin resulting in the highest mean (36.123 mg 100g-1). In contrast, the treatment with 0 ml L-1 auxin and 2 ml L-1 seaweed extract resulted in the lowest mean carotene content (14.763 mg 100g-1), with significant differences between treatments.

Table 5: Effect of Atonic and Seaweed Extract on Moringa leaf content of carotene (100 mg/g-1).

Atonic acid 1ml	Seaweed Extract 1 ml-1 liter			Effect of Atonic acid
	0	1	2	
0	23.817	24.780	14.763	21.120
1	15.973	24.117	36.437	25.509
2	30.227	15.260	36.123	27.203
LSD 0.05	0.256			0.148
Effect of Seaweed Extract	23.339	21.386	29.108	
LSD 0.05	0.148			

4-2-3: Carbohydrate Content in Leaves (mg 100g-1 dry weight)

The results in Table 6 show the effect of auxin and seaweed extract on carbohydrate content in leaves (mg 100g-1). The auxin treatment at a concentration of 2 ml L-1 resulted in the highest carbohydrate content (83.39 mg 100g-1) compared to 70.46 mg 100g-1 for the comparison treatment, which gave the lowest carbohydrate content, with a significant effect. The same table shows that the seaweed extract treatment had a significant effect on carbohydrate content, with the 2 ml L-1 concentration outperforming the comparison treatment, which recorded 85.30 and 74.65 mg 100g-1, respectively, with significant differences between treatments. The interaction between the study factors had a significant effect on carbohydrate content, with the combination of auxin and seaweed extract at 1 ml L-1 seaweed with 2 ml L-1 auxin resulting in the highest mean (88.84 mg 100g^-1). In contrast, the comparison treatment resulted in the lowest mean carbohydrate content (60.75 mg 100g-1), with significant differences between treatments

Table 6: Effect of Atonic and Seaweed Extract on Carbohydrate content of Moringa leaves (mg/100g dry weight).

Atonic acid 1ml	Seaweed Extract 1 ml-1 liter			Effect of Atonic acid
	0	1	2	
0	60.75	70.55	80.09	70.46
1	79.81	76.54	88.84	81.73
2	83.39	79.81	86.97	83.39
LSD 0.05	2.201			1.271
Effect of Seaweed Extract	74.65	75.64	85.30	
LSD 0.05	1.271			

Discussion of Chemical Traits of Leaves:

The results in Tables 4, 5, and 6 show significant differences between treatment means for the chemical traits of leaves (chlorophyll, carotenoids, and carbohydrates) when Moringa plants were treated with auxin and seaweed extract and their interaction. The auxin treatment at a concentration of 1 ml L-1 and the seaweed extract treatment at a concentration of 1 ml L-1 resulted in the highest chlorophyll content, reaching (0.541 and 0.560) mg 100g-1, respectively. The results in Tables 5 and 6 indicate that the highest carotene and carbohydrate content was achieved when Moringa plants were treated with 2 ml L-1 auxin and 2 ml L-1 seaweed extract, reaching (27.203 and 29.108 and 83.39 and 85.30) mg 100g-1, respectively. The interaction between auxin and seaweed extract treatments had a significant effect, with the highest values recorded at the interaction between 1 ml L-1 auxin and 2 ml L-1 seaweed extract, reaching (0.632 and 36.437 and 88.84) mg 100g-1, respectively.

The superiority of plants treated with auxin in chemical traits of leaves can be attributed to the role of auxin in improving soil physical properties (Varanini et al., 1995), biological and chemical properties (Keeling et al., 2003; Al-Rukabi, 2025), and its role in eliminating pathogens in the soil and improving soil properties and nutrient availability for plant uptake (Mohamed et al., 2009). Auxin also stimulates enzymes and plant hormones (Sarir et al., 2005), which reflects on increasing the efficiency of photosynthesis and increasing metabolic products, leading to an increase in chemical components of leaves.

The results of the role of auxin in increasing the percentage of carbohydrates and chlorophyll and carotene content in leaves are consistent with the findings of Al-Rukabi and Al-Zubaidi (2021) in increasing chlorophyll content in cucumber leaves, and with the results of Al-Rukabi et al. (2025) on cucumber plants, and with the findings of Fadlallah et al. (2023).

The reason for the superiority of seaweed extract treatments may also be attributed to the presence of auxins, cytokinins, gibberellins (GA3), and salicylic acid, which reduce stress and promote root growth, nutrient uptake, and vegetative growth, as well as resistance to drought and tolerance to harsh conditions. Additionally, seaweed extracts prevent oxidation of vitamins C and E in chloroplasts, increasing the efficiency of photosynthesis and reflecting on the increase in chlorophyll, carotene, and carbohydrate content (O'Dell and Jensen, 2003, 2004).

The increase in chlorophyll content may be attributed to the activation of pigment breakdown or the stimulatory effect of natural hormones in seaweed extracts on the biosynthesis of these pigments (Nasser et al., 2025).

The increase in seaweed level had a significant effect on increasing the carbohydrate content in leaves, which may be due to the effect of seaweed on increasing the activity of photosynthesis by increasing the availability of basic materials needed by plants, such as amino acids, chlorophyll, and some enzyme cofactors and energy compounds, leading to an increase in carbohydrates (Al-Bayati, 2011).

REFERENCES

1. Al-Bayati, Marvi Rashid Samin (2011). Effect of Spraying with Fenugreek and Garlic Extracts and Some Seaweed Extracts on Growth, Yield, and Mineral Content of Cucumber Plant. Thesis, College of Agriculture, University of Tikrit, Ministry of Higher Education and Scientific Research, Iraq.
2. Al-Sahaf, Fadel Hussein Rida (1989). Applied Plant Nutrition. Al-Hikma House Press, Iraq: 258 pp.
3. Al-Timimi, Jamil Yasin Ali and Basma Hammad Az Aldin (2014). Effect of Organic Fertilizers and Chelated Iron on Vegetative Growth Traits of Peppermint Plant. Journal of Tikrit University for Agricultural Sciences, 14(2): 181-187.

4. Al-Timimi, Jamil Yasin Ali Kahf (1998). Factors Affecting Biological Nitrogen Fixation in Leguminous Plants. Ph.D. Thesis, College of Agriculture, University of Baghdad, Ministry of Higher Education and Scientific Research, Iraq.
5. Arora, D. S.; Onsare, J. G. and Kaur, H. (2013). Bioprospecting of Moringa (Moringaceae): microbiological perspective. J. Pharmacog Phytochem, 1(6): 193–215.
6. Ashfaq, M.; Basra, S. M. A. and Ashfaq, U. (2012). Moringa: a miracle plant for agro-forestry. Journal of Agriculture and Social Sciences, 8(3): 115–122.
7. Bajracharya , D. (1999). Experiments in plant physiology . Narosa publishing Host. New Delhi. India. Eshun, K. and Q. He. (2004). Aloe Vera: A valuable ingredient for the food, Pharmaceutical and cosmetic industries – A review. Crit. Rev. Food Sci. Nutr. 44: 91-96.
8. Dubois, M. K.; K. A. Crilles; J. K. Hamilton; D. A. Rebers and F. Smith (1956). Colorimetric method for determination of sugars and related substances. Anal .Chem., 28:350 – 365.
9. Fadala, Laila Turki, Taain , Dhia Ahmed and Hassan, Fatima Ali (2023).Role of Humic Acid and Some Spraying Treatments in Improving Vegetative Growth Parameters, Chemical Components of Leaves and Yield of Hot Pepper Plants (Capsicum annuum L.)Planted in Unheated Plastic Houses Conditions AIP Conf. Proc. 2845, 020009 .
10. G.Z.K. AL-RIKABI, L.T. FADALAH, and A.S. JEWAR(2025) MANAGEMENT OF CUCUMBER (CUCUMIS SATIVUS L.) IN INTEGRATION WITH BIOSTIMULANT ATONIK BASED ON PHYSICAL AND BIOCHEMICAL PROPERTIES SABRAO Journal of Breeding and Genetics 57 (4) 1510-1517.
11. Ghufran Zaid Khalaf AL-Rikabi, & Batool Hanoon Falih AL-Zubaidy. (2021). Effect of foliar spraying with atonic on some vegetative and flowering characteristics of cucumber Cucumis melo. Var flexuosus. University of Thi-Qar Journal of Agricultural Research, 10(1), 95-103.
12. Gollan, J. R. and J. T. Wright (2006). Limited grazing pressure by native herbivores on the Invasive Seaweed Caulerpa. Taxi Folia in a Temprate. Australia Estuary Marine and Fresh Water Research. 57 (7): 685-694.
13. Gopalakrishnan , L.; Doriya, K. and Kumar, D. S. (2016). Moringa oleifera : a review on nutritive importance and its medicinal 078 application. Food Science and Human Wellness, 5(2): 49–56.
14. Jensen, E. (2004). Seaweed ; Fact or fancy from the organic broadcaster. Moses the Midwest Organic and Sustainable Eductation. From the Broadcaster, 12(3): 164-170.
15. Keeling, A. A.; K. R. McCallum and C. P. Beckwith (2003). Crop and environment. Research Centre. Harper Adams University College. Newport. Shropshire. UK. Bioresource Tech., 90 (2): 127-137.
16. L.T.Fadalah, G. Z. Al-Rikabi and Hadiah A. Atiyah(2023) Effect of adding Nano-NPK fertilizer and humic acid on some vegetative growth characteristics and active components of Myrtle Myrtus communis L. J. Glob. Innov. Agric. Sci., 2023, 11(2):229-234.
17. Lopez, R., F. E. Cabera, F. Madajen, Sancho and M.Alvares (2008). Urban compost as alternative for peat in foresty nursery growing media. Dynamic plant. 1 Special Issue Composts 1: 60-66.
18. Mani, S.; Jaya, S. and Vadivambal, R. (2007). Optimization of solvent extraction of Moringa (Moringa oleifera) seed kernel oil using response surface methodology. Food and Bioproducts Processing, 85(4): 328–335.

19. Mohamed, A.; A. Bakry ; Y. R. A. Soliman and S. A. M. Moussa (2009). Importance of micronutrients. organic manure and bio-fertilizer for improving maize yield and its components grown in desert sandy soil. Res. J. Agric. and Bio. Sci., 5 (1): 16-23.
20. Nasser J. Kashash, Laila T. Fadala and Basem K. Hassan (2025)Effect of adding Bio-humic fertilizer and planting date on vegetative and chemical growth characteristics of onion Allium cepa L. International Journal of Environmental Sciences ISSN: 2229-7359 Vol. 11 No. 3S.
21. O'Dell, C. (2003). Natural plant hormones are biostimulants helping plants develop, plant antioxidant activity for multiple benefits. Virginia Vegetable, Small Fruit and Special Crops, 2(6): 1 – 3.
22. Omotesho, K. F.; Sola-Ojo, F. E.; Fayeye, T. R.; Babatunde, R. O.; Otunola, G. A. and Aliyu, T. H. (2013). The potential of Moringa tree for poverty alleviation and rural development: Review of evidence on usage and efficacy. International Journal of Development and Sustainability, 2(2): 799–813.
23. Paliwal, R.; Sharma, V. and Pracheta, J. (2011). A review on horse radish tree (Moringa oleifera): A multipurpose tree with high economic and commercial importance. Asian Journal of Biotechnology, 3(4): 317–328.
24. Premi, M., and Sharma, H. K. (2013). Oil extraction optimization and kinetics from Moringa oleifera (PKM 1) seeds. International Journal of Agriculture and Food Science Technology, 4(4), 371–378.
25. Radovich, T. (2010). Farm and forestry production and marketing profile for Moringa oleifera. Specialty Crops for Pacific Island Agroforestry. Permanent Agriculture Resources, Holualoa.
26. Saini, R. K. (2013). Studies on enhancement of carotenoids, folic acid, iron and their bioavailability in Moringa oleifera and in vitro propagation. University of Mysore.
27. Saini, R. K.; Shetty, N. P.; Prakash, M. and Giridhar, P. (2014). Effect of dehydration methods on retention of carotenoids, tocopherols, ascorbic acid and antioxidant activity in Moringa oleifera leaves and preparation of a RTE product. Journal of Food Science and Technology, 51(9); 2176–2182.
28. Sarir, M. S.; M. Sharif; Z. Ahmed and M. Akhlaq (2005). Influence of different levels of humic acid application by various methods on the yield and yield components of maize. Sarhad J. Agric., 21 (1): 75 81.
29. Thomas, S. C. L. (1996). Nutrient Weeds as Soil Amendments for Organic Cally Growth Herbs. Jour. of Herbs, Species and Medicinal Plant. 4 (1): 3-8.
30. Varanini, Z.; R. Pinton; H. D. Behnke; U. Luttge; K. Esser; J. W. Kadereit and M. Runge (1995). Humic substances and plant nutrition. Progress in Botany: Structural Botany, Physiology, Genetics and Taxonomy- Geobotany, 56: 97-117.