

The effect of spraying with seaweed extract and adding chemical fertilizer on the growth and productivity of cucumber grown in greenhouses

Khalid Abdulla Sahar Al-Hamdani¹, Marwa Noman Hussein², Najm Abdulla Sahar³

^{1,2}Department of Horticulture/College of Agriculture /Samarra University, Iraq

E mail: khalid.a.s@uosamarra.edu.iq

marwa.n015@tu.edu.iq

Abstract

The study was performed in the greenhouses associated with the Department of Horticulture and Garden Engineering at Samarra University during the 2024-2025 agricultural season to examine the impact of various seaweed extracts and chemical fertilizers on the vegetative growth and yield of cucumber plants. The study comprised nine combined treatments, with the control group receiving only water, while the experimental groups were treated with GOFAR SEAWEED extract at concentrations of 0.5 g/L and 1 g.L⁻¹. plants treated with chemical fertilizer at concentrations of 1 and 2 grams, and three replicates for each treatment, following a completely randomized design for the experiment. The findings indicated that the application of seaweed extract and chemical fertilizer resulted in a notable enhancement in plant height, leaf dimensions, and branch quantity relative to the control treatment. The values attained were 103.8, 4.48, 21.20, and 24.80, with the application of 2 : g.L⁻¹ of chemical fertilizer and a spray of 2 g of seaweed extract yielding superior results, as they produced the highest average of 39.33 fruits per Plant, 38.67 (39.67) fruits. The maximum fruit weights attained were 103.4 g and 102.2 g, respectively, while the yield per plant was 4066.72 g and 3952.07 g.plant⁻¹.

Keywords: seaweed, vegetative growth, yield, cucumber

Introduction:

The cucumber plant (*Cucumis sativus*) is a significant vegetable crop within the Cucurbitaceae family [1]. It is grown for its fruit, which is eaten fresh or pickled because of its low caloric value [2]. Fresh cucumbers are regarded as significant fruits for their antioxidant properties, with their substantial nutritional worth. They comprise significant proportions of protein (0.4%), carbs (2.8%), minerals (0.3%), and lipids (0.1%), along with varied levels of calcium and phosphorus [3], trace amounts of vitamins (A, C, and K), and fiber [4]. Moreover, its fruits are characterized by the presence of enzymes that facilitate the digestion of fats and proteins. During the ingestion phase, cucumbers comprise 4-6% dry matter. Cucumbers, which contain enzymes that facilitate the digestion of fats and proteins, provide several health benefits such as hydration, blood pressure regulation, weight loss, cholesterol reduction, maintenance of bone health, and diabetes management [5]. Cucumbers aid in regulating stomach acidity,

and their skin includes caffeic acid and ascorbic acid, which promote good skin [6].

Due to the economic significance of cucumbers, together with their nutritional and therapeutic properties, and their swift growth, farmers have recently boosted their production of this crop. This has prompted initiatives to improve agricultural production through the implementation of technologies that augment yields, decrease expenses, and elevate economic returns. Therefore, the significance of utilizing seaweed extracts in this study to enhance plant productivity, consequently augmenting farmers' economic returns.

Extensive studies have established the significance of utilizing seaweed extracts in horticulture. [7] revealed that seaweed extract functions as an eco-friendly biofertilizer and provides substantial economic advantages to farmers. [8] documented various beneficial benefits of seaweed extracts, such as higher germination and root development, superior leaf quality, increased overall plant vigor, and augmented resistance to diseases.

[9] asserted that food products with seaweed extracts can enhance branch development and stimulate vegetable growth. According to [10], the application of seaweed extracts enhances plants' tolerance to biotic and abiotic stressors. [11] determined that the application of seaweed extract to cucumber plants in protected cultivation resulted in notable enhancements in vegetative development characteristics and all examined yield attributes relative to the control group. The cucumber plants demonstrated the highest measurements for plant height (173.67 cm), total chlorophyll content (39.75%), total yield (100.92 t/ha), fruit weight (126.55 g), length (18.3 cm), and diameter (2.46 cm). Conversely, the control plants exhibited a height of 119.43 cm, total chlorophyll content of 27.28%, total yield of 58.20 t/ha, fruit weight of 99.27 g, and length of 14.76 cm. Having a diameter of 2.13 cm. Utilizing seaweed extracts as a foliar spray is advised to enhance development and overall production in cucumbers.

In a greenhouse study, two seaweed extracts were applied to Halouba cucumber plants. Algean was used at concentrations of 10, 20, and 30 ml/L of water, while Atonik was applied at 2.5, 5, and 10 ml/L of water. The foliar spray treatment significantly surpassed the control, achieving optimal results in leaf/plant growth, with a leaf area of 2.396 m²/plant, a fruit set percentage of 69.33%, an average of 27.1 fruits/plant, and a total yield of 240 g/plant, compared to the control, which recorded 17.23 leaves/plant, a leaf area of 1.87 m²/plant, a fruit set percentage of 58.66%, and a yield of 176.1 g/plant [12].

[13] demonstrated that in 2012, the application of Altra marine extract at a concentration of 1.5 ml/L, administered in three instances—initially one month post-planting, subsequently 10 days after the first application, and finally 10 days after the second—exceeded most growth parameters of the Babylon cucumber variety and yielded the highest β -carotene levels in the fruits. The use of seed inoculation with nitrogen-fixing cyanobacteria (*Nostoc* sp.) and the administration of Altra marine extract surpassed the majority of the evaluated

parameters, achieving the highest sex ratio (0.40) and a ratio of 39.66 female flowers to 98.33 male flowers per plant.

[14] established that the optimal fruit yield from foliar applications of *Ascophyllum nodosum* extract occurred at a concentration of 2 g.L⁻¹. Moreover, the interplay between the seaweed extract and nitrogen fertilizer yielded the subsequent outcomes. Marked disparities were noted in fruit output and fruit length following foliar application of *Ascophyllum nodosum* seaweed extract, indicating substantial variances across all examined characteristics.

[15] illustrated that the application of specific organic nutrients, particularly *Alga ci fo 300* derived from *Ascophyllum* algae at a concentration of 302 g/L, administered weekly from the appearance of the third true leaf until harvest, surpassed all evaluated parameters: yield per plant, fruit quantity, and fruit length and diameter.

[16] discovered that seaweed extracts enhance plant nutrient absorption, bolster tolerance to biotic stressors, and improve production quality.

[17] discovered that treatment with two seaweed extracts resulted in a notable increase in the quantity of female flowers and the fruit set % in comparison to the control group. The treatment shown an augmentation in the quantity of fruits per plant. Weight of fruit and overall production.

Inoculating cucumber seeds in protected cultivation with the biofertilizer Biohaelh (comprising 10% *Trichoderma harzianum*, 10% *Bacillus subtilis*, 75% humic acid, and 5% seaweed extract) prior to sowing, followed by immersing the seedling roots in a 10 g/L solution before transplanting, and applying the organic nutrient (Siapton L10) throughout the growing season, yielded a markedly enhanced treatment for the interaction between the two compounds. This treatment produced the highest measurements for plant height, total yield, leaf area, fruit weight, and fruit quantity [18].

[19] revealed that a *Chlorella vulgaris* suspension enhanced cucumber seed

germination relative to control seeds. The optimal treatments were 0.17 g/L and 0.252 g/L of the seaweed suspension for the vegetative traits of tomato and cucumber plants, respectively. This study aims to assess the impact of seaweed extract and chemical fertilizer on the growth and production of cucumber plants, as well as to ascertain the appropriate dose for foliar application under protected culture settings.

Materials and Methods

A study was performed at the research facility of the Department of Horticulture and Garden Engineering at Samarra University's College of Agriculture during the winter season of 2024-2025 in an unheated greenhouse.

The earth was tilled, subsequently leveled, smoothed, and irrigated. To facilitate movement within the greenhouse, three rows, each 60 cm wide, were allocated for planting in the center. The spacing between plants was 40 cm, with planting occurring on both sides of the row. A Randomize Complete Block Design (R.C.B.D.) was employed for the factorial experiment one way. The means were analyzed using Duncan's Multiple Range Test at a significance level of 5%. The SAS software was employed for statistical data analysis. The experiment, conducted with three replications, encompassed two factors: the first factor was Gofar Seaweed, a nutritional amalgamation derived from seaweed that fulfills all the requirements of the plant. The spraying procedure was conducted four times using Gofar Seaweed extract at concentrations of 0.5 g/L and 1 g/L, with a 14-day interval between each application.

The second factor pertains to the chemical fertilizer N.P.K at concentrations of (0, 1, 2) g.L⁻¹.

The hybrid cucumber seeds of the "Sura" variety, originating from the Netherlands and classified as parthenocarpic female type, were sown on December 11, 2024, with three seeds placed in each hole. The experimental field was irrigated subsequent to the complete planting of the seeds. Furthermore, seeds were sown at the commencement and conclusion of each area to

function as sentinel plants. Upon completion of germination, the seedlings were thinned by retaining one specimen in each cavity. All agricultural operations were executed in accordance with the established standards for greenhouse crop production, encompassing watering and weeding of uncovered units when necessary. The plants were subsequently secured with strings to the wires above each section.

The plants were treated with many preventive sprays to combat diseases and pests. The benlate insecticide was applied at a concentration of 2 g.L⁻¹ two weeks post-planting as the initial preventive treatment. To avert wilt disease, the plants were treated with the systemic fungicide Basten at a dose of 1 ml. 1 ml/l, three sprays with a one-month interval between each, commencing one month after the initial preventive spray.

The house's structure was enveloped in plastic on December 11, 2024, and the covering was removed on January 4, 2025. The harvest commenced on December 30, 2024, and concluded on March 29, 2025.

The following readings were taken from the plants as follows:

Vegetative Growth Indicators:

Plant Height (cm): Measure the height of the selected plants from each experimental unit from their soil contact point to the growing tip and record the average.

Number of Branches Formed on the Plant.

Leaf Length and Width (cm): Measure the length of three leaves from each of the three selected plants in each experimental unit and record the average length.

Total Number of Leaves per plant: Calculate the total number of leaves per plant for the three plants in each experimental unit and record the average.

Productivity Indicators:

Number of Fruits: Calculated by dividing the total number of fruits in each experimental unit by the number of plants in that unit.

Fruit Weight: Calculated by dividing the average total yield of plants in each experimental unit by the number of fruits in that unit.

Total Yield per Plant (kg): Calculated by dividing the total yield of plants in each experimental unit by the number of fruits in that unit.

Results and discussion:

The effect of the study factors on vegetative growth characteristics:

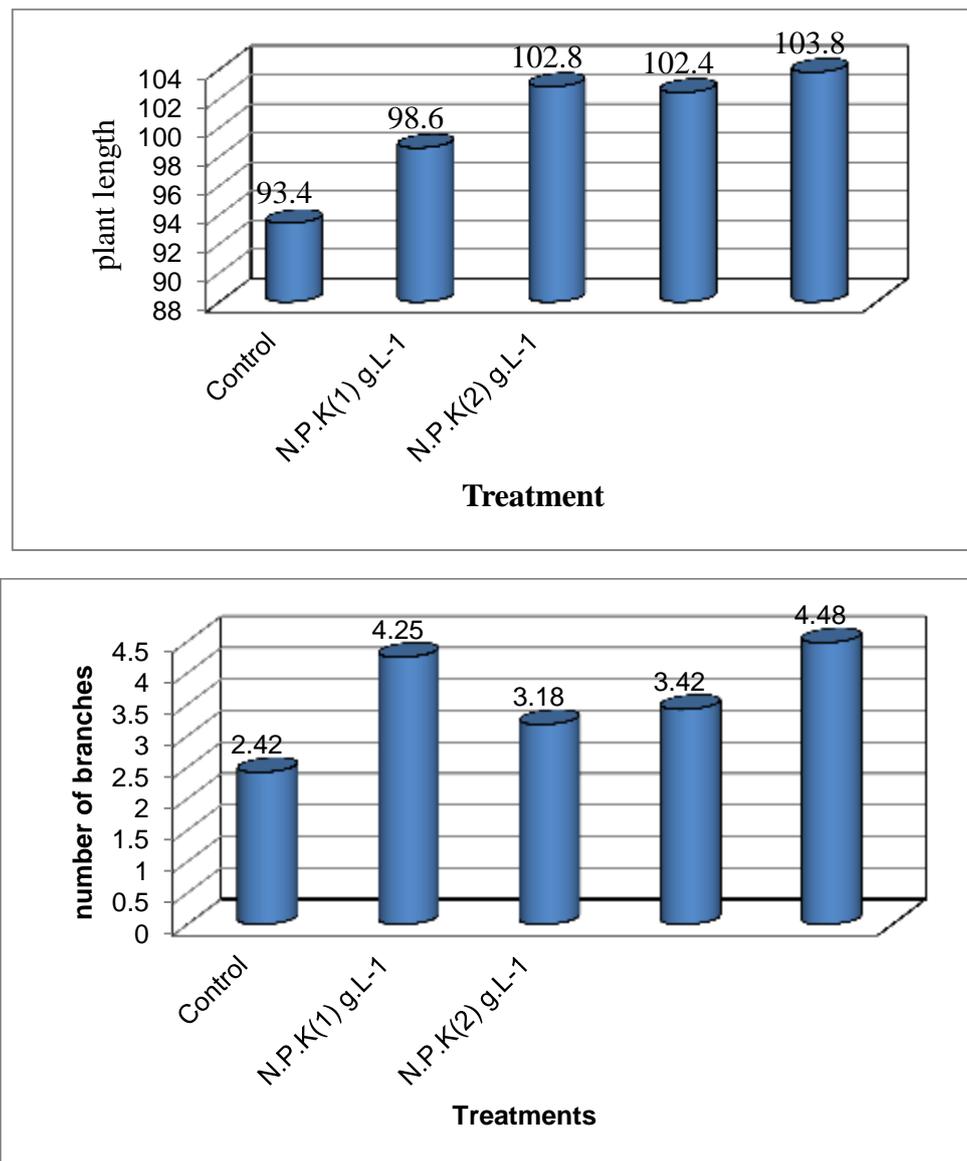
The height of the plants rose with larger concentrations of seaweed extract, and all treatments exhibited significant changes when compared to the control treatment. In the comparison of treatments, the treatment with the highest concentration of GOFAR SEAWEED extract (g L^{-1}) greatly surpassed the other experimental treatments, yielding the tallest plant height of 103.8 cm, followed by the treatments utilizing 2 g.L^{-1} of chemical fertilizer. Litter and seaweed at a concentration of 0.5 g. The litter treatment yielded average plant heights of 102.8 cm and 102.4 cm, respectively, whereas the control treatment resulted in the lowest height of 93.4 cm. This aligns with the findings of [15] on cucumber plants in controlled environments, as well as the results of [20].

The augmentation in plant height following the application of seaweed extract is attributed to the stimulation of cell division (Cytokinins and Auxins) and cell elongation (Gibberellins) by the extract. This can be ascribed to the plethora of vital nutrients, both macro and micro, and their influence on the mechanisms of photosynthesis and respiration. Nitrogen and phosphorus, integral to the composition of nucleic acids (DNA and RNA) essential for cell division and the proliferation of internodes, contribute to increased plant height; thus, chemical fertilizers also aid this growth. This can be ascribed to the quick degradation of chemical fertilizers, rendering them easily accessible and absorbable by the plant [21]. This led to nutritional equilibrium, fostering the growth of an effective vegetative mass

through nutrient absorption and enhanced biological activities, thus augmenting plant height.

All treatments administered in the experiment surpassed the control group, exhibiting substantial differences in branch quantity. The application of seaweed extract at a concentration of 1 g/L resulted in the maximum number of plant branches, significantly outperforming other treatments, with an average of 4.48 branches per plant. The lowest rate was seen for the chemical fertilizer treatment at a concentration of 1 g/L, which exhibited a significant difference. At a concentration of 1 g/L, it attained a height of 4.25 cm, whereas the control treatment had the lowest average branch count, reaching 2.42 branches per plant. This aligns with the conclusions of [20]. Utilizing organic fertilizers on cucumber plants within the greenhouse. This can be ascribed to the nitrogen concentration and critical elements in seaweed extract that are vital for photosynthesis and plant growth. The beneficial impact of seaweed extracts can be ascribed to their capacity to promote root development and expansion, resulting in improved uptake of vital nutrients for plant growth and, subsequently, augmented vegetative growth.

The 1 g/L spray treatment was superior. GOFAR SEAWEED surpassed the other treatments, exhibiting substantial variations in leaf length and width for cucumber plants, achieving measurements of 21.20 cm and 24.80 cm, respectively, compared to the control treatment's 16.80 cm and 18.80 cm. Quantity of leaves and leaf surface area of the plants: The GOFAR SEAWEED g/l spray treatment surpassed the other treatments, exhibiting substantial variations in leaf count and leaf area, achieving 34.40 cm^2 and 1061 cm^2 , in contrast to the control treatment, which recorded 24.08 cm and 4529 cm^2 .



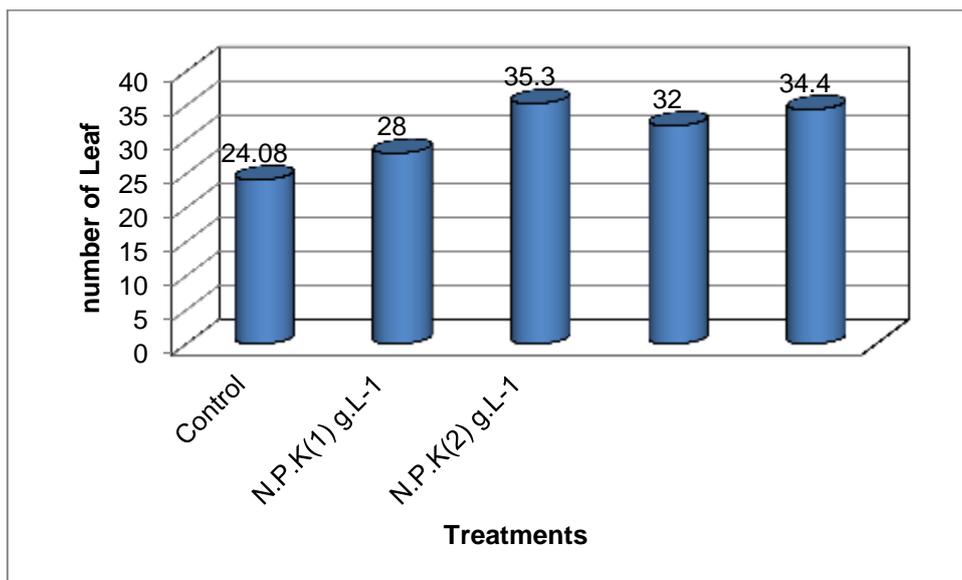
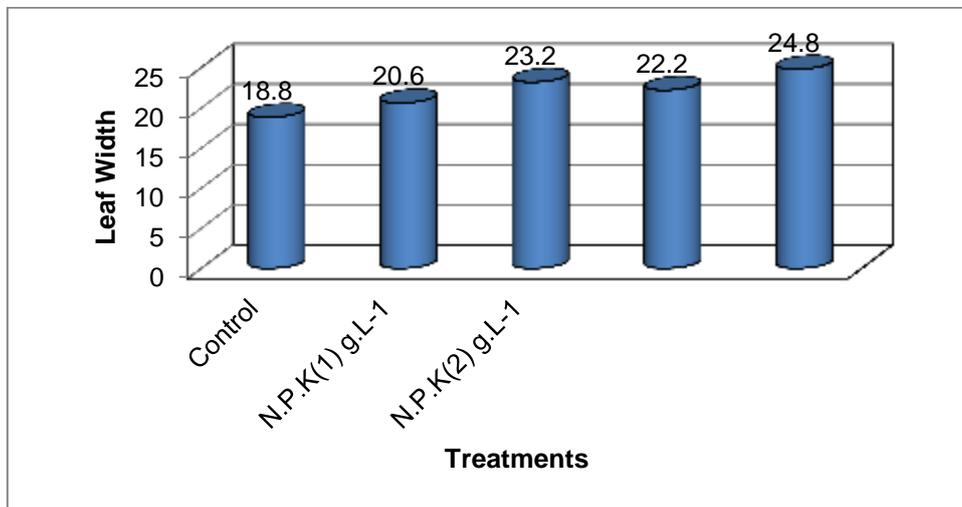
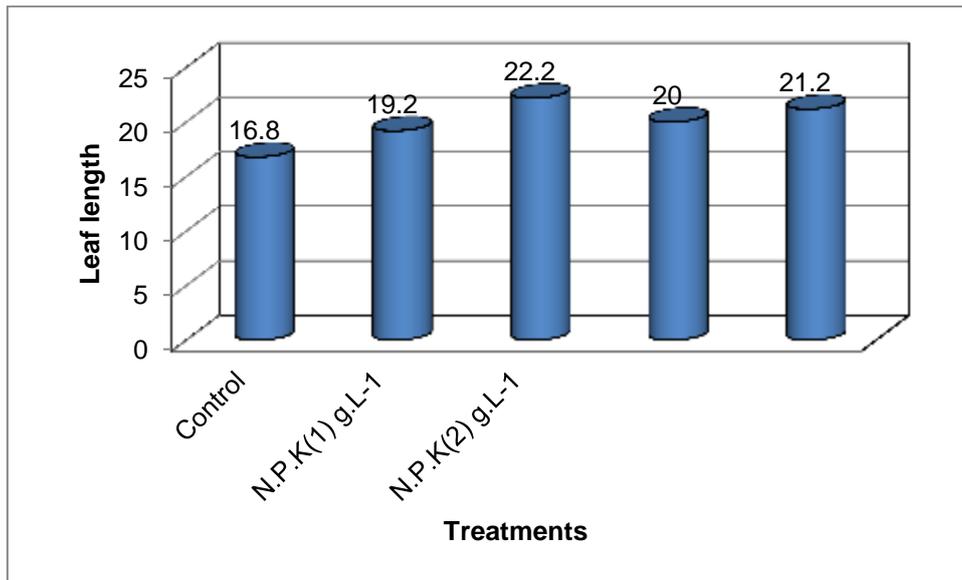
Figures (1 and 2) show the effect of treatment with SEAWEED GOFAR seaweed extract and the N.P.K chemical fertilizer on the plant height and the number of branches in cucumber plants.

Dimensions, breadth, and quantity of leaves

The chemical fertilizer application at a concentration of 2 g/l demonstrated superior performance. The maximum average leaf length was 22 cm, followed by the seaweed treatment with average lengths of 21.2 cm and 20 cm, respectively, while the control treatment had the lowest average lengths of 16.80 cm and 18.80 cm, respectively. The GOFAR SEAWEED g/l spray treatment surpassed the other treatments, exhibiting a notable leaf breadth of 24.80 cm, followed by the chemical fertilizer treatment at a concentration of 2 g/l.

The average leaf width was 23.2 cm, whereas the control treatment yielded the lowest average of 18.8 cm.

The two treatments utilizing the chemical fertilizer at 2 g/l demonstrated superior leaf quantity. The application of GOFAR SEAWEED at g/l concentrations surpassed the other treatments, demonstrating statistically significant differences and resulting in the highest average leaf count of 35.3 and an area of 34.40 cm², in contrast to the control treatment, which measured 24.08 cm².



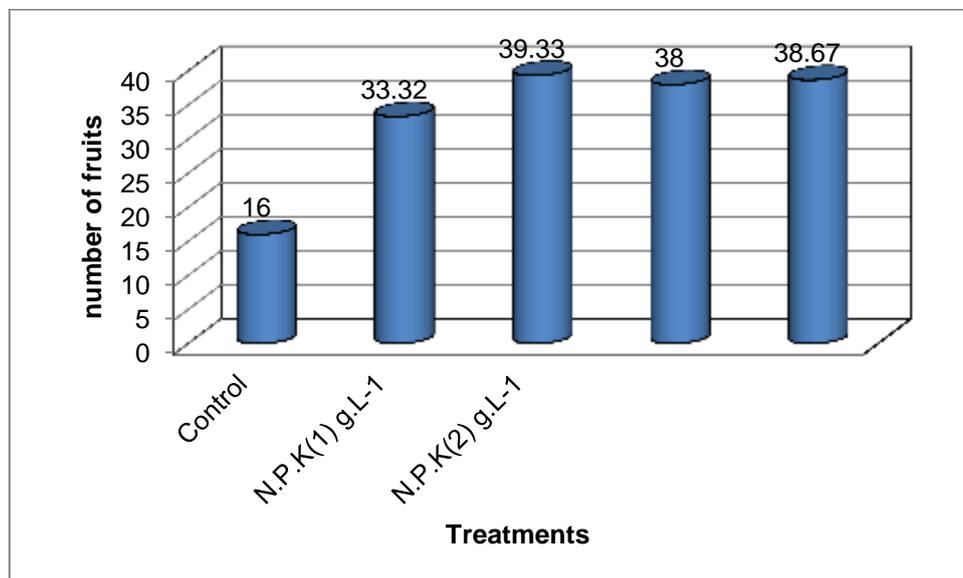
Figures (3, 4, and 5) Effect of treatment with GOFAR seaweed extract and the N.P.K chemical fertilizer on the length, width, and number of leaves.

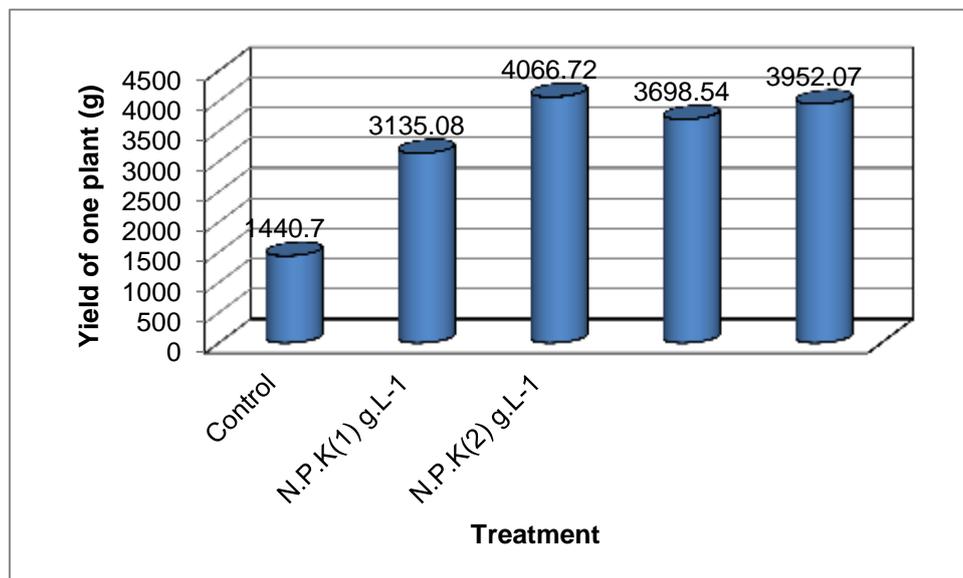
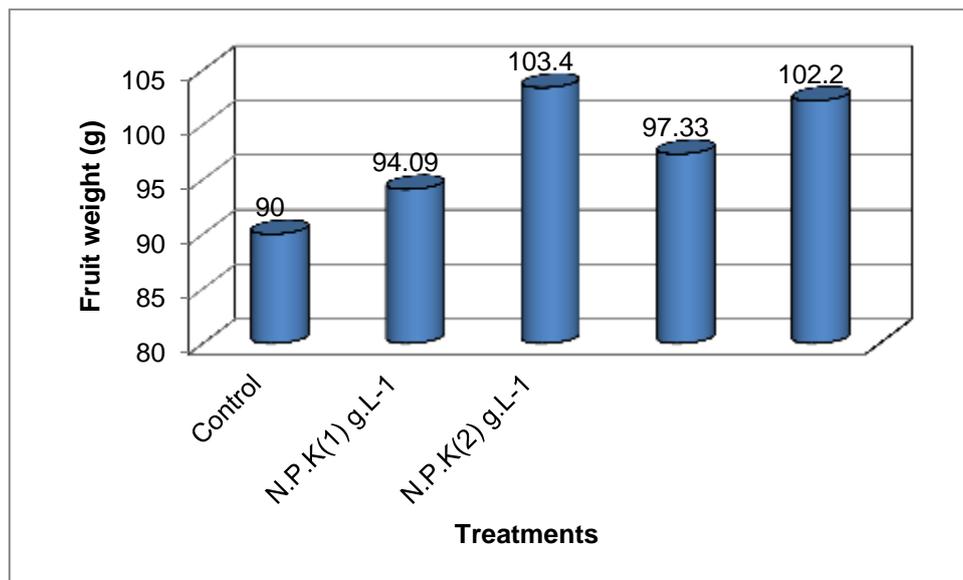
The quantity of fruits escalated with the elevation of chemical fertilizer concentration at 2 g per liter, yielding the greatest average of 39.33 fruits. Plant, subsequently treated with a seaweed spray at a dosage of 1 g. The average fruit count was 38.67 fruits per plant, whereas the control treatment yielded the lowest count of 16 fruits per plant. This is ascribed to the beneficial effects of seaweed extracts in enhancing leaf quantity, leaf area, and nutrient uptake, which subsequently improved photosynthetic efficiency and carbohydrate storage, culminating in an increased fruit yield [22].

The presence of auxins and cytokinins in seaweed extracts resulted in an increased fruit set % and a higher quantity of fruits per plant, corroborating the findings of [12] on cucumber plants.

The data presented in Figures 7 and 9 reveal substantial variations attributable to the experimental treatments regarding fruit weight and yield per plant. The statistical analysis indicated that the highest concentration of

chemical fertilizer and seaweed extract significantly surpassed the other experimental treatments, attaining maximum fruit weights and yields per plant of 103.4 g, 102.2 g, 4066.72 g, and 3952.07 g, respectively. The lower concentration treatments of seaweed extract and chemical fertilizer yielded average fruit weights and plant yields of 97.33 g, 94.09 g, 3698.54 g, and 3135.08 g, respectively, with notable variations observed. Conversely, the control treatment yielded the lowest average fruit weight and yield per plant, measuring 90 g and 1440.70 g, respectively. The augmentation of fruit weight resulting from the application of seaweed extract and chemical fertilizer can be ascribed to the influence of these substances on promoting vegetative growth, as demonstrated by the measurements of plant height and leaf area. This results in elevated glucose levels in the leaves, which are then transported and stored in the fruits, hence augmenting fruit weight. This observation aligns with the results of [18; 20] regarding cucumber plants.





Figures (6, 7, and 8) Effect of treatment with GOFAR seaweed extract and the N.P.K chemical fertilizer on the number of fruits, fruit weight, and yield per plant.

Conclusions

The findings of this study demonstrate that the application of seaweed extract and chemical fertilizer significantly enhanced the vegetative growth and yield parameters of cucumber plants cultivated in a greenhouse, in comparison to the control treatment. The interventions resulted in marked improvements in plant height, leaf size, branch quantity, fruit count, fruit weight, and yield per plant. The chemical fertilizer at a concentration of 2 g and the seaweed extract spray at 2 g/L⁻¹ yielded

the highest values across most evaluated characteristics, particularly in terms of fruit quantity, weight, and overall yield per plant, thereby underscoring the efficacy of these treatments in augmenting productivity. Consequently, the utilization of seaweed extracts is recommended as an alternative or supplementary option to chemical fertilizers, owing to their beneficial impact on growth and production while mitigating dependence on chemical inputs.

References:

- [1] **Uthpala, T. G. G., Marapana, R. A. U. J., Lakmini, P. C., & Wettimuny, D. (2020).** Nutritional bioactive compounds and health benefits of fresh and processed cucumber (*Cucumis sativus* L.). *Sumerianz Journal of Biotechnology*, 3(9), 75–82. DOI: 10.13140/RG.2.2.17510.04161
- [2] **Behera, S. S., Sheikha, A. F. E., Hammami, R., & Kumar, A. (2020).** Traditionally fermented pickles: How the microbial diversity associated with their nutritional and health benefits? *Journal of Functional Foods*, 70, Article 103971. <https://doi.org/10.1016/j.jff.2020.103971>
- [3] **Javid, H., Fatima, U., Rukhsar, A., Hussain, S., Bibi, S., Bodlah, M. A., Shahzad, H., Dilshad, M., Waqas, M., & Sharif, A. (2024).** Phytochemical, nutritional and medicinal profile of *Cucumis sativus* L. (Cucumber). *Food Science and Engineering. Advance online publication*. <https://doi.org/10.37256/fse.5220244795> (<https://www.google.com/search?q=https://doi.org/10.37256/fse.5220244795>)
- [4] **Saini, P. (2025).** Nutritional benefits and health effects of cucumbers. *Acta Entomology and Zoology*, 6(1), 255-261. <https://doi.org/10.33545/27080013.2025.v6.i1d.215> (<https://www.google.com/search?q=https://doi.org/10.33545/27080013.2025.v6.i1d.215>)
- [5] **Naganatha, S., Hertline, R (2015):** Cucumber nutritional fact . *J Veg Nutr* 15:1419-1440.
- [6] **Pawar, V., Meena, M.K., Jadia, M., Basediya, S. S. (2019):** Study of influence of Plant Growth Regulators (PGRs) on yield Attributing Characters in Cucumber. *Inter. J. of Pure Applied Bioscience, Depart. of soil and Water Engineering, JNKVV, Jabalpur, India.* 7(3): 318-324.
- [7] **Kumar, G., Sahoo, D (2011):** Effect of seaweed liquid extract on growth and yield of triticum sativum var. Pusa Gold. *J. of Applied Phycology* ,23 (2): 251-255
- [8] **Khan W, Rayirath UP, Subramanian S, Jithesh MN, Rayorath P, Hodges DM, Critchley AT, Craigie JS, Norrie J, Prithviraj B (2009):** Seaweed extracts as biostimulants of plant growth and development. *Plant growth regular* 28:386-399
- [9] **Strik WA, Arthur GD, Lourens AF, Novak O, Strnad M, Van Staden J (2004):** Changes in cytokinins and auxin concentration in seaweed concentrates when stored at an elevated temperature. *J Appl Phycol* 16:31-39
- [10] **MORET-GAUDRY J.F. (2009).** International seminar on fertilizers in Paris on the 9th September 2009, INRA-Versailles, Academie d Agriculture de France.
- [11] **Sarhan, Taha Zubair; Samira, Marai; and Sana, Rashid. (2011):** The effect of adding baker's yeast and seaweed extract on the growth of cucumber plants (*Cucumis*). *Sativus L. and its productivity and fruit quality. Journal of Mesopotamian Agriculture.* Vol. 26-34:2(39).
- [12] **Hammad, Hamid Saleh; Ubaid, Abdul Rahim Assi; and Anjal, Subhi Abdul Wahab. (2011):** The effect of spraying with Algean seaweed extract and Atonik on the growth and yield of cucumbers grown under greenhouses. *Tikrit University Journal of Agricultural Sciences*, Volume 11 (1), pp. 146-152.
- [13] **Abbas, Adeeb Jassim; Saleh, Ziad Khalaf; Ali, Jamil Yassin; Kamel, Ashjan Nizar. (2012):** The effect of Treatment of locally isolated cyanobacteria and seaweed extracts on the vegetative, flowering, and yield

- characteristics of cucumber (*Cucumis sativus* L.), Tikrit University Journal of Agricultural Sciences, Department of Horticulture and Landscape Engineering, College of Agriculture, Tikrit University, Iraq, Vol. 12 (4), pp. 101-107.
- [14] **Danesh,R.K.,Bidarigh,S.,Azar pour,E.,Moraditochae,M.,Bozorgi,H .R.(2012):**Study effects of nitrogen fertilizer management and foliar spraying of marine plant *Ascophyllum nodosum* extract on yield of cucumber (*Cucumis sativus* L.). Inter. J. of Agric. and crop sci.(IJACS) VOI.4NO.20PP.1492-1495 ref.23.
- [15] **Abd Saud, Omar; Abdul Shammari, Aziz Midi (2013):** The effect of spraying with some organic nutrients and soil management on the growth and yield of three cucumber hybrids under protected cultivation conditions. Diyala Journal of Agricultural Sciences, Vol. 5 (2), College of Agriculture, Diyala University, Iraq, pp. 283-294.
- [16] **Battacharyya, D., Babgohari, M.Z., Rathor, P., Prithivirai, B. (2015):** Seaweed Extracts as biostimulants in horticulture. Depart. of Envir. Sci., Dalhusie Univ., Truro, NS, Canada, B2N 5E3.Sci. Horti. 196:39-48.
- [17] **Sarhan, Taha Zubair. (2014):** The effect of low temperature and seaweed extract on flowering and yield of two cucumber varieties. International Journal of Agricultural and Food Research. Vol. 1(3): 209-214.
- [18] **Drifel, Khalid Abdul Hussein; Alawi, Muhammad Mustafa. (2016):** The role of biofertilizers and spraying with some nutrients on the growth and yield of cucumbers grown under protected environmental conditions. Al-Furat Journal of Agricultural Sciences, Volume 8 (2), pp. 1-8.
- [19] **Bumandalai ,O., Tserennad mid ,R.(2019):**Effect of chlorella vulgaris as abiofertilizer on germination of tomato and cucumber seed. Inter. J. Of Aquatic Biology.7(2):95-99.
- [20] **Sarhan, Taha Zubair; Samin, Mar'i Rashid; Ali, Jamil Yassin; Matar, Imad Ayal; Mahdi, Adhfaf Ra'i. (2013):** The effect of spraying with some natural plant extracts and seaweed on the growth, yield, and mineral content of cucumber (*Cucumis Sativus* L.). Tikrit University Journal of Agricultural Sciences. Vol. 13(3). pp. 113-121.
- [21] **Al-Barbary, A. G. M., Alkharpotly, A. A., Gabal, A. A. A., & Aly, M. A. (2022).** Effect of seaweed extract and gibberellic acid on growth and productivity of globe artichoke. Journal of Plant Production, Mansoura University, 13(8), 589-595. <https://doi.org/10.21608/jpp.2022.150702.1141> (<https://www.google.com/search?q=http://doi.org/10.21608/jpp.2022.150702.1141>)
- [22] **Canellas ,L.P. and Olivares ,F.L.(2014):**Physiological Responses to Humic Substance as Plant Growth Promoter .Chemical and Biological Technologies in Agriculture .Vol.1(3),1-11.