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# Effect of seaweed extract on the growth, flowering, bulb productivity and chemical compositions of tuberose (*Polianthus tuberosa* L.) in Aswan, Egypt

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## Abstract:

The current investigation was conducted at the floriculture nursery and laboratory of the Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt during the two seasons of 2022/2022 and 2023/2024, with the aim of studying the impact of with different concentrations of seaweed extract as soil drenching on the growth, flowering, and bulb production aspects as well as chemical components of tuberose (*Polianthes tuberosa* L.) plants. This experiment was arranged as a randomized completely design with four replicates. Five algae extract treatments namely; control or untreated plants, 0.5, 1.0, 1.5 and 2.0 g/l were applied. It was found that treating tuberose plants with 1.5 g/l seaweed extract with obtaining maximum values for the vegetative growth measurements i.e. leaves number/ plant, leaves length, fresh and dry weight of leaves and leaves area. Treating plants with 1.5 g/l produced the maximum values of the flowering attributes like spike length, spike fresh and dry weight, rachis length, number of florets/plant, flower diameter, and the least days to flowering time. Also, the best results regarding the bulb production and the content of N,P, K, pigments, total carbohydrates as well as polyphenols were recorded with 1.5 g/l marine algae extract as comparing with the other treatments. In general, the obtained results showed that applying seaweed extract improved the growth, flowering, and bulb production as well as chemical characteristics of tuberose plants under the environmental conditions of Aswan region.

**Keywords:** *Polianthes tuberosa* L, tuberose, seaweed extract.

## 1- Introduction

*Polianthes tuberosa* L. is the scientific name for tuberose, belongs to the Agavaceae family and a monocot subfamily **(Barba-Gonzalez et al., 2012).** The tuberose plant is one of the most important perennial summer bulbs in Egypt. It is easy to grow and produce a large number of bulbs, which allows for rapid spread. The plant has a high coordination and export value. Tuberose is grown in gardens and flower beds and produces fragrant flowers. Its flowers, which bloom on the spike from bottom to top, are leathery in texture and trumpet-shaped, suitable as cut flower and can withstand shipping shocks upon export. In Egypt, the plant can give an additional production of flowers in the fall in addition to its main flowering period in the summer.

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Natural extracts are a good source of nutrients and growth stimulants, and this is reflected in the chemical compositions of the plant. Seaweed extract is a natural organic fertilizer extracted from seaweed and can be classified as multicultural and a macroscopic marine algae **(Thirumaran et al., 2009a).** It contains micro elements as B, Co, Mo, Cu, and Zn and many growth regulators like gibberellins, auxins, and cytokinins **(Jensen, 2004)**. This is in addition to containing macro elements as nitrogen, phosphorus and potassium, and alginates, as well as polysaccharides. Marine algae also consist of many organic compounds that stimulate the growth of different ornamental plants **(Kularathne et al., 2021)**. The effective stimulant of seaweed extract is due to available synthetic fertilizers. Its stimulating role is due to its growth hormones and micro and macro nutrients, which increase the growth and quality of various ornamental plans. *Ascophyllum nodosum* is widely used on horticultural crops to improve soil properties, growth and productivity. It contains many of elements and rich in natural components, especially hormones such as auxins, cytokinins and gibberellin, that improve biological processes in the plant and improve the plant growth and yield. It is also rich in organic compounds such as vitamins, carbohydrates and amino acids that maintain the plant vitality. Numerous studies proved the positive effect of *A. nodosum* extract application on the ornamental plants **(Abdel Aziz et al., 2011; Hamid et al., 2014; Yuqi and Mattson, 2015; Yaseen and Kadim, 2017; Saleh and Sheikhy, 2018; Al-Saad, 2020).**

Various researches have indicated the significant impact of marine algae extracts on the growth, productivity, photosynthetic pigments and macro-nutrients content in comparison to the control **(Gharib et al., 2014). Nofal et al. (2021)** studied the effect of seaweed extract (0, 1 and 2 g/l) as spraying alone or interacting with NPK fertilization on the chemical compositions of *Tagetes erecta* L. They showed that seaweed extract treatments resulted in increasing in all chemical compositions. Treating with 2 g/pot NPK combined with 2 g/l seaweed extract attained the most enhancements. **Abd-El-Hady (2020)** investigated the response of tuberose to seaweed as foliar application indicated that seaweed extract showed significant increment in the plant growth, flowering traits and production. Seaweed extract at a rate of 1.5 $cm^3$/L improved the plant height, number of leaves/plant, leaf width, florets number/spike, length of spike and rachis as well as fresh weight of spike. Furthermore, Harhash **et al. (2023)** on their investigation on the effect of seaweed extract as foliar application on the growth and productivity *Dahlia variabilis* L. plants reported that when compared to untreated plants, seaweed extract at 1500 mg/l recorded maximum measurements for the vegetative growth and flowering traits. Therefore, this investigation aimed to study the effect of using seaweed extract as a soil drenching on the vegetative growth, flowering, bulb productivity and chemical characteristics responses of tuberose plant grown under Aswan conditions, Southern Egypt.

## 2. Materials and methods

A pot experiment was conducted during the two seasons of 2022/ 2023 and 2023/2024 at Floriculture Nursery, Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt (23°59'53.0"N 32°51'29.5"E). The main objective was to evaluate the effects of seaweed extract (SWE) as soil drenching on the vegetative growth, productivity and chemical compositions of tuberose (*Polianthus tuberosa* L.). Bulbs of tuberose were purchased from a commercial-nursery for ornamental plants in Al Kanater El Khayria, Qalubia governorate, Egypt.

Healthy tuberose bulbs, weighing about 25 g with a diameter of 2.5-3.0 cm were soaked in a fungicide solution before being planted on 10$^{th}$ March for the two seasons, in PVC pots of 30 diameter and packed with one of the different media. The growing media is a mixture of sand: clay1:1v/v; its physical and chemical properties was presented in Tables 1&2.

Tuberose plants in all experimental units were received the chemical fertilizers in two doses, thirty-five and forty-five days following bulb planting. Five seaweed extract treatments (control, 0.5, 1.0, 1.5 and 2.0 g/l) was applied. Seaweed extract as powder form (Acadian) was used as soil drenching 200 ml/pot, with a 15-day gap between supplementations. Acadian SWE produced by Canadian Acadian Sea Plans Company, and it was imported by Chema Industries Company, Egypt. Table (3) showed the nutritional components of the used Acadian as extract. Tuberose plants were randomly selected to measure the vegetative growth, flowering, bulb production and chemical compositions as follows:

**2.1Growth characteristics:** leaf length in cm, leaves fresh and dry weights /plant, leaf number/plant at flowering time and leaf area index ($cm^2$).

**2.2. Flowering Characteristics:** number of days to reach flowering (days), length of spike in cm, spike fresh and dry weight (g), rachis length (cm), florets number/flowering spike and flower diameter (cm).

**2.3. Bulb production**: number of new formed bulbs, fresh weight of hill (g), fresh weights of new formed bulbs (g) and diameter of the new formed bulbs (cm).

**2.4. Chemical constituents:**

**2.4.1.Photosynthetic pigments**

Samples of fresh leaves were randomly gathered for each treatment, and the content of chlorophyll a &b and carotenoids was determined using the **Metzner et al. (1965)** method.

**2.4.2.N, P, and K analysis:**

To estimate N, P and K elements, 0.2 g of dry leaves were ground and wet-digested in concentrated (1:1 v/v) $H_2SO_4$:$H_2O_2$ by using a heating digester (DK, Velp Scientific Srl, Italy) and the resulting extract is used to estimate these elements. To measure nitrogen content, the semi-micro kjeldahl method is used (**Black et al., 1965**). Phosphorus and potassium contents were measured according to **Chapman and Pratt (1961).** To estimate phosphorus, the color density is measured using a spectrophotometer at a wavelength 470 nm and calculated using the standard curve of potassium dihydrogen orthophosphate ($KH_2PO_4$). Meanwhile, potassium was estimated by using a flame photometer, which is standardized with a standard solution.

**2.4.3.Total carbohydrates:**

Total carbohydrates (%) in dry leaves of tuberose were evaluated calorimetrically by using the method of **Dubois et al. (1956).**

**2.4.4. Total polyphenols determination:**

Total polyphenol has been measured in tuberose leaves using Folin-Ciocalteu reagent **(Ghedadba et al., 2015).** The reduced form of the phenolic compounds leads to format a complex blue colored, which is measured calorimetrically at a wavelength of 765 nm. Mix of 0.2

ml of the extract (1 mg/l) with 1 ml of Folin-Ciocalteu reagent diluted to 1 to 10. Incubate for 4 minutes, then add 0.8 ml of sodium carbonate, 75 mg/l. Absorbance is measured after 2 hours of incubation at room temperature at 765 nm. The calibration curve is obtained under the same conditions using a wide range of gallic acid solution concentrations as 10-160 µg.ml/l. Total phenolic level is estimated using regression curve y=0.0091x+0.0125; y: absorbance and x: concentration of gallic acid, R2=0.9945, and expressed in microgram equivalent of gallic acid/ mg of extract (µg EAG.mg/l E).

### 2.4.5.Statistical analysis:

Statistical analysis of the data was done using analysis of variance **(Snedecor and Cochran, 1980).** Least significance difference (LSD) was used to differentiate means at 5% level of probability. To compare the differences between means, a computer program of Statistics version 9 was used **(Analytical software, 2008).**

**Table 1:** The physical and chemical properties of the used sandy soil under study.

| Soil properties | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical properties | | | | Chemical properties Soluble cations (mmol/l) | | | | Chemical properties Soluble anions (mmol/l) | | | | pH (1:1 soil suspension) | EC (dS/cm) | N (ppm) | P (ppm) | K (ppm) |
| Clay (%) | Silt (%) | Sandy (%) | Textural class | Ca++ | Mg++ | K+ | Na+ | $CO3^{--}$ | $HCO_3^-$ | $Cl^-$ | $SO4^{--}$ | | | | | |
| 3.00 | 0.00 | 97.00 | Sandy | 3.06 | 1.02 | 0.83 | 0.76 | 0.00 | 7.10 | 3.60 | 0.40 | 8.7 | 0.33 | 25.0 | 35.6 | 56.0 |

**Table 2.** Analysis of the used clay soil and its physical and chemical properties

| Particle size distribution | | Soluble cations and anions ($mmol_cL^{-1}$) | |
|---|---|---|---|
| Coarse-sand | 7.10 % | $Ca^{++}$ | 6.25 |
| Fine-sand | 24.90 % | $Mg^{++}$ | 3.28 |
| Silt | 25.75 % | $Na^+$ | 4.98 |
| Clay | 42.25 % | $K^+$ | 1.45 |
| Textural class | Clay | $CO3^{--}$ | --- |
| pH (1:2.5) soil –water suspension | 8.2 | $HCO_3^-$ | 1.60 |
| E.C soil paste extract (dS/m) | 1.10 | $Cl^-$ | 10.09 |
| Organic matter (mg/kg) | 11.20 | N (ppm) | 75.0 |
| Organic carbon (mg/kg) | 7.35 | P (ppm) | 63.4 |
| C.E.C ($cmmol_c/kg$) | 33.20 | K (ppm) | 216.0 |

**Table 3:** The nutritional components of the used Acadian marine extract from *Ascophyllum nodosum* under study.

| Acadian marine extract | | | |
|---|---|---|---|
| Organic matter (%) | 45-55 | Na (%) | 3-5 |
| Total nitrogen (%) | 0.8-1.5 | B (ppm) | 75-150 |
| $P_2O_5$ (%) | 1-2 | Fe (ppm) | 75-250 |
| $K_2O$ (%) | 17-22 | Mn (ppm) | 5-20 |
| S (%) | 1-2 | Cu (ppm) | 1-5 |
| Mg (%) | 0.2-0.5 | Zn (ppm) | 25-50 |
| Ca (%) | 0.3-0.6 | Amino acids (%) | 4.4 |

## 3. Results and discussion

### 3.1. Growth characteristics:

3.1.1.Leaves number/plant, length and fresh weight:

The effect of seaweed extract treatments on number of leaves, leaf length and leaves fresh weight was tabulated in Table (4). There were significant differences in these traits as result of applying different seaweed extract levels on tuberose. Among the seaweed levels used, applying

1.5g/l seaweed extract leads to the highest values of leaves number per plant (58.6 and 58.5), leaf length (43.6 and 43.8 cm) and leaves fresh weight (237.4 and 238.7 g) compared to all other levels in the 1st and 2nd seasons, respectively. The lowest values of these characters were registered with the control, followed by tuberose plants treated with 0.5% seaweed extract.

**Table 4:** Number of leaves/plant, leaf length (cm) and leaves fresh weight (g/plant) of *Polianthes tuberosa* L as affected by seaweed extract application during the two seasons of 2022/2023 and 2023/2024.

| Seaweed extract levels (g/l) | Number of leaves/plant | | Leaf length (cm) | | Leaves fresh weight (g/plant) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| 0 | 51.8 | 51.9 | 36.9 | 37.0 | 194.0 | 196.1 |
| 0.5 | 53.8 | 53.9 | 38.8 | 39.0 | 206.3 | 207.6 |
| 1.0 | 56.2 | 56.3 | 41.2 | 41.4 | 221.1 | 223.1 |
| 1.5 | 58.6 | 58.5 | 43.6 | 43.8 | 237.4 | 238.7 |
| 2.0 | 58.1 | 58.2 | 43.1 | 43.2 | 234.6 | 234.5 |
| LSD 5% | 0.03 | 0.08 | 0.03 | 0.01 | 12.30 | 14.79 |

3.1.2.Leaves dry weight and leaves area:

Statistically, significant differences were detected in leaves dry weight and leaves area of tuberose as result of applying different levels of seaweed extract as shown in Table (5). Results showed that applying 1.5 g/l seaweed extract coincided with the highest weight of dry leaves (76.2 and 76.6 g) and leaves area (60.7 and 61.0 $cm^2$), while the lowest ones were recorded with the control plants, followed by those treated with 0.5 g/l seaweed extract in the 1st and 2nd seasons, respectively. In the current study, applying 1.5 g/l seaweed extract, followed by 2.0 g/l as soil drench caused an improve in the vegetative growth of tuberose plants. Our results were in agreed with **El-Alsayed et al. (2018)**, who studied the effect of seaweed extracts at rates of 0.0, 0.5, 1 and 1.5 % on the vegetative growth, of *Dahlia pinnata*. They showed that the maximum improve in these characteristics was produced at the rate of 1% seaweed extract compared to all other treatments. Also, our results concerning the influence of seaweed extract were agreed with those obtained by **Adnan et al. (2014).**

**Table 5:** Leaves dry weight (g/plant) and leaves area ($cm^2$) of *Polianthes tuberosa* L. as affected by seaweed extract application during the two seasons of 2022/2023 and 2023/2024.

| Seaweed extract levels (g/l) | Leaves dry weight (g/plant) | | Leaves area ($cm^2$) | |
|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season |
| 0 | 61.8 | 61.9 | 54.7 | 54.8 |
| 0.5 | 65.9 | 66.0 | 56.4 | 57 |
| 1.0 | 71.1 | 71.2 | 58.5 | 58.8 |
| 1.5 | 76.2 | 76.6 | 60.7 | 61.0 |
| 2.0 | 75.2 | 75.2 | 60.4 | 60.7 |
| LSD 5% | 0.03 | 0.99 | 0.24 | 0.27 |

**3.2.Flowering responses:**

3.2.1. Number of days to flowering, spike length and spike fresh weight:

There were significant differences between the means of days to reach flowering, spike length and spike fresh weight of tuberose plants as affected by the different seaweed extract levels

(Table 6). The obtained data demonstrate that adding of seaweed extract resulted in the lowest days to reach the flowering stage, highest spike length and highest spike fresh weight compared to untreated plants. It is obviously that the plants received 1.5 g/l seaweed extract recorded the shortest days until the flowering time (104.1 and 103.8 days), highest spike length (79.6 and 79.9 cm) and highest spike fresh weight (115.6 and 116.3 g) while the longest ones resulted from plants without seaweed extract in the 1st and 2nd seasons, respectively.

**Table 6:** Number of days to flowering (days), spike length (cm) and spike fresh weight (g) of *Polianthes tuberosa* L. as affected by seaweed extract application during the two seasons of 2022/2023 and 2023/2024.

| Seaweed extract levels (g/l) | Number of days to flowering (days) | | Spike length (cm) | | Spike fresh weight (g) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| 0 | 114.9 | 114.6 | 68.6 | 68.8 | 95.2 | 95.8 |
| 0.5 | 113.6 | 112.8 | 71.7 | 71.9 | 101.1 | 101.6 |
| 1.0 | 111.1 | 109.9 | 75.6 | 75.8 | 108.3 | 108.9 |
| 1.5 | 104.1 | 103.8 | 79.6 | 79.9 | 115.6 | 116.3 |
| 2.0 | 107.2 | 106.8 | 78.8 | 78.9 | 114.1 | 114.6 |
| LSD 5% | 0.89 | 0.89 | 0.03 | 0.05 | 0.02 | 0.03 |

3.2.2. Spike dry weight, rachis length, number of florets and flower diameter:

It was showed that spike dry weight, rachis length, number of florets and flower diameter was significantly affected by seaweed extract levels (Table 7). In this regard, significantly higher values of spike dry weight (29.6 and 29.6 g), rachis length (26.5 and 26.5 cm), number of florets/plant (37.2 and 37.5) and flower diameter (4.9 and 5.3 cm) was recorded by using seaweed extract at a rate 1.5 g/l in the 1st and 2nd seasons, respectively. The least values of these characters were registered with untreated plants. The present study was in agreed with **Al-Saad (2020)**, who studied the effect of seaweed extract at 0,1, and 2 g/ pot on the growth and flowering of *Gladiolus hybrid*. They showed that the addition of seaweed extract at a rate of 2 g to the soil resulted in improving all flowering parameters. **Abd-El-Hady (2020)** pointed out that applying tuberose plants with 1.5 $cm^3$/l improved the flowering traits. Treating of *Tagetes patula* with seaweed extract at a rate of 5 ml/l increased the flowering parameters **(Ayyat and Abdel-Mola, 2020).**

**Table 7:** Spike dry weight (g), rachis length (cm), number of florets/plant and flower diameter (cm) of *Polianthes tuberosa* L. as affected by seaweed extract application during the two seasons of 2022/2023 and 2023/2024.

| Seaweed extract levels (g/l) | Spike dry weight (g) | | Rachis length (cm) | | Number of florets/plant | | Flower diameter (cm) | |
|---|---|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| 0 | 20.7 | 20.8 | 22.7 | 22.9 | 29.0 | 29.3 | 4.4 | 4.7 |
| 0.5 | 23.2 | 23.3 | 23.8 | 23.9 | 31.4 | 31.7 | 4.6 | 4.8 |
| 1.0 | 26.4 | 26.5 | 25.1 | 25.3 | 34.3 | 34.6 | 4.8 | 5.1 |
| 1.5 | 29.6 | 29.6 | 26.5 | 26.5 | 37.2 | 37.5 | 4.9 | 5.3 |
| 2.0 | 28.9 | 29.0 | 26.2 | 26.3 | 36.6 | 36.9 | 4.9 | 5.2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LSD 5% | 0.02 | 0.03 | 0.02 | 0.04 | 0.02 | 0.08 | 0.03 | 0.05 |

### 3.3.Bulb production

It can be argued that the number of new bulbs per plant, fresh weight of hill, diameter of new bulbs and fresh weight of new bulbs was significantly affected by the seaweed extract treatments (Table 8). Application of all seaweed extract levels significantly increased these parameters compared to untreated plants. Generally, adding of 1.5 g/l resulted in the highest values of number of new bulbs/plant (13.0 and 13.2), fresh weight of hill (696.24 and 700.74 g), diameter of new bulbs (4.84 and 4.86 cm) and fresh weight of new bulbs (125.4 and 126.1 g) compared to the control in the 1st and 2nd seasons, respectively. These findings were in accordance with **Swedan and Youssef (2023)**, who reported that the highest values of lily bulbs registered with applying 2.5 ml/l seaweed extract. The enhancement in the bulb production in tuberose plants received seaweed extract compared to untreated plants may be due to the enhancements in the vegetative growth, which in turn improved nutrients uptake and photosynthesis by the plant leaves, then improved the growth and bulb production **(Ampong et al., 2022).**

**Table 8:** Number of new bulbs/plant, fresh weight of hill (g), diameter of new bulbs (cm) and fresh weight of new bulbs (g) of *Polianthes tuberosa* L. as affected by seaweed extract application during the two seasons of 2022/2023 and 2023/2024.

| Seaweed extract levels (g/l) | Number of new bulbs/plant | | Fresh weight of hill (g) | | Diameter of new bulbs (cm) | | Fresh weight of new bulbs (g) | |
|---|---|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| 0 | 10.9 | 11.0 | 482.7 | 488.9 | 4.2 | 4.2 | 99.6 | 100.0 |
| 0.5 | 11.6 | 11.6 | 545.2 | 549.9 | 4.4 | 4.4 | 107.0 | 107.4 |
| 1.0 | 12.3 | 12.3 | 620.6 | 624.5 | 4.6 | 4.6 | 116.2 | 116.6 |
| 1.5 | 13.0 | 13.2 | 696.2 | 700.7 | 4.8 | 4.9 | 125.4 | 126.1 |
| 2.0 | 12.8 | 12.7 | 680.8 | 684.2 | 4.8 | 4.8 | 123.6 | 123.8 |
| LSD 5% | 0.14 | 0.12 | 14.70 | 22.33 | 0.02 | 0.01 | 0.02 | 0.06 |

### 3.4. Chemical composition:

3.4.1.N,P and K contents:

Applying of seaweed extract concentrations had a substantial effect on nitrogen, phosphorus and potassium % in tuberose leaves (Table 9). Furthermore, higher records of N (1.96 and 1.96 %), P (0.491 and 0.493 %) and K (2.36 and 2.37 %) were obtained as result of applying 1.5 g/l seaweed extract compared with the all other treatments in the 1st and 2nd seasons, respectively.

**Table 9:** Nitrogen content (%), phosphorus content (%) and potassium (%) of *Polianthes tuberosa* L. as affected by seaweed extract application during the two seasons of 2022/2023 and 2023/2024.

| Seaweed extract levels (g/l) | Nitrogen content (%) | | Phosphorus content (%) | | Potassium content (%) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| 0 | 1.88 | 1.89 | 0.429 | 0.430 | 2.00 | 2.01 |
| 0.5 | 1.90 | 1.90 | 0.447 | 0.448 | 2.11 | 2.11 |
| 1.0 | 1.92 | 1.92 | 0.468 | 0.471 | 2.23 | 2.24 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.5 | 1.96 | 1.96 | 0.491 | 0.493 | 2.36 | 2.37 |
| 2.0 | 1.95 | 1.95 | 0.487 | 0.488 | 2.34 | 2.34 |
| LSD 5% | 0.010 | 0.007 | 0.003 | 0.009 | 0.001 | 0.008 |

3.4.2. Chlorophyll a & b and Carotenoids (mg/g FW):

There is a significant difference in chlorophyll a & b and carotenoids measurements as a result of applying different seaweed extract levels on tuberose plants. Among the used levels, applying 1.5 g/l seaweed extract as soil drench increased chlorophyll a & b and carotenoids contents compared to the other treatments. On the other side, the least chlorophylls a & b and carotenoids contents were registered with the control.

**Table 10:** Chlorophylls a & b and carotenoids (mg/g FW) of *Polianthes tuberosa* L. as affected by seaweed extract application during the two seasons of 2022/2023 and 2023/2024.

| Seaweed extract levels (g/l) | Chlorophylls a (mg/g FW) | | Chlorophyll b (mg/g FW) | | Carotenoids content (mg/g FW) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| 0 | 0.885 | 0.890 | 0.627 | 0.627 | 0.634 | 0.627 |
| 0.5 | 0.911 | 0.920 | 0.646 | 0.647 | 0.640 | 0.647 |
| 1.0 | 0.942 | 0.950 | 0.669 | 0.670 | 0.651 | 0.670 |
| 1.5 | 0.972 | 0.980 | 0.692 | 0.692 | 0.661 | 0.692 |
| 2.0 | 0.964 | 0.970 | 0.688 | 0.688 | 0.659 | 0.688 |
| LSD 5% | 0.007 | 0.008 | 0.004 | 0.007 | 0.001 | 0.007 |

3.4.3.Total carbohydrates and polyphenols content:

Data illustrated that the total carbohydrates and polyphenols contents of tuberose leaves were significantly affected by the addition of seaweed extract levels as soil drench. Application of 1.5 g/l seaweed extract achieved the maximum values of total carbohydrate percentages (24.93 and 25.20 %) and polyphenols contents (29.58 and 29.60 µg EAG/mg E) compared to all other treatments in the 1st and 2nd seasons, respectively. The results in this study indicate that using seaweed extract at a concentration of 1.5 g/l is superior to other levels for all measurements of the chemical content of tuberose plants. This was also pointed out by **Ibrahim and Tawfik (2021)** on gladiolus plant, where they found that treating the plant with seaweed extract at a rate of 50 or 100 ppm led to better results for chemical composition than at a rate of 150 ppm. This improve in chemical composition is related to the effective role of seaweed extract in supplying the plant with the necessary elements such as potassium, phosphorus, zinc and nitrogen, which improves the amino acids level and the production of proteins important in stimulating cell division. In addition, the role of nitrogen and zinc as construction materials of amino acid Tryptophan, which is important in the manufacture of IAA, which increases cell elongation and increases plasticity and elasticity of the cell walls, which results in increased chemical composition **(Abd Al-Karimjassim and Radhi, 2019).** Our results were in good line with **Abd-El-Hady (2020)**, who pointed out that applying tuberose plants with 1.5 $cm^3$/l improved the chemical compositions i.e. N, P, K and total chlorophylls, total carbohydrates and polyphenols content. Treating of *Tagetes patula* with seaweed extract at a rate of 5 ml/l increased the chemical composition and essential oil percentage **(Ayyat and Abdel-Mola, 2020).** The results in this study indicate that using seaweed extract at a concentration of 1.5 g/l is superior to other levels for all measurements of the chemical contents of tuberose plants.

From the obtained results it can be concluded that the application of seaweed extract as soil drenching positively enhanced plant growth, flowering, bulb production and the chemical composition of tuberose plants. The most promotion effect of seaweed extract on enhancing the studied traits was coincided with the rate of 1.5 g/l.

**Table 11:** Total carbohydrates (%) and polyphenols content (µg EAG/mg E) of *Polianthes tuberosa* L. as affected by seaweed extract application during the two seasons of 2022/2023 and 2023/2024.

| Seaweed extract levels (g/l) | Total carbohydrates (%) | | Polyphenols content (µg EAG/mg E) | |
|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season |
| 0 | 21.78 | 22.1 | 29.28 | 29.30 |
| 0.5 | 22.78 | 23.1 | 29.32 | 29.50 |
| 1.0 | 23.75 | 24.1 | 29.42 | 29.50 |
| 1.5 | 24.93 | 25.20 | 29.58 | 29.60 |
| 2.0 | 24.77 | 24.9 | 29.52 | 29.50 |
| LSD 5% | 0.200 | 0.535 | 0.04 | 0.06 |

## Conclusion

In light of this study, the importance of adding seaweed extract becomes clear in order to produce plants with superior growth and strong, as well as healthy horticultural production for tuberose. Therefore, when planting this plant, we recommend adding 1.5 g/l of seaweed extract to achieve the desired purposes of growing tuberose.

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