Response Two Strawberry Cultivars (Fragaria X Ananassa Duch.) for Foliar Application of Two Organic Fertilizers

Mufty R.K.1 and Taha Sh. M.2

1,2Department of Horticultural, College of Agriculture Engineering, University of Salahaddin, Erbil, Iraq.

Abstract

This study was undertaken during the seasons of 2019-2020. The experiment examines the impact of Humic acid and Seaweed extract at three concentrations on growth, flowering and yield as a foliar spray and their interactions on growth, chemical composition, production and quality of strawberry at two strawberry cultivars (Fragaria X ananassa Duch.) Albion and Rubygem. The results showed that the higher leaf dry weight, root dry weight, number of flowers, yield per plant, with Rubygem, higher value of Nitrogen % in leaf, phosphorus %, anthocyanin (Mg/100g F.Wt.) observed for Rubygem. As well as the higher value of root dry weight (g. plant -1), yield per plant (g. Plant -1) Nitrogen % in leaf recorded with Humic acid, treatment. Moreover, the combined treatment between organic fertilizers and two strawberry cultivars exhibited the significant effect in root dry weight (g. plant -1), Nitrogen % in leaf, phosphorus (%), number of flowers, yield per plant (g. plant -1) and anthocyanin (Mg/100g F.Wt.). As well as the combination between organic fertilizers and concentrations and organic fertilizers, two strawberry cultivars and concentrations had significantly effect in all the studied traits.

Keywords: Strawberry cv. Albion, Strawberry cv. Rubygem, Humic acid, Seaweed, Organic fertilizers.

1. Introduction

Strawberry (Fragaria x Ananassa Duch.) is a member of the rose family (Rosaceae) because of its low chilling requirement, therefore it is cultivated in temperate and subtropical regions. ‘Rubygem’ originated from a 1998 cross between ‘Earlibrite’ and ‘Carlsbad’ ‘Rubygem’ was first selected as a desirable genotype based on appearance, a new short-day strawberry, produces high yields of moderately firm, attractive well-flavored fruit from late autumn through early spring. ‘Rubygem’ is recommended for trial in areas with mild winter climates, especially where rainfall is unlikely and a well-flavored berry is required [1].

Albion” strawberry cultivar was developed in USA and recently introduced to many countries, it cultivated under several climatic conditions and cultivation modes [2]. Albion is a day-neutral (everbearing) cultivar similar to Diamante, but with higher quality fruit, lower cull rate, darker fruit, and substantially better resistance to Phytophthora cactorum. It is similar to Aromas, but with larger, higher quality, firmer and better-flavored fruit. The fruit shape for Albion can vary but is typically a long and Symmetrical conic [3]. The Albion variety has firm fruits with a high marketable yield percentage due to the shape and volume of the fruits. The ideal color and acceptable flavor of strawberry fruits are obtained at maturity. The Albion variety is very strong and produces a high number of daughter plants and stolon’s [4].

Strawberries are mainly produced through runners [5]. Berries contain a diverse range of high levels of phytochemicals, most of which are phenolic molecules. These phytochemicals include a variety of beneficial compounds, such as essential minerals, vitamins, fatty acids and dietary fibers. Berries are an important source of vitamin A, minerals, vitamin C and B complex vitamins. Berries are rich in both macro- and micronutrients, among which honeyberry is a rich source of these minerals. The major mineral elements found in berries are phosphorus, potassium, calcium, magnesium, iron, manganese, copper, sodium and aluminum [6].

Recently, there has been a resurgence of interest in environmentally friendly sustainable agricultural practices. In the development and implementation of sustainable agriculture techniques, organic-fertilization is a great importance in order to alleviate deterioration of natural and environmental pollution. Organic fertilization is very important in organic fruit production. Strawberries have been grown in many countries with different ecological conditions and strawberry growing has spread quickly to areas where other agricultural crops have been grown previously for a long time [7]. Strawberry has traditionally been a popular delicious fruit for its flavor, taste and fresh use, freezing and prosing. It contains relatively high quantities of ellagic acid [8].
Vegetable plants are grown very well under organic circumstances and play a significant role in the agricultural worldwide economy. Hence, some natural substances, such as Humic acid are applied for plant cultivation in a large quantity around the globe. Humic substances are utilized about 65-70% of organic matter in different areas on arable land, plant physiology and environmental sector, because of the multiple roles they play in these areas [9]. The research and knowledge of organic Humic acid that increases plant growth is not known, but most experiments and details have been provided by scientific research for improving vegetable growth of crops [10]. Humic acids useful in foliar applications, it is a vital for increasing cell wall permeability in plants. When cell membranes become more permeable, nutrients can more easily enter through the plant (often carried by fulvic acids, which are particularly good chelators). Recently a study has been provided the growth of plants by the application of Humic acid. In addition, HA decreased water evaporation and increase its use by plant [11]. Strawberry plants are very responsible to Humic substances application due to their shallow root system and high productivity, in relation to the plant size. The uptake of humic substances by plant tissue resulting in various biochemical effects through an increased nutrient uptake and maintaining levels of vitamins and amino acids in plant tissues and thus stimulating root growth and whole plant [12].

The reason of increasing vegetative growth, yield quantity and quality, due to properties as a result of Seaweed extract application may be the role of Mg, B and S in stimulating growth characters [13]. Furthermore, their role in an improving the nutrient uptake by roots [14]. Resulting in the increasing root dry weight in two concentrations with improving water activation efficiency. Thereby, causing enhanced general plant growth and increasing the leaf and root dry weight, and the role of these elements in activating photosynthesis process. These results are in an agreement with those obtained by [15], and [16], who indicated that application of Humic acid, significantly, increased all the studied growth traits. Seaweed increases nutrient and water uptake by providing strong root development of plants and encourages vegetative growth by accelerating the formation of chlorophyll. In addition, yield and quality of the products are improved by increasing the balanced and long-term uptake of macro and micro nutrients from the soil and supply well-balanced crop nutrients; thus, the quantity and quality value of the product are increased [17].

Seaweed extracts increase the uptake of micro elements by chelating the micronutrients. Side branching and fruit formation in fruit trees also have been increased with seaweed application. Moreover, flower and fruit losses have been decreased and yield increased up to 30%. Seaweeds also have been reported to increase the impacts of pesticides by 25%, also improved rooting architecture could be a result of small levels of phytohormones present in the extracts such as auxins as well as various stimulatory processes engaged in the plant system upon treatment with these extracts [18]. Seaweed extracts contain adequate amounts of nitrogen that increases the additional protein in different concentrations that help the plant leaves grow larger and thus increase leaf area available for photosynthesis. Thus, allowing plants to grow faster, increase metabolism, cell division, and elongation of cells thus stimulating growth as well as new leaf formation [19]. In addition, it contains amounts of K, which have a significant effect on enzyme activation, protein synthesis, photosynthesis, stomata movement, water relationship in plants, and its necessity to transport dissolved in phloem and to maintain cation: anion balance in the cytosol as well as in the vacuole. Moreover, the extreme seaweed extract that is a natural organic fertilizer is highly nutritious, promotes faster and increases yield and resistant ability of many crops [20]. The chemical constituents of seaweed extract include complex polysaccharide, fatty acids, vitamins, phytohormones and mineral nutrients [21]. Applications of seaweed extract at different concentrations, as a foliar spray, brought an increase in total soluble solids (TSS) and anthocyanin of two strawberry cultivars [22]. A commercial extract of Ascophyllum nodosum caused such increases in strawberry yield, fruit diameter, fruit weight and number of cells per area of parenchymatous tissue, fruit yield, size and total anthocyanin (27) studied the impact of spraying three seaweed extract (Algaren, Soluamine and Marmarine) in two varieties of Strawberry (Hapil and Kaiser's samling).

Results indicated that spraying cv. Kaiser's samling with seaweed extract (Algaren) led to significant increase in strawberry fruit size, number of fruits per plant and plant yield, total yield per unit area. As for the cv. Hapil when using Algaren extract there was an increase in weight and size of fruit. Foliar application of seaweed extracts as (solutemine) to strawberry plants caused significant increase in strawberry fruit size, number of fruits per plant and plant yield, while seaweed extracts as (marmarine) caused significant increase in fruit fresh weight. [23]. Investigated the effect of sea weed extract on two strawberry short day cultivars; ‘Rubygem’ and ‘Florida Fortuna’ a rate of was sprayed to the plants at a rate of 10L.ha-1 two times, before and after flowering respectively, and was repeated that the Rubygem cultivar recorded highest significant value in number of fruits per plant (18.52), fruit fresh weight (9.75 g) and plant yield (180.57 g-plant-1), however no significant difference was found in the fruit size between the two cultivars. The significant differences observed may be due to the genetic variability between the two cultivars. There is substantial evidence that genetic factors control the growth, yield and fruit quality of strawberry. [24], studied the effects of seaweed extract on the fruit yield and fruit quality of strawberry cv. (Rubygem). Results indicated that increasing seaweed extract and humic acid concentrations significantly increased anthocyanins content (mg/100g F.Wt.) in juice of strawberry which the highest was obtained from (4mL.L-1) as compared to control had the lowest compared to the untreated plants. The main objectives of this study aimed to comparison of cultivars and investigate the interaction between foliar applications and response them to different concentrations of organic fertilizers.
2. Material and Methods

This study takes place during the growing season of 2019-2020 in the Hanara field in Erbil Governorate/ Kurdistan Region / Iraq. This study was carried out in order to study the effect of spraying three concentrations of Humic acid (0, 2 and 4 ml.L\(^{-1}\)) and seaweed extract with concentration (0, 2 and 4 ml.L\(^{-1}\)) on growth, flowering, yield and qualitative properties of two strawberry cv. Robygem and Albion, by the six spraying during the experiment. The first Foliar spray was after one month of the transplanting plants. In order to increase contact, a few drops of tween 20 added to the area of solution and leaves. For maximum absorption, foliar spraying was done in the morning when air was cooler. The investigated strawberry plants were cv. Robygem and Albion which get from the Danas Company for general trading and processing agriculture materials in Sulaimanya. All transplants were pruned by removing excess and damaged leaves and remaining three leaves on each plant as well as pruning roots to get the balance between roots and vegetative growth, also roots treated sterilized with Fungicide (previcur energy 250 ml net). The transplants were spaced at 0.30 m between plants and 0.40 m between rows culture. Drip irrigation system was used. Flowers were continuously removed from plants during the first month after transplanting. All plants undertaken in this study received the regular agricultural and horticultural practices that usually carried out in the commercial strawberry field. Therefore, the experiment consist of twelve treatments (three concentration of humic acid ,three concentration of seaweed extract and two strawberry cultivars with three replication and six pots for each experimental unit in gradarasha field and six plants for each experimental unit in hanara field. Applied as a factorial experiment (2*2*3) by using Randomized Complete Block Design (RCBD). Data were analyzed by SPSS 17 software and means were compared according to Duncan's multiple ranges test at 5% level [25].

The spray treatments were started one month from transplanting and repeated at 15-day intervals conducted six times through the growing season. The spray solution was maintained just to cover completely the plant foliage. In the early morning, The control treatment also sprayed with tap water only after the irrigation of the seedlings carried out one day before the spraying process to increase the efficiency of the plants in absorbing the sprayed material. Three seedlings were selected from each treatment and measurements taken for the following characteristics:

Data recorded
- leaf dry weight
- Root dry weight
- Determination of leaves content of elements (N and P)
- Mineral elements were estimated according to:
  - Nitrogen by chloride method using Micro - Kjeldahl (19)
  - Phosphorus were estimated in a mild digestion using ascorbic acid in the spectrophotometer [26].
- Number of flowers,plant\(^{-1}\)
- Plant yield (g. plant\(^{-1}\)): Was calculated according to the following equation:
  \[ \text{Plant Yield (g. Plant}^{-1}\) = \frac{\text{No. of fruit per five plants } \times \text{ Weight of Fruit}}{\text{Number of plants (five plants)}} \]

- Anthocyanin (mg. 100g\(^{-1}\) fresh weight) [26].

3. Results and Discussion

3.1. Leaf dry weight (g.plant\(^{-2}\))

Table (1) the leaf dry weight, while there is no defferent between humic acid and Seaweed. Humic acid and Seaweed were significantly affected on cultivars, the higher value was obtained at (Humic acid + Seaweed + Rubygem) compared with the lower value at (Humic acid + Seaweed + Albion). Also, the interaction between organic fertilizer and concentration significantly decreased. It is argued that there was a negative impact on the leaf dry weight, the treatment combination of (0.0 + Humic acid) gave the maximum value (45.61g) as compared with the other treatment when it compared to the lowest value (39.43g) at the interaction between (2ml.L\(^{-1}\) + Humic acid) but there was no significant different between (0.0 + Humic acid) and (2ml.L\(^{-1}\) + Seaweed). The results also indicated in the same table that the interactions between Humic acid, seaweed concentration and cultivars were significantly decreased the leaf dry weight. The highest value (51.16 g) was obtained from (0.0 + Humic acid + Rubygem, while the minimum result (37.90 g) was recorded from (2ml.L\(^{-1}\) + Humic acid + Rubygem).
Table 1. Cultivars for Foliar Application of organic fertilizers on Leaf dry weight (g. plant\(^{-1}\)).

| Fertilization | Concentration ml. L\(^{-1}\) | Cultivars     | Fertilization | Concentration * Concentration |
|---------------|-----------------------------|---------------|---------------|-----------------------------|
|               |                             | Albion        | Rubygem       |                             |
| Humic acid    | 0                           | 40.05 e-f     | 51.16 a       |                              |
|               | 2 ml. L\(^{-1}\)           | 40.95 de      | 37.90 h       | 39.43 c                     |
|               | 4 ml. L\(^{-1}\)           | 38.99 f-h     | 45.75 c       | 42.37 b                     |
| Seaweed       | 0                           | 38.43 gh      | 42.39 d       | 40.41 b                     |
|               | 2 ml. L\(^{-1}\)           | 41.81 d       | 47.61 b       | 44.71 a                     |
|               | 4 ml. L\(^{-1}\)           | 39.75 e-g     | 44.82 c       | 42.29 b                     |

Means of each factor and their interactions followed by the same letters are not significantly different from each other, according to Duncan's multiple range test at the 5 % level.

3.2. Root dry weight (g.plant\(^{-1}\))

Table (2) clearly illustrate the effect of fertilization humic acid and seaweed on the Albion and Rubygem, the fertilizer was significantly affected on root dry weight. The higher value was (43.36 g) from humic acid and the lower value was (42.47 g) from seaweed. Also, the interaction between Fertilization + Cultivars showed significant effect, the highest value was recorded at Rubygem in both fertilizers, but the lowest value recorded at (seaweed+ Albion). The close result was observed at the interaction between Fertilization + Concentration, while the maximum value was (47.54 g) at (Humic acid + 0.0 concentration), the lowest value was (40.17 g), but there was no significant difference between (Humic acid + 2ml.L\(^{-1}\)) and (seaweed+ 0.0 concentration). The combination between all factors Fertilization + Concentration + cultivars on the root dry weight showed significant effect, the highest value was obtained at (51.16 g) from (Humic acid + control + Rubygem) compared with the lowest value at (37.90 g) from (Humic acid + 2ml.L\(^{-1}\) + Rubygem).

Table 2. Foliar Application of organic fertilizers on root dry weight (g.plant\(^{-1}\)).

| Fertilization | Concentration ml. L\(^{-1}\) | Cultivars     | Fertilization | Concentration |
|---------------|-----------------------------|---------------|---------------|--------------|
|               |                             | Albion        | Rubygem       |               |
| Humic acid    | 0                           | 43.91 cd      | 51.16 a       | 47.54 a       |
|               | 2 ml. L\(^{-1}\)           | 42.44 d       | 37.90 f       | 40.17 d       |
|               | 4 ml. L\(^{-1}\)           | 38.98 f       | 45.75 bc      | 42.37 c       |
| Seaweed       | 0                           | 38.43 f       | 42.39 d       | 40.41 d       |
|               | 2 ml. L\(^{-1}\)           | 41.81 de      | 47.61 b       | 44.71 b       |
|               | 4 ml. L\(^{-1}\)           | 39.75 e       | 44.82 c       | 42.29 c       |

Means of each factor and their interactions followed by the same letters are not significantly different from each other, according to Duncan's multiple range test at the 5 % level.
3.3. Nitrogen % in leaf

The obtained result in table (3) revealed that Rubygem cultivar was significantly superior over Albion cultivar in Nitrogen %. Also, obviously that foliar application of organic fertilizers significant effect on the nitrogen percentage in leaf of strawberry plant. Humic acid gave the maximum value (2.45 %) compare to the seaweed extract which recorded the minimum value (2.35%). Data in table (3) shows that the interactions between fertilizers and two strawberry cultivars significantly affected on N % in leaf of strawberry plant, results indicated that maximum nitrogen (2.33%) was recorded from the combination of humic acid Rubygem , but the minimum value (2.22 was recorded at seaweed + Rubygem.

Leaf phosphorus content (%): Table (4) illustrates that the higher value of phosphorus% was in Albion which was (0.77%) when contrast with the Rubygem cultivar value (0.46%). Obviously that the result of fertilization such as humic acid and seaweed had not significant effect on the phosphorus percentage in the leaf of strawberry plants. From the interactions, there was a significant effect between Fertilizations and Cultivars. Nevertheless, there was a significant effect between cultivars on the phosphorus percentage in leaf of strawberry plants. Another significant effect was recorded at the interactions among Fertilization + Concentration, the highest value was (0.77%) was obtained by the phosphorus percentage from the (Humic acid + 0.0 concentrations). While the lowest value (0.45%) was obtained from the (Humic acid + 2ml.L-1). For the combinations of interactions between three factors, there was a significant effect between them, the maximum value (1.21%) was recorded from the combination of (Humic acid + 0.0 concentrations + Albion) compared with the minimum value (0.21%) from the combination of (seaweed + 2ml.L-1+ Rubygem).

### Table 3. Cultivars for Foliar Application of organic fertilizers on Nitrogen % in leaf.

| Cultivars | Fertilization | Concentration ml. L⁻¹ | Concentration | Albion | Rubygem | Fertilization mean |
|-----------|---------------|------------------------|---------------|--------|---------|-------------------|
| Humic acid| 2 ml. L⁻¹     | 0                      | 1.91 e        | 1.88 e | 1.90 e  | 2.31 c            |
|           | 4 ml. L⁻¹     | 0                      | 1.77 g        | 1.83 f | 1.80 e  | 2.40 b            |
| Seaweed   | 2 ml. L⁻¹     | 0                      | 2.45 d        | 2.61 c | 2.53 c  | 2.40 c            |
|           | 4 ml. L⁻¹     | 0                      | 2.69 b        | 2.76 a | 2.65 a  | 2.40 c            |

Means of each factor and their interactions followed by the same letters are not significantly different from each other, according to Duncan's multiple ranges test at 5% level.

3.4. Number of flowers Plant⁻¹

The table (5) indicates that there was not significant effects on the number of flowers of Albion and Rubygem in the study. Moreover, the interaction between Fertilization+ Cultivars the result also had not significant effect on the number of flowers. However, the interactions among the Fertilization + Concentration the effect had no significant effect on the number of flowers. For the combination, it clearly shown that the interactions between three factors was significantly difference, the highest value (22.89) flower. plant⁻¹ recorded from the seaweed + control + Albion and the lowest value (14.68) flower. plant⁻¹ was recorded from the (Humic acid + control + Rubygem). But there was no significant difference between (seaweed + control + Albion) and (Humic acid + 4ml.L⁻¹ + Albion).

3.5. Plant yield (g.plant⁻¹)

Indicated that cultivars having significant effect on yield per plant. Rubygem which gave the higher yield per plant (509.69 g) and Albion gave the lower value (403.85 g). Fertilizers had significant effect on yield per plant of strawberry, the maximum yield plant (460.66 g) was noticed at humic acid and the minimum yield plant (452.52 g) obtained from seaweed as shown in table (12). Concerning the interactions among the factor’s fertilizers and cultivars, it’s clear from Table (12) that the maximum significant yield per plant was recorded from the interactions of (Humic acid +Rubygem) which was (521.13 g), while the minimum value (406.78 g) was showed at the (seaweed + Albion). The interactions between of fertilizers and concentrations significantly efforted in the yield per plant, the interactions of (4mg.L⁻¹ + seaweed) was (514.82 g) appeared to
be the most operative combination treatment, as it records the maximum value (385.8 g) obtained at (0.0 + seaweed). The combinations among the three studied factors significantly affected on the yield per plant. The maximum value (542.88 g) was obtained from combination of (Humic acid + 2ml.L\(^{-1}\) + Rubygem) compared to minimum value (367.42 g) was obtained from (Humic acid + 0.0 + Albion).

**Table 4. Cultivars For Foliar Application of organic fertilizers on phosphorus (%) in leaf.**

| Fertilization | Concentration ml. L\(^{-1}\) | Cultivars | Fertilization * Concentration |
|---------------|-------------------------------|-----------|-------------------------------|
|               |                               | Albion    | Rubygem                       |
| Humic acid    | 0                             | 1.21 a    | 0.34 g                        | 0.77 a                        |
|               | 2 ml. L\(^{-1}\)              | 0.34 g    | 0.57 e                        | 0.45 d                        |
|               | 4 ml. L\(^{-1}\)              | 0.79 c    | 0.50 f                        | 0.64 b                        |
|               | 0                             | 0.84 c    | 0.47 f                        | 0.66 b                        |
| Seaweed       | 2 ml. L\(^{-1}\)              | 0.90 b    | 0.21 h                        | 0.56 c                        |
|               | 4 ml. L\(^{-1}\)              | 0.59 e    | 0.72 d                        | 0.66 b                        |

Means of each factor and their interactions followed by the same letter’s are not significantly different from each other, according to Duncan’s multiple ranges test at 5% level.

**Table 5. Cultivars for Foliar Application of organic fertilizers on number of flowers per plants.**

| Fertilization | Concentration ml. L\(^{-1}\) | Cultivars | Fertilization * Concentration |
|---------------|-------------------------------|-----------|-------------------------------|
|               |                               | Albion    | Rubygem                       |
| Humic acid    | 0                             | 33.44 d   | 37.11 b                       | 35.28 c                       |
|               | 2 ml. L\(^{-1}\)              | 37.88 b   | 37.65 b                       | 37.77 b                       |
|               | 4 ml. L\(^{-1}\)              | 35.67 c   | 39.90 a                       | 37.79 b                       |
|               | 0                             | 28.89 e   | 34.43 d                       | 31.66 d                       |
| Seaweed       | 2 ml. L\(^{-1}\)              | 38.89 ab  | 39.65 a                       | 39.27 a                       |
|               | 4 ml. L\(^{-1}\)              | 39.43 a   | 41.69 a                       | 40.56 a                       |

Means of each factor and their interactions followed by the same letter’s are not significantly different from each other, according to Duncan’s multiple ranges test at 5% level.

Table (7) shows the effect of two strawberry cultivars had significant effect on the anthocyanin content in Albion and Rubygem cultivar, the higher result recorded in the Rubygem cultivar which was (60.71 mg/100g F.Wt.) compared with the lower value was (46.09 mg/100g F.Wt.) recorded in Albion cultivar. The same table indicates that fertilization of humic acid and seaweed shows in, the effect had no significant effect of fertilization on the anthocyanin content of Albion and Rubygem cultivars. The interaction of Fertilization and Cultivars on the anthocyanin content of strawberry was showed significant effect between Albion and Rubygem in amount of anthocyanin. The maximum value (60.73 mg/100g F.Wt.) recorded from humic acid + Rubygem and the lowest value (46.09 mg/100g F.Wt.) recorded from (Humic acid, seaweed + Albion). Also, the interactions of Fertilization + Concentration on the anthocyanin content of strawberry was showed significant effect on the Albion and Rubygem cultivars, from (seaweed + 4ml.L\(^{-1}\)) recorded the highest value (55.07 mg/100g F.Wt.) likewise, from the (0.0 + seaweed) recorded the lowest value (52.03 mg/100g F.Wt.).

The interaction between Fertilization + Concentration + Cultivars was significantly affected anthocyanin content on the Albion and Rubygem. the maximum value recorded was (66.56 mg/100g F.Wt.) from (seaweed + 4ml.L\(^{-1}\) + Rubygem), but the minimum value recorded was (43.58 mg/100g F.Wt.) from (seaweed + 4ml.L\(^{-1}\) + Albion).
Table 6. Cultivars for Foliar Application of organic fertilizers on yield per plant.

| Fertilization | Concentration ml. L⁻¹ | Cultivars       | Fertilization | Concentration |
|---------------|------------------------|-----------------|---------------|---------------|
|               |                        | Albion          | Rubygem       |               |
| Humic acid    | 0                      | 367.42 h        | 494.13 d      | 430.78 d      |
|               | 2 ml. L⁻¹              | 406.16 g        | 542.88 a      | 474.52 b      |
|               | 4 ml. L⁻¹              | 426.98 f        | 529.39 b      | 478.19 b      |
| Seaweed       | 0                      | 282.23 e        | 489.36 e      | 385.8 e       |
|               | 2 ml. L⁻¹              | 418.06 f        | 495.82 a      | 456.71 c      |
|               | 4 ml. L⁻¹              | 520.06 b        | 509.57 c      | 514.82 a      |

Cultivars:

| Fertilization | Cultivars       | Fertilization mean |
|---------------|-----------------|--------------------|
| Humic acid    | Albion          | 400.19 c           |
|               | Rubygem         | 521.13 d           |
| Seaweed       | 406.78 d        | 498.25 b           |

Cultivars mean:

| Fertilization | Cultivars       | Fertilization mean |
|---------------|-----------------|--------------------|
| Humic acid    | Albion          | 403.49 b           |
|               | Rubygem         | 509.69 a           |

Means of each factor and their interactions followed by the same letters are not significantly different from each other, according to Duncan's multiple ranges test at 5% level.

From table 1-7. (Leaf nitrogen % and anthocyanin) recorded higher value with Rubygem. Also (leaf dry weight, root dry weight, number of flowers, plant⁻¹, and yield, plant⁻¹) recorded significant value with Rubygem superior the Albion, but leaf phosphorus %, significantly increased with Albion. Spraying strawberry cultivars with Humic acid and Seaweed had no significant differences in (leaf dry weight, leaf phosphorus %, number of flowers, plant⁻¹ and anthocyanin). But Humic acid affected significantly at root dry weight. As also Humic acid significantly increased leaf nitrogen % and yield, plant⁻¹. But interaction of organic fertilizers and two strawberry cultivars which observed that Humic acid with Albion significantly increased (root dry weight, number of flowers, plant⁻¹ and yield, plant⁻¹), while Humic acid, seaweed with Albion significantly increased in (Root dry weight, Phosphorus % and number of flowers, yield, plant⁻¹) while leaf phosphorus % significantly increased from the interaction of Humic acid + Albion. As also distinguished the interaction of fertilizers and concentrations in combination were significantly increased some parameters characteristics of the strawberries including (leaf nitrogen %, number of flowers, yield, plant⁻¹ and anthocyanin) at interaction of (Humic acid, seaweed+4ml.L⁻¹), (seaweed+4ml.L⁻¹) and (Humic acid, seaweed+4ml.L⁻¹). The interaction between three factors (Fertilization+ concentration + cultivar) were significantly increased (root dry weight, leaf nitrogen % an, number of flowers, yield, plant⁻¹ and anthocyanin). The highest recorded with (Seaweed+4ml.L⁻¹ + Rubygem), (humic acid+ 2ml.L⁻¹ + Rubygem), (seaweed+2ml.L⁻¹ + Rubygem), (Seaweed+4ml.L⁻¹ + Albion), (Seaweed+2ml.L⁻¹ + Rubygem) respectively.

Table 7. Cultivars For Foliar Application of organic fertilizers on anthocyanin (Mg/100g F.Wt.).

| Fertilization | Concentration ml. L⁻¹ | Cultivars       | Fertilization | Concentration |
|---------------|------------------------|-----------------|---------------|---------------|
|               |                        | Albion          | Rubygem       |               |
| Humic acid    | 0                      | 45.59 gh        | 58.91 c       | 52.25 cd      |
|               | 2 ml. L⁻¹              | 45.24 h         | 63.89 b       | 54.57 a       |
|               | 4 ml. L⁻¹              | 47.44 ef        | 59.39 c       | 53.42 b       |
| Seaweed       | 0                      | 46.66 fg        | 57.40 d       | 52.03 d       |
|               | 2 ml. L⁻¹              | 48.02 e         | 58.14 cd      | 53.08 bc      |
|               | 4 ml. L⁻¹              | 43.58 i         | 66.56 a       | 55.07 a       |

Cultivars:

| Fertilization | Cultivars       | Fertilization mean |
|---------------|-----------------|--------------------|
| Humic acid    | Albion          | 46.09 b            |
|               | Rubygem         | 60.73 a            |
| Seaweed       | 46.09 b         | 60.70 a            |

Cultivars mean:

| Fertilization | Cultivars       | Fertilization mean |
|---------------|-----------------|--------------------|
| Humic acid    | Albion          | 46.09 b            |
|               | Rubygem         | 60.72 a            |

Means of each factor and their interactions followed by the same letters are not significantly different from each other, according to Duncan's multiple ranges test at 5% level.
The true objective of this research was to discover the effect of different concentrations, application of seaweed extract and Humic acid solutions on vegetable growth, yield quantity and quality. The analyses showed that more treatments applied with different concentrations of foliar fertilizers and two strawberry cultivars positively affected most morphological characteristics of on strawberry growth. A significant increase in nitrogen percentage was observed in turn, it led to an increase in leaf dry weight and root dry weight. Also, the role of different concentrations of Humic acid and seaweed extracts. Humic acid as a foliar fertilizer might useful for plant growth by increasing two factors such as nutrient uptake and hormonal effects. The determination of HA and other nutrients on growth, essential and non-essential nutrients. Vegetable plants are grown very well under organic circumstances and play a significant role in the agricultural worldwide economy. Hence, some natural substances, such as humic acid are applied for plant cultivation in a large quantity around the globe. Humic substances are utilized about 65 -70% of organic matter in different areas on arable land, plant physiology, and environmental sector, because of the multiple roles they play in these areas [13]. The research and knowledge of organic Humic acid that increases plant growth is not known, but most experiments and details have been provided by scientific research for improving vegetable growth of crops [22]. Humic acids useful in foliar applications, Humic acids are vital for increasing cell wall permeability in plants. When cell membranes become more permeable, nutrients can more easily enter through the plant (often carried by fulvic acids, which are particularly good chelators). Recently a study has been provided the growth of plants by the Appling of Humic acid. In addition, HA decreased water evaporation and increase its use by plant [25].

Strawberry plants are very responsive to Humic substances application due to their shallow root system and high productivity, in relation to the plant size. The uptake of humic substances by plant tissue resulting in various biochemical effects through an increased nutrient uptake and maintaining levels of vitamins and amino acids in plant tissues; and thus, stimulating root growth and whole plant [20].

It is obvious from tables (1-7) that foliar application of seaweed extract significantly increased most vegetative growth properties. The reason of increasing vegetative growth, yield quantity and quality. Properties as a result of Seaweed extract application may be due to the role of Mg, B and s in stimulating growth characters [8,11], and their role in an improving the nutrient uptake by roots [13], resulting in the increasing root dry weight in two concentrations with improving water activation efficiency, thereby causing enhancing general plant growth and increasing the leaf and root dry weight, and the role of these elements in activating photosynthesis process. These results are in an agreement with those obtained by [17], who indicated that application of Humic acid, significantly, increased all the vegetative growth traits, quantity and quality of fruits.

Seaweed increases nutrient and water uptake by providing strong root development of plants and encourages vegetative growth by accelerating the formation of chlorophyll. In addition, yield and quality of the products are improved by increasing the balanced and long-term uptake of macro and micro nutrients from the soil and supply well-balanced crop nutrients; thus, the quantity and quality value of the product are increased [20]. Seaweed extracts increase the uptake of micro elements by chelating the micronutrients. Side branching and fruit formation in fruit trees also have been increased with seaweed application. In addition, flower and fruit losses have been decreased and yield increased up to 30%. Seaweeds also have also been reported to increase the impacts of pesticides by 25%, also improved rooting architecture could be a result of small levels of phytohormones present in the extracts such as auxins as well as various stimulatory processes engaged in the plant system upon treatment with these extracts [18]. Alternatively, since it contains adequate quantities of nitrogen supply that increase the extra protein, which allows the plant foliage to grow larger and hence increases its surface area available for photosynthesis. This allows the plants to grow faster, increases rate of metabolism, cell division, cell elongation and thereby stimulated apical growth as well as formation of leaves. It also contains adequate quantities of K which has a substantial effect on enzyme activation, protein synthesis, photosynthesis, stomata movement and water-relation in plants and its necessity for phloem solute transport and for the maintenance of cation: anion balance in the cytosol (cytoplasmic matrix) as well as in the vacuole. On the other hand, the extreme seaweed extract that is a new generation of natural organic fertilizers is highly nutritious, promotes faster and increases yield and resistant ability of many crops. [24], reported that foliar spray of strawberry plants with two levels of seaweed extract 0.75 and 1.5ml/l gave the highest significant values in all tested vegetative growth characters compared with other treatments. The chemical constituents of seaweed extract include complex polysaccharide, fatty acids, vitamins, phytohormones and mineral nutrients [16]. Applications of seaweed extract, as a foliar spray, brought an increase in total soluble solids (TSS) and vitamin C of two strawberry cultivars [8]. A commercial extract of Ascophyllum nodosum; caused such increases in strawberry yield, fruit diameter, fruit weight and, number of cells per area of parenchymatous tissue, fruits yield, size, and total anthocyanin.

These results are in an agreement with those obtained by [12,22], who indicated that application different concentrations of seaweed extract and Humic acid, significantly, increased all the vegetative growth traits, quantity and quality of fruits.
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