Foliar Application of two organic Fertilizers on Two Strawberry Cultivars (*Fragaria* × *ananassa* Duch.)

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Abstract

This study was conducted during growing season 2019-2020, in order to evaluate the impact of organic fertilizers on growth and development of two strawberry cultivars (*Fragaria* X *ananassa* Duch.). where two different organic fertilizers humic acid and seaweed with three levels (0.0, 2.0 and 4.0) $mL.L^{-1}$ were foliar sprayed at different growth stages of two strawberry cultivars has been used; Albion and Rubygem. Randomized complete block design (RCBD) was implemented with three replications. The results show that Robygem was recorded the higher leaf area (96.27 cm^2), root fresh weight (61.25 g) and anthocyanin content (41.92 Mg/100g F.Wt.) when compared with Albion cultivar. While Albion was demonstrated the maximum value for root dry weight (41.71 g), phosphorus and potassium percentage (0.62% and 1.63%) % respectively, the number of flowers. $Plant^{-1}$ (36.55 flower. plant-1), fruit weight (11.11 g) and yield per plant (363.82g). Humic acid led to significant increases in yield. $plant^{-1}$ (295. 31g.$plant^{-1)}$ compared with Robygem cultivar. Moreover, organic fertilizers had no significant effect on the leaf area, root fresh weight, root dry weight, phosphorus percentage, potassium percentage, fruit weight and anthocyanin content. Meanwhile, humic acid had a significant effect on increasing plant yield compared with seaweed extract.

Key words: Strawberry. Albion, Rubygem, Humic acid, Seaweed, organic fertilizers.

تأثيرالرش الورقي لنوعين من السماد العضوي على الصنفين من الشليك (*Fragaria X ananassa* Duch)

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الملخص

أجريت هذه الدراسة خلال موسم النمو(2019-2020) وتناولت التجربة تأثير رش السماد العضوي على نمو وتطور صنفين من الشليك (Fragaria X ananassa Duch.) Albion و Rubygem حيث استخدمت سمادين عضويين بثلاث تراكيز (0.0, 2.0 and 4.0) $mL.L^{-1}$ رشاً على الاوراق في مراحل نمو مختلفة. أجريت التجربة باستخدام تصميم القطاعات العشوائية الكاملة (RCBD) بثلاث مكررات. أظهرت النتائج المتحصل عليها أن صنف Rubygem سجل أعلى مساحة ورقية (96.27 سم 2) والوزن الطري للجذور (61.25 غم) والأنثوسيانين (41.92 ملغم / 100 جم وزن الطري) مقارنةً مع صنف Albion. بينما برهن صنف Albion أعلى قيمة للوزن الجاف للجذور (41.71 غم). نسبة الفسفور (0.62٪) ، نسبة البوتاسيوم (1.63٪) ، عدد الأزهار. النبات $^{-1}$ (36.55 زهرة. نبات $^{-1}$) ، وزن الثمرة (11.11 غم) والمحصول لكل نبات (363.82 غم نبات -1) مقارنة مع صنف Robygem. اضافة الى ذلك لم يكن للأسمدة العضوية أي تأثير معنوي على مساحة الورقة ووزن الجذور الطرية ووزن الجذور الجافة ونسبة الفسفور ونسبة البوتاسيوم ووزن الثمار ومحتوى الأنثوسيانين. بينما كان لحمض الهيوميك تأثير معنوي في زيادة كمية الحاصل للنبات مقارنة بمستخلص البحري.

الكلمات المفتاحية : Strawberry. Albion, Rubygem, Humic acid, Seaweed, organic fertilizers.

1. **Introduction**

Strawberry (*Fragaria x ananassa* Duch.) belongs to the Rosaceae family in the genus Fragaria. The genus Fragaria was named by the botanist Carl Linnaeus, on the basis of the Latin word 'fragrans', meaning 'sweet scented', describing its striking, highly aromatic fruit (Edger et al., 2019). Because of its low chilling requirements, strawberry has been cultivated in temperate and semitropical regions (Darrow, 1966). Strawberry fruits contain a diverse range of high levels of phytochemicals, most of which are phenolic molecules, such as essential minerals (phosphorus, potassium, calcium, magnesium, iron, manganese, copper, sodium, and aluminum), vitamins (vitamin A, vitamin C, and B complex), fatty acids and dietary fibers (Nile and Park, 2014).

Organic fertilization is very important in organic fruit production. Vegetable and fruit plants are grown very well organically and play a significant role in the agricultural worldwide economy. Various studies have been examined the positive impact of humic acid on different plant species and cultivars (Russo and Berlyn, 1999). Humic substances are multifunctional compounds, and it was found that humic acid was improved physiological parameters and tolerance to environmental stresses in strawberry and Arabidopsis, respectively (Tehranifar and Ameri, 2014), (Petran *et al*., 2017). (Cha *et al*., 2020) (Kilic et al., 2021).

Humic acids are vital for increasing cell wall permeability in plant, it was found that humic acid was decreased water evaporation and increased its use in the strawberry plants under controlled conditions (Shafshak *et al.,* 2011). Strawberry plants respond effectively to humic substances application due to their shallow root system. The uptake of humic substances by root and leaves were increased nutrient uptake and maintained levels of vitamins and amino acids in plant tissues; and thus, stimulating root and shoot growth and enhancing the yield of strawberry under normal and slat stress conditions (Alkharpotly *et al.,* 2017; Khodamoradi, *et al.* 2020).

Crouch, *et al.,* (1990); Kulk, (1995) were suggested that increasing vegetative growth, the quality and quantity of yield as the result of application seaweed, maybe due to the role of magnesium, boron, and sulphate in activating growth properties. It was shown that seaweed extract strength plant root system and vegetative growth by accelerating chlorophyll synthesis and micro and macronutrients uptake from soils, consequently was improved the quality and quantity of the plant product (Hong *et al.,*

2007), (Soni *et al.*, 2018) , (Sharma. and Negi, 2019), (Yadav *et al.*, 2020) In addition, it was claimed that 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 (Blunden *et al*., 2012). Battacharyya *et al.*, (2015) was demonstrated that the seaweed fertilizer consists of vitamins, polysaccharides, growth regulators, minerals or nutrients and fatty acids. Masny *et al.*, (2004) also was shown that using seaweed extract at different concentrations as the foliar application was led to an increase in total soluble solids and anthocyanin of two cultivars of strawberry. Furthermore, spraying seaweed (Algaren) on Kaiser's samling, a strawberry cultivar, was led to the increase of fruit, size, plant yield, also total yield per plant when was compared to Marmarine, Soluamine, seaweed extracts and on Hapil, a strawberry cultivar (Taha, 2008). Many other studies have examined the effect of seaweed extract and humic acid on different strawberry cultivars and were found that the cultivars respond differently to the application method of the seaweed extracts and humic substances (Taha and Haji, 2015; Karim *et al.*, 2019). Therefore, the aim of this study is to examine the impact of foliar application of organic fertilizers on flowering and the quality and quantity of the fruits of Rubygem and Albion cultivars of strawberry.

2. Material and Methods

This study carried out during the growing season 2019-2020 at Grdarasha field (plastic house) the college of Agriculture, Salahaddin University – Erbil, in order to study the spray three concentrations of HA (0.0, 2 and 4) $ml.L^{-1}$ and Seaweed extract with (0.0, 2 and 4) $ml.L^{-1}$ levels on vegetative and fruit properties of two strawberry cv. Rubygem and Albion, using six sprays, the first Foliar spray was after one month of the transplanting plants. few drops of tween 20 added to solution, for maximum absorption, foliar spraying was done in the morning

All transplants were removed and extremely pruned removing three leaves per plant, also injured leaves in addition to thinning roots to obtain the balance among the vegetative growth, Roots also treated with fungicide (previcur energy 250 ml net). The strawberry nursery plants were planted to polyethylene bags and transferred to 5 kg bags in the plastic house in Grdarasha field. The flowers continuously removed from the plant, the first month after, received the regular agricultural and horticultural practices that usually carried out in the commercial strawberry field.

The studied experiment consisted of twelve treatments of three levels for both Humic acid, and Seaweed extract applied on two strawberry cultivars with three replicates and six containers (pots) for each. investigational which was (2*2*3) as a factorial experiment via (RCBD). Data were analyzed by SPSS 17 software and means were compared according to Duncan's multiple range test at 5% level (SAS Institute Inc., 1990).

After 30 days from transplanting, cultivars were sprayed with fertilizers, and repeated at fifteen-day intervals for 6 times during the growing season. The control treatment also sprayed with tap water. Three seedlings were selected from each treatment and measurements taken for the following characteristics:

1- Leaf area (cm^2): Leaf area was measured non-destructively using the easy leaf area mobile app (Samsung android A70 plus 2018 mobile).

2- Root fresh weight (g. plant $^{-1}$): The root of plants was randomly collected from each treatment. Then separate roots from canopy part. the roots were washed very well with tap water then calculate the weight of fresh root **(Torki-Harchegani, *et al.*, 2016).**

3- Root dry weight (g. plant $^{-1}$): The roots of plants were randomly collected from each treatment. Then the roots were washed very well with tap water and putted in brown paper bags and transferred to the laboratory. After that the roots weight was taken, they were oven dried at 70 ^{0}C until the weight was fixed **(Torki-Harchegani, *et al.*, 2016).**

4- Phosphors (%): The percentage phosphorus: Phosphors was measured in leaves of each sample by spectrophotometer as described via **(Parsons *et al.*, 1984).**

5- potassium (%): The percentage of Potassium: Potassium ions were determined in leaves for each sample using flame photometer according to **(Jackson, 1958).**

6- Number of flowers per plant: Number of flowers per plant determine by Calculated all flowers producing per each plant

$$\text{Number of flowers} = \frac{\text{Total No. of Flowers}}{\text{No. of Plants}}$$

7- fruit weight (g): For calculating average fruit weight, five fruit per plant were weighted. Fruit weight was measured with scales (Sartorius, Goettingen, Germany, accuracy ± 0.001 g).

8- yield per plant (g. plant $^{-1}$): Was calculated according to the following equation:
No. of fruit in plant X Mean weight of fruit

9- anthocyanin (Mg/100g F.Wt.): Anthocyanin (mg. 100g^{-1} fresh weight) Anthocyanin in fruit was determined by taking (2.5g) of fruit juice, then added 50 ml mixture of 85% Alcohol (95%) + 15% HCl (1.5 N), and left for 24 hours at 4°C, then filtered through filter paper (0.1N) then it estimated by using Spectrophotometer at a wavelength of 535nm. **(Spayed and Morris, 1978).**

3. Result and Discussion

3.1. Leaf area (cm^2):

In table (1) clearly shows that cultivars have significant effect on leaf area, the maximum value of the Rubygem was (96.27 cm2) compared with the Albion (71.88 cm2), there was no significant effect of Humic acid and Seaweed on leaf area. Concerning the interactions between Fertilization + Cultivars, the data revealed that there was significant effect of fertilizations on cultivars (Humic acid , Seaweed + Rubygem) significantly superior over (Humic acid , Seaweed + Albion) of this parameter. Also, shows the combination between Fertilization + Concentration significantly affected the leaf area of. The maximum value (90.70 cm^2) was recorded from the combination of (Humic acid + 2ml.L^{-1}) compare with the minimum value (73.19 cm2) from the combination of (Humic acid + 0.0). Concerning the interaction of (Fertilization + Concentration + Cultivars) on the leaf area of Albion and Rubygem, there was significant effect of three factors, the maximum value was recorded from (Humic acid + 2ml.L-1 + Rubygem) the minimum value was recorded from (Humic acid + 0.0 concentration + Albion).

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid	0	67.87 j	78.51 f	73.19 e
	2 ml. L^{-1}	70.63 i	110.77 a	90.70 a
	4 ml. L^{-1}	76.95 g	99.52 c	88.24 b
Seaweed	0	70.53 i	95.43 d	82.98 c
	2 ml. L^{-1}	74.52 h	105.83 b	90.17 a
	4 ml. L^{-1}	70.74 i	87.54 e	79.14 d
Fertilization		Cultivars		Fertilization Mean
		Albion	Rubygem	
Humic acid		71.82 b	96.27 a	84.04 a
Seaweed		71.93 b	96.27 a	84.09 a
Cultivars Mean		71.88 b	96.27 a	

Table (1): Foliar Application of organic fertilizers for two Strawberry Cultivars on leaf area (cm^2).

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.

3.2 . Root fresh weight (g. plant $^{-1}$):

Table (2) showes that shows that cultivars have significant effect on in root fresh weight character, which is the Rubygem value higher than the Albion (61.25 g and 58.09 g) respectively, but Humic acid and Seaweed had no significant effect on root fresh weight. İn addition, interaction between type of fertilizers and diferrent cultivars shows that there was siginificant effect on root fresh weight, (Humic acid, Seaweed + Rubygem) significantly higher effect than (Humic acid, Seaweed + Albion), but there was no significant effect between Humic acid, Seaweed with Albion cultivar and smilarly of Humic acid, Seaweed with Rubygem cultivar. Also there was significant effect observed at different concentration level Comparison with the fertilization, the value of (62.09 g) was the highest from (Seaweed + 2ml.L^{-1}) if compared with the value (56.65 g) was the lowest from (Seaweed + 4ml.L^{-1}). For combination of three factors Fertilization + Concentration + Cultivars, result showed significant effect between them, the interaction of (Seaweed + 2ml.L^{-1} + Rubygem) was the highest value (64.48 g) compared the (54.16 g) from (Seaweed +4ml.L^{-1} + Albion). But there was no

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid	0	56.12 d	61.35 b	58.74 d
	2 ml. L^{-1}	60.19 bc	59.18 c	59.68 cd
	4 ml. L^{-1}	58.53 c	63.23 a	60.88 b
Seaweed	0	59.88 bc	60.13 bc	60.00 bc
	2 ml. L^{-1}	59.69 c	64.48 a	62.09 a
	4 ml. L^{-1}	54.16 e	59.14 c	56.65 e

Fertilization	Cultivars		Fertilization Mean
	Albion	Rubygem	
Humic acid	58.28 b	61.25 a	59.77 a
Seaweed	57.91 b	61.25 a	59.58 a
Cultivars Mean	58.01 b	61.25 a	

Table (2): Foliar Application of organic fertilizers for two Strawberry Cultivars on Root fresh weight (g. plant $^{-1}$).

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.

signficant difference between (Humic acid + 4ml.L^{-1} + Rubygem) and (Seaweed + 2ml.L^{-1} + Rubygem).

3.3. Root dry weight (g. plant $^{-1}$):

Table (3) shows that the Albion was significantly superior than the Rubygem in root dry weight (g. plant $^{-1}$) value which is (41.70 g, 38.74 g) respectively, same table indicates that Humic acid and Seaweed had no significant effect on on root dry weight. Morever, that the interactions between type of fertilizers and two strawbery cultivars significantly affected on root dry weight, (Humic acid, Seaweed + Albion) significantly higher effect than (Humic acid, Seaweed+ Rubygem), but there was no significant effect of Humic acid, Seaweed with Rubygem cultivar and smilarly of Humic acid, Seaweed with Albion cultivar. It is clearly that the interaction between Fertilization and Concentration had significant affect on the root dry weight ,the highest value was (43.34 g) from (Seaweed + 4ml.L^{-1}), and the lowest value was (37.35 g) from (Seaweed+ 2ml.L^{-1}). Addtionally, significant effect was recored at the interaction of Fertilization + Concentration + Cultivars the maximum value (45.83 g) from the interaction (Seaweed+ 4ml.L^{-1} + Albion) compared with the minimum value (35.51 g) from the interaction (Seaweed+ 2ml.L^{-1} + Rubygem).

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid	0	43.87 b	38.65 f	41.26 b
	2 ml. L^{-1}	39.80 d-f	40.82 cd	40.31 c
	4 ml. L^{-1}	41.45 c	36.76 g	39.11 d
Seaweed	0	40.11 de	39.86 d-f	39.99 c
	2 ml. L^{-1}	39.19 ef	35.51 h	37.35 e
	4 ml. L^{-1}	45.83 a	40.86 cd	43.34 a

Fertilization	Cultivars		Fertilization Mean
	Albion	Rubygem	
Humic acid	41.71 a	38.74 b	40.23 a
Seaweed	41.71 a	38.74 b	40.23 a
Cultivars Mean	41.71 a	38.74 b	

Table (3): Foliar Application of organic fertilizers for two Strawberry Cultivars on root dry weight (g. plant $^{-1}$)

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

3.4. Leaf Phosphors (%): Recorded result of table (4) illustrated that significantly affected of the phosphorus percentage in leaf between the two strawberry cultivars. the effect provided higher result in the Albion cultivar was (0.62%) and the lower value in Rubygem cultivar was (0.36%). Humic acid and Seaweed had no significant effect on phosphorus percentage in the leaf. Same table shows that fertilization interaction of Humic acid, Seaweed and two strawberry cultivars on phosphorus percentage in the leaf was significantly affected, Seaweed + Albion recorded the maximum value (0.62%) but the Humic acid+ Seaweed at Rubygem recorded the lowest value (0.36%). Also, interaction between Fertilization + Concentration provided significant effect, the maximum value which is recorded at (Humic acid + 0.0) concentration compared with the minimum value recorded at (Humic acid + 4ml.L^{-1}). The combination between three factors Fertilization + Concentration + Cultivars showed significant effect on the phosphorus percentage, the highest value recorded at (Seaweed+ 0.0 concentration + Albion) cultivar, the lowest value recorded at (Humic acid + 4 ml.L^{-1} concentration + Rubygem cultivar).

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid		0.63 bc	0.52 f	0.58 a
	2 ml. L^{-1}	0.64 b	0.32 h	0.48 d
	4 ml. L^{-1}	0.58 d	0.22 j	0.40 f
Seaweed	0	0.68 a	0.31 i	0.49 c
	2 ml. L^{-1}	0.62 c	0.43 g	0.53 b
	4 ml. L^{-1}	0.55 e	0.33 h	0.44 e

Fertilization	Cultivars		Fertilization Mean
	Albion	Rubygem	
Humic acid	0.61 a	0.36 b	0.49 a
Seaweed	0.62 a	0.36 b	0.49 a
Cultivars Mean	0.62 a	0.36 b	

Table (4): Foliar Application of organic fertilizers for two Strawberry Cultivars Phosphors (%)

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

3.5. leaf potassium (%):

In table (5) revealed that significantly affected occurred at strawberry cultivars Albion and Rubygem in leaf potassium %, the Albion cultivar was the higher and Rubygem values was lower (1.63% and 1.52%). Humic acid and Seaweed had no significant effect on the potassium percentage in leaf. Morever, that the interactions between fertilizers and cultivars significantly affected on potassium percentage in the leaf, (Humic acid. Furthermore, the significant effect observed at the interactions among Fertilization + Concentration, the maximum value (1.69%) was obtained from the (Seaweed + 0.0) while the minimum value (1.52%) was obtained from the (Seaweed + 2 ml. L^{-1}). For the combinations, the interactions among the factors (cultivar + concentration + fertilization) significant difference, the extreme rate (1.69%) was noted in the mixture of (Seaweed + control + Rubygem and Albion). If compared to the lowest rate (1.40%) from the (Seaweed + 2 ml. L^{-1}+ Rubygem).

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid		1.66 ab	1.49 f	1.58 b
	2 ml. L^{-1}	1.61 c	1.53 e	1.57 b
	4 ml. L^{-1}	1.63 bc	1.54 de	1.59 b
Seaweed	0	1.69 a	1.69 a	1.69 a
	2 ml. L^{-1}	1.63 bc	1.40 g	1.52 c
	4 ml. L^{-1}	1.57 d	1.48 f	1.53 c
Fertilization		Cultivars		Fertilization Mean
		Albion	Rubygem	
Humic acid		1.63 a	1.52 b	1.578 a
Seaweed		1.63 a	1.52 b	1.58 a
Cultivars Mean		1.63 a	1.52 b	

Table (5): Foliar application of organic fertilizers for two Strawberry Cultivars on potassium (%):

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

3.6. Flower number. Plant $^{-1}$

Table (6) shows significant different between two strawberry cultivars in the number of flowers. $Plant^{-1}$, Albion superiority on Rubygem (36.55, 25.93) flower. $Plant^{-1}$ respectively. but fertilizers had no significant effect on the number of flowers per plant. For interaction, the interaction between Fertilization + Cultivars, had significant effect on the number of flowers per plant, superiority (Humic acid, Seaweed + Albion) on (Humic acid, Seaweed +Rubygem), the higher value was (36.82) flower. $plant^{-1}$ compared with lower value (25.93) flower. $plant^{-1}$ but there was non-significantly between the fertilizers in same cultivar.

Another interaction was observed for Fertilization + Concentration, the effect was significantly difference, the maximum value (38.12) flower. $plant^{-1}$ was obtained from the combination of (Seaweed + 4ml.L^{-1}) compare with the minimum value (24.9) flower. $plant^{-1}$ from the combination of (Seaweed + 0.0 concentration). Regarding the combination between three factors Fertilization + Concentration + Cultivars on the number of flowers per plant Albion and Rubygem cultivars, there were significant effect of three factors on the number of flowers. Plant-1, the maximum value (46.12) was recorded from (Seaweed + 4ml.L^{-1} + Albion), the minimum value (21.34) was recorded from (Seaweed + 0.0 concentration + Rubygem).

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid		30.66 de	21.78 fg	26.22 de
	2 ml. L^{-1}	38.12 bc	25.45 e-g	31.78 bc
	4 ml. L^{-1}	41.67 ab	30.56 de	36.12 b
Seaweed	0	28.45 d-f	21.34 g	24.9 e
	2 ml. L^{-1}	34.23 cd	26.34 e-g	30.28 cd
	4 ml. L^{-1}	46.12 a	30.12 de	38.12 a

Fertilization	Cultivars		Fertilization Mean
	Albion	Rubygem	
Humic acid	36.82 a	25.93 b	31.37 a
Seaweed	36.27 a	25.93 b	31.1 a
Cultivars Mean	36.55 a	25..93 b	

Table (6): Foliar Application of organic fertilizers for two Strawberry Cultivars on number of flowers.

Plant $^{-1}$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

3.7. Number of fruits. Plant $^{-1}$

Table (7) illustrates the significant between two strawberry cultivars, the maximum value of fruits. Plant^{-1} recorded in Albion was (32.71) fruits. Plant $^{-1}$ and the minimum value recorded in Rubygem was (22.08) fruits. Plant^{-1}. Humic acid and Seaweed had no significant effect on the number of fruits of Albion and Rubygem. Regarding the interactions of fertilizers and two strwaberry cultivars maximum value (32.71) fruits. Plant^{-1} was resulted from the (Humic acid, Seaweed + Albion) compared with the minimum value (22.08) fruits. Plant^{-1} of (Humic acid, Seaweed + Rubygem) respectively.

Additionally, the interactions of Fertilization + Concentration, was significantly difference, the (Seaweed + 4ml.L^{-1}) recorded highest value which was (35.50) fruits. Plant^{-1} , while the (Seaweed + 0.0 concentration) recorded the lowest value which was (20.11) fruits. Plant $^{-1}$. But there was no significant difference between (Seaweed + 4ml.L^{-1}) and (Humic acid + 4ml.L^{-1}), also there is no significant difference between (Seaweed + 0.0) and (Humic acid + 0.0 concentration). Moreover, other significant effect was recorded at interaction between all factor, the interaction between three factors Fertilization + Concentration + Cultivars gave the maximum value (44.00) fruits. Plant^{-1} was at (Seaweed + 4ml.L^{-1} + Albion) and (Humic acid, Seaweed + 0.0 + Rubygem) provided the minimum value (16.78)
(17.78) fruits. Plant^{-1}.

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid		26.45 cd	17.78 e	22.12 cd
	2 ml. L^{-1}	33.34 bc	20.89 de	27.11 b
	4 ml. L^{-1}	38.34 ab	27.56 cd	32.95 a
Seaweed	0	23.44 de	16.78 e	20.11 d
	2 ml. L^{-1}	30.67 c	22.45 de	26.56 bc
	4 ml. L^{-1}	44.00 a	27.00 cd	35.50 a
Fertilization		Cultivars		Fertilization Mean
		Albion	Rubygem	
Humic acid		32.71 a	22.08 b	27.39 a
Seaweed		32.71 a	22.08 b	27.39 a
Cultivars Mean		32,71 a	22.08 b	

Table (7) Foliar Application of organic fertilizers for two Strawberry Cultivars on number of fruits. Plant

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

3. 8. yield per plant (g. plant $^{-1}$)

İn table (8) he cultivars of strawberry significantly effected on the properties of yield plant, while the higher plant yield was (363.82 g. plant $^{-1}$) shown in Albion and the lower plant yield was (214.66 g. plant $^{-1}$) from Rubygem. The effect of fertilizers was significantly effected on yield plant, Humic acid which gave the higher value (295.31 g) and lower value (283.17 g. plant $^{-1}$), was recorded from Seaweed).

For interaction, the interaction between Fertilization + Cultivars, had significant effect on the yield per plant, superiority (Humic acid + Albion) on other interactions which recorded the higher value (373.19 g. plant $^{-1}$), compeered with the lower value (217.42 g. plant $^{-1}$) in (Humic acid + Rubygem).

The interactions between fertilizers and concentrations revealed that there was significant effect on yield per plant. The highest value was recorded from (Humic acid + 4mg.L^{-1}) (398.21 g) as compared with (Seaweed + 0.0 concentration) (200.72 g). that gave lowest value. For the effect of interactions fertilizers, two strawberry cultivars and concentrations on the yield per plant, significant differences were found between interactions and the maximum value which was obtained from the interactions of (Seaweed + Albion + 4ml.L^{-1}) was (520.52 g), which significantly differed from most of other combinations. The interactions of (Humic acid, Seaweed + 0.0 + Rubygem) recorded minimum value

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid		269.00 e	161.26 i	215.13 d
	2 ml. L^{-1}	361.72 c	183.41 h	272.57 c
	4 ml. L^{-1}	488.84 b	307.57 d	398.21 a
Seaweed	0	235.81 fg	165.62 i	200.72 e
	2 ml. L^{-1}	307.01 d	230.57 g	268.79 c
	4 ml. L^{-1}	520.52 a	239.49 f	380.01 b
Fertilization		Cultivars		Fertilization Mean
		Albion	Rubygem	
Humic acid		373.19 a	217.42 c	295.31 a
Seaweed		354.45 b	211.89 d	283.17 b
Cultivars Mean		363.82 a	214.66 b	

Table (8): Foliar Application of organic fertilizers for two Strawberry Cultivars on yield. Plant -^{1}

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.

3. 9. Anthocyanins content (mg/100g F.Wt.)

Table (9) demonstrates strawberry cultivars had significant effect on the anthocyanin content of Albion and Rubygem, which was the higher value recorded in Albion cultivar and the lower value recorded in Rubygem cultivar which was (41.56 mg/100g F.Wt. and 38.64 mg/100g F.Wt.) respectively. Humic acid and Seaweed had no significant effect on the anthocyanin content. Focusing on specific interaction effect of fertilizers and two strawberry cultivars on anthocyanin content, data in table (9) illustrated that (Humic acid + Rubygem) was significantly recorded the higher (42.52 mg/100g F.Wt.) anthocyanins compared to (Humic acid + Albion) (39.35 mg/100gF.Wt.) lower value, but there was no significant difference between fertilizers with Albion cultivars and fertilizers with Rubygem cultivars. Furthermore, concerning to the interactions of Fertilization + Concentration, there was a significant effect, which (Humic acid + 2ml.L^{-1}) recorded the highest value (47.69 mg/100g F.Wt.), compared with the lowest value (33.63 mg/100g F.Wt.) in (Humic acid + 0.0). The interaction among all factors such as Fertilization + Concentration + Cultivars indicated a significant effect of anthocyanin content of the Albion and Rubygem. the maximum value was (50.96 mg/100g F.Wt.) from (Humic acid + 2ml.L^{-1} + Rubygem), compared with the minimum value was (33.36 mg/100g F.Wt.) from (Humic acid + 0.0 + Rubygem). But there was no significant difference between (Humic acid + 0.0 concentration + Albion, Rubygem) and (Seaweed + 0.0 + Rubygem).

Fertilization	Concentration ml. L^{-1}	Cultivars		Fertilization * Concentration
		Albion	Rubygem	
Humic acid		33.89 f	33.36 f	33.63 e
	2 ml. L^{-1}	44.34 d	50.96 a	47. 69 a
	4 ml. L^{-1}	39.84 d	43.25 b c	41.55 c
Seaweed	0	31.67 e	33.57 f	35.15 d
	2 ml. L^{-1}	42.82 c	43.84 e	43.33 b
	4 ml. L^{-1}	45.40 b	46.54 b	44.68 b

Fertilization	Cultivars		Fertilization Mean
	Albion	Rubygem	
Humic acid	39.35 b	42.52 a	40.94 a
Seaweed	39.96 b	41.31 a	40.54 a
Cultivars Mean	39.66 b	41.92 a	

Table (9): Foliar Application of organic fertilizers for two Strawberry Cultivars on Anthocyanins content (mg/100g F.Wt.)

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

From table (1-9). (Leaf area, root fresh weight and anthocyanin) recorded higher value with Rubygem, however (root dry weight, phosphour %, potassium%, No of flower, No of fruits, yield. $Plant^{-1}$) recorded significant value with Albion superior on the Rubygem. Spraying strawberry cultivars with Humic acid and Seaweed had no significant differences in (Leaf area, root fresh weight, root dry weight, phosphour %, potassium%, No of flower. $plant^{-1}$, No of fruit. $plant^{-1}$, and anthocyanin). But Humic acid affected significantly at (yield. $Plant^{-1}$). But interaction of Humic acid and **Seaweed** with two strawberry cultivars observed that Humic acid, Seaweed with Rubygem significantly increased (leaf area, root fresh weight and anthocyanin), however Humic acid, Seaweed with Albion significantly increased in (Root dry weight, Phosphorus %, Potassium %, number of flowers and number of fruits), but Humic acid with Albion significantly increased Yield. $Plant^{-1}$.

As also distinguished the interaction of fertilizers and concentrations in combination were significantly increased some parameters characteristics of the strawberries including (leaf area and root fresh weight at(Seaweed+2ml.L^{-1}), root dry weight at (seaweed+4ml.L^{-1}), number of flowers and number of fruits at(seaweed+4ml.L^{-1}), yield. $plant^{-1}$ at (Humic acid + 4ml.L^{-1}) and anthocyanin at (Humic acid + 2ml.L^{-1}). The interaction between three factors (Fertilization+ concentration + cultivar) were significantly increased some parameters characteristics leaf area at (Humic acid+ 2ml.L^{-1} + Rubygem), root fresh weight at (Humic acid+ 2ml.L^{-1} + Rubygem and Seaweed+4ml.L^{-1} + Rubygem), root dry weight, number of flowers per plant, number of fruits per plant, yield per plant at (Seaweed+4ml.L^{-1} + Albion), but anthocyanins at (Humic acid+ 2ml.L^{-1} + Rubygem),

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

area, root fresh 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 (Tehranifar and Ameri, 2014), Khodamoradi, *et al.* 2020) ,(Kilic et al., 2021), (Soni *et al.*, 2018) , (Sharma. and Negi, 2019), (Yadav *et al.*, 2020).

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 (Russo and Berlyn, 1999). 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 (Shafshak *et al.*, 2011).

Alkharpotly *et al.*, (2017) investigated that Humic acid have a great effect on the Strawberry cultivars because of it's a shallow root thus it is very reactive to (HS) application and in relative to the size of plant. (HS) uptake by tissue of plants, resulting in several effect of biochemical by increased nutrient uptake and sustaining amino acids in plant tissues and vitamin levels; thus, motivating growth of roots.

Kulk, (1995); Adreas (1999) investigated that the reason shows the purpose of increasing vegetative growth, yield quality and quantity property that the result of application Seaweed may be due to the role of magnesium, boron, and sulphate in activating growth properties. Also, the role of Seaweed to increasing and improving the water and nutrient uptake through the roots. and their role in an improving the nutrient uptake by roots (Crouch, *et al.*, 1990). Shafshak *et al.*, (2011); Mohamed (2015); who indicated that application of Humic acid, significantly, increased all the vegetative growth traits, quantity and quality of fruits. The result showed that 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, also the elements have a role in photosynthesis activity process, (HA) application increased significantly growth studied characters thereby causing enhancing general plant growth and increasing the leaf and root dry weight, and the role of these elements in activating photosynthesis process.

Hong *et al.*, (2005) studied that Seaweed has a great effect on the nutrient and water uptake by suppling strong root growth of plants and vegetative growth promotion by hurrying the produce of chlorophyll. Moreover, improving the quality of the fruits through the increasing the balanced also of macro and micro nutrients from the soil and supply well-balanced crop nutrients; consequently, the quality and quantity rate of the product are increased. The micro elements uptake was increasing through seaweed

extract fertilizer by chelating the micronutrients. Seaweed application increased the fruit development and lateral branching in fruit trees, also fruits and flowers losses have been declined then yield improved up to 30 percentage , also seaweed fertilizer influences of pesticide and insecticide by 26 percentage. 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 (Blunden et al., 2012).

Alternatively, this may be attributed to contains acceptable amounts of nitrogen which increasing the extra proteins, at different concentrations which make the foliage of plants to growing bigger and after that the process of photosynthesis occur better because of increasing of surface area. This allowing the plants to growing faster, also the rate of metabolism increases, cell division and extension and thus encouraged apical growth as well as establishment of leaves. Likewise contains adequate amounts of potassium that has significant result on synthesis of protein, activation of enzyme, photosynthesis, stomata movement then relation of water in plants and its requirement for phloem solute transfer and for the preservation balancing of anion and cation in the cytosol (cytoplasmic matrix) along with in the vacuole. Instead, that is a new generation of organic fertilizers which is seaweed extract is extremely nutritious, encourages faster and increasing crop and ability resistant of several crops (Dhargalkar and Pereira, 2005), (Cha *et al*., 2020) (Kilic et al., 2021).

The foliar spray of strawberry plants with two concentration of Seaweed fertilizer (0. 75ml.L and 1.5ml/L) gave the maximum significant rate in wholly tested vegetative growth properties if compare with the other treatments. The Seaweed fertilizer include a complex fatty acid, polysaccharide, phytohormone, vitamin, and mineral nutrients (Abo Sedera *et al.*, 2014). Battacharyya *et al.*, (2015) reported that Applications of seaweed extract, as a foliar spray, brought an increase in (TSS) and vitamin C of two strawberry cultivars (Masny et al. 2004). 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 (Taha, 2008; Taha and Haji 2015). Karim et al., (2019) 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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