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Effect of Foliar Application of Seaweed Extract and Amino Acids on Some Vegetative and Anatomical Characters of Two Sweet Pepper (*Capsicum Annuum* L.) Cultivars

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Abstract: *The current study was conducted in a greenhouse belongs to the College of Agriculture / University of Al-Qadisiya during the growing season of 2013 in order to study the effect of spraying seaweed extract at concentrations of 0, 3 or 6 ml . L^{-1} and amino acids at 0,400 or 800 mg . L^{-1} in addition to their combination on some vegetative and anatomical characters of two cultivars of sweet pepper plant (Capsicum annuum L.) cv. Flavio F1 and California wonder. The results showed a significant increase in plant height, number branches and the percentage of dry matter of shoots in both cultivars when treated with seaweed extract at 6 ml. L^{-1} or amino acids at 800 mg. L^{-1}. Also, it was clear from the anatomical characters of the stem that the thickness of cortex and vascular cylinder and diameter of vascular units increased significantly when they treated with the higher concentration of each of seaweed and amino acids as well, while the two factors caused a decrease in the thickness of the pith area in comparison with control treatment of both cultivars. For the interaction, the combination of seaweed extract at 6 ml. L^{-1} and amino acids at 800 mg. L^{-1} has recorded the highest values for most of the characters measured in comparison with control, except the pith thickness which was decreased as the concentration increased.*

Keywords: *sweet pepper, seaweed extract, amino acids, dry matter, cortex, vascular cylinder.*

1. INTRODUCTION

Sweet pepper plant (*Capsicum annuum* L.) is the third most important crop of Solanaceae family after tomatoes and potatoes. Pepper is one of the richest vegetable in vitamin C. It was stated that one fruit of pepper weighing 70 gm can meet the necessary requirements of vitamin C for a person's during the day. It also contains a good amount of vitamin A, B1 and other vitamins which are essential for growth [1]. Foliar fertilizer using algae and seaweed extract, is rich in natural plant hormones such as auxin and cytokinins, vitamins, and some macro and micro nutrients. Seaweed extract is considered as one of modern means used to increase agricultural production away from the use of chemical fertilizers with its side disadvantages in term of health and environmental pollution. Also, it is known that foliar application has rapid impact in supplying plants with its requirements. There have been encouraging results using seaweed which had positive impact in stimulating the physiological events that leads to increase growth and development of plants [2]. They also increase the plant's resistance to external conditions as a result of their direct role in enhancing the metabolic paths leading to build up antioxidant molecules in plant cell [3]. In studies conducted by [4] and [5] on pepper plants using of seaweed extract as a foliar spray on shoot, they found significant increase in plant height and percentage of total chlorophyll. [6] Mentioned that spray tomato plants (*Lycopersicon esculentum* Mill) with seaweed extract caused significant increases in all vegetative parameters measured by 60.89% compared to control plants as well as increase the total chlorophyll content in leaves. The use of amino acids spray on plant shoot is one of the modern methods used to improve plant growth and productivity because of their direct role in increasing the tissue content of proteins and essential enzymes for organizing the metabolic events or activation of antioxidants. Hence, more plant resistance toward stressful conditions is achieved [7], as well as better performance under such conditions [8]. [9] found that the spray of pepper plants with a mixture of amino acids led to raise the efficiency of photosynthesis, and thus, give the best vegetative growth. In addition, [10] and [11] found that the use of amino acids at 0.27 and 0.45 g. plant $^{-1}$ led to a pronounced increase in plant

height, number of branches and dry weight of shoots, especially after 50 days of treatment compared to non-treated plants.

A number of researchers studied the effect of the two factors on the anatomical characteristics of stem of some plants. [12] studied stem cross sections of bean plant treated with algae extract and seaweed extract and found that there is a clear increase in the thickness of the epidermis, cortex, size of paranchyma cells and pith with increasing concentrations of extract used in comparison to non-treated plants. [13] and [14] mentioned that the use of a mixture of amino acids at different concentrations led to an increase in stem diameter of tomato plant as a result of increased in the thickness of epidermis and cortex as well as increasing the thickness of xylem, especially the number of vessels, compared to non-treated plants. From the above stated results, the aim of the current research is to study the effect of seaweed extract and amino acids and their combination on some vegetative and anatomical characters of stem of two cultivars of sweet pepper plant.

2. MATERIALS AND METHODS

This experiment was carried out during the growing season of 2013 in a plastic house belong to the College of Agriculture/ Al-Q adisiya University to study the effect of foliar application of seaweed extract and amino acids on some growth and anatomical characters of sweet pepper (*Capsicum annuum* L.) cv. Flavio and California wonder. The soil used for cultivation characterized as silty clay with a pH 7.6, EC 3.22, and 3.20% organic matter. The seaweed extract (Basfoliar Kelp SL, Australia Company) contains; IAA 11mg.L^{-1}, cytokinin 0.31mg.L^{-1}, Vitamin 0.25%, proteins1.95 % and carbohydrates 4.38%. The seaweed extract was used at rates of 0, 3, and 6 m. L^{-1}. Amino acids (Green River Company) was used at concentrations of 0, 400, and 800 mg.L^{-1}.

Seeds of sweet pepper planted in cork dishes containing peat moss on 18/2/2013. After the establishment of seedlings and having (2-3) true leaves, they were transferred to the plastic house where they planted on both sides of lines 70 cm apart and 40 cm between plants. All agricultural practices were done as usual and as needed. The seaweed extract and amino acids concentrations were sprayed twice, the first one was done one month after the transfer of plants into plastic house, the other spray was done after one month from the first spray. Spray was done at the early morning. Three plants were chosen randomly at the beginning of blooming at 28/4/2013 for anatomical study. Vegetative characters of plants such as; plant height, number of branches per plant, and shoot dry weight were taken on three plants of each replicates on 3/7/2013.

2.1. Preparation of Samples

Cross sections of the middle part of the stem were taken. The fresh samples were preserved in glass tubes containing ethyl alcohol at a concentration of 70% to keep them fresh until use. Hand sectioning was used to prepare thin sections. Sections were transferred carefully by a brush into clean slides containing drops of Safranin dye and left for a period of 5-7 minutes. Then, stained sections were transferred to other slides containing drops of glycerin for immersion. Samples were examined under light microscopy and measurements were taken in micrometer using Ocular Micrometer. Thickness of cortex, vascular bundles, pith and vascular units diameter were recorded. Sections were filmed using Lucida camera, wild type, erected on microscope under the force of (X40). Experiment was designed as a factorial experiment with two factors (3X3) in a completely randomized design with three replications. Means were compared using LSD at 0.05.

3. RESULTS

Results in table (1) indicate that all the concentrations used of seaweed extract significantly affected plant height of both cultivars. The seaweed extract at 6 ml. L^{-1} recorded the highest plant height which was 113.56 cm and 85.74 cm for Flavio F1 and California wonder cultivar, respectively, compared to the control plant at which the plant height was 83.55 and 61.73 cm for the two cultivars, respectively too. The use of amino acids has led to an obvious increase in plant height as the level of them increases. It turns out that the high concentration of the amino acids have achieved the highest plant height which was 107.60 and 81.62 cm for both cultivars; Flavio F1 and California wonder, respectively.

The results also showed the existence of differences in plant height as a result of the combination between the two factors. The combination consisting of 6 ml. L^{-1} of seaweed extract with 800 mg. L^{-1} amino acids recorded the highest plant height which was 124.84 cm, compare to 73.92 cm for the control treatment of Flavio F1, and 89.80 cm compare to 47.36 cm for the control treatment of California wonder cultivar. Regarding the number branches, results of table (2) showed that the number increased significantly with increasing concentrations of both seaweed extracts and the amino acids for the two cultivars. The highest number of the branches was at the treatment of the high concentration of seaweed extract, which was 28.14 and 10.96 branch. plant $^{-1}$ for Flavio F1 and California wonder, respectively. Using the amino acids, the higher concentration gave the highest number of branches which were 26.00 compare to 18.83 branch. plant $^{-1}$ for control treatment for Flavio Fi cultivar and 9.98 compared to 8.67 branch. plant $^{-1}$ for the control treatment for California wonder cultivar. For the interaction, it was found that all of them have increased significantly the number of branches compared to the control treatment.

Table1. *Effect of seaweed extract and amino acids concentrations and their interaction on plant height (cm) of two sweet pepper (Capsicum annuum L.) cultivars*

Seaweed extract conc.(ml. L^{-1})	Flavio F1			mean	California wonder			mean
	Amino acids conc.(ml. L^{-1})				Amino acids conc.(ml. L^{-1})			
	0	400	800		0	400	800	
0	73.92	84.16	92.58	83.55	47.36	63.91	73.91	61.73
3	97.83	101.07	105.38	101.43	71.82	77.47	81.15	76.81
6	103.42	112.42	124.84	113.56	80.63	86.80	89.80	85.74
mean	91.72	99.22	107.60		66.60	76.06	81.62	

LSD p<0.05	**seaweed extract**	**amino acids**	**interaction**
Flavio F1	**6.61**	**6.61**	**11.49**
California wonder	**2.72**	**2.72**	**6.08**

Table2. *Effect of seaweed extract and amino acids concentrations and their interaction on number of branches of two sweet pepper (Capsicum annuum L.) cultivars.*

Seaweed extract conc.(ml. L^{-1})	Flavio F1			mean	California wonder			mean
	Amino acids conc.(ml. L^{-1})				Amino acids conc.(ml. L^{-1})			
	0	400	800		0	400	800	
0	13.93	15.91	18.78	16.21	6.75	8.08	8.37	7.73
3	18.63	23.42	25.88	22.64	8.67	9.24	10.33	9.41
6	23.94	27.15	33.34	28.14	10.58	11.05	11.25	10.96
mean	18.83	22.16	26.00		8.67	9.46	9.98	

LSD p<0.05	**seaweed extract**	**amino acids**	**interaction**
Flavio F1	**0.65**	**0.65**	**1.17**
California wonder	**0.34**	**0.34**	**0.95**

Overall, treatment combination of seaweed extract at a concentration of 6 ml. L^{-1} with amino acids at a concentration of 800 mg. L^{-1} gave the highest mean number of branches which reached 33.34 branch. $Plant^{-1}$ in Flavio F1 cultivar. In California wonder, combination of seaweed extract at 6 ml. L^{-1} with amino acids at both concentrations recorded the highest number of branches which did not differ significantly from each other.

Results regarding the percent of shoot dry matter pointed out that the seaweed extract significantly affected the percent as the concentrations used increased (Table 3). The highest percent was at 6 ml. L^{-1}, which recorded 20.07% in Flavio F1 cultivar and 16.75% in California wonder. It was also noted that all concentrations of amino acids used increased the percent of shoot dry matter. The higher percent was at a concentration of 800 mg. L^{-1} of the amino acids in both cultivars. The results indicate that all combination treatments had significant effects on the dry matter. The combination of seaweed extract at a concentration of 6 ml. L^{-1} and amino acids at a concentration of 800 mg. L^{-1}

was superior over the other combinations by giving a higher percent of dry matter (22.37% in Flavio F1 and 18.00% in California wonder).

Table3. *Effect of seaweed extract and amino acids concentrations and their interaction on percent dry weight of shoot of two sweet pepper (Capsicum annuum L.) cultivars.*

Seaweed extract Conc.(ml. L^{-1})	Flavio F1			mean	California wonder			mean
	Amino acids Conc.(ml. L^{-1})				Amino acids Conc.(ml. L^{-1})			
	0	400	800		0	400	800	
0	13.71	14.51	16.06	14.76	10.03	12.79	13.22	12.01
3	15.84	17.00	19.25	17.36	13.26	15.34	17.11	15.24
6	18.11	19.73	22.37	20.07	16.08	16.18	18.00	16.75
mean	15.89	17.08	19.23		13.12	14.77	16.11	

LSD p<0.05	**seaweed extract**	**amino acids**	**interaction**
Flavio F1	**1.12**	**1.12**	**2.04**
California wonder	**0.54**	**0.54**	**1.10**

The stem cross-section of sweet pepper (Fig. l.) showed that it consists of several layers. Starts from the epidermis layer, which consists of a single row of rectangular shape cells with straight walls and guard cells are distributed among them. Epidermis is covered with a layer of cuticle. Following the epidermis layer, there are several layers of cortex consisting of chlorenchyma tissue, which is located directly underneath the epidermis. Under the chlorenchyma tissue, there are several rows of angular collenchyma cells followed by a group of ordinary parenchyma cells with oval or elongated shape and thin walls separated by an interspaces. After the cortex layers, there are layers of meristematic cells separated from the vascular cylinder called endodermis. It was observed that the vascular tissues are arranged in a continuous vascular cylinder composing of phloem to the outside, followed by xylem to the inside and separated by a continuous ring of vascular cambium, which gives at division phloem to the outside and xylem toward the inside of the stem. Xylem tissue consisting of vessels and tracheids arranged as arms of varying length. The pith area, which occupies the stem center, is composed of paranchyma cells of large size and thin walls.

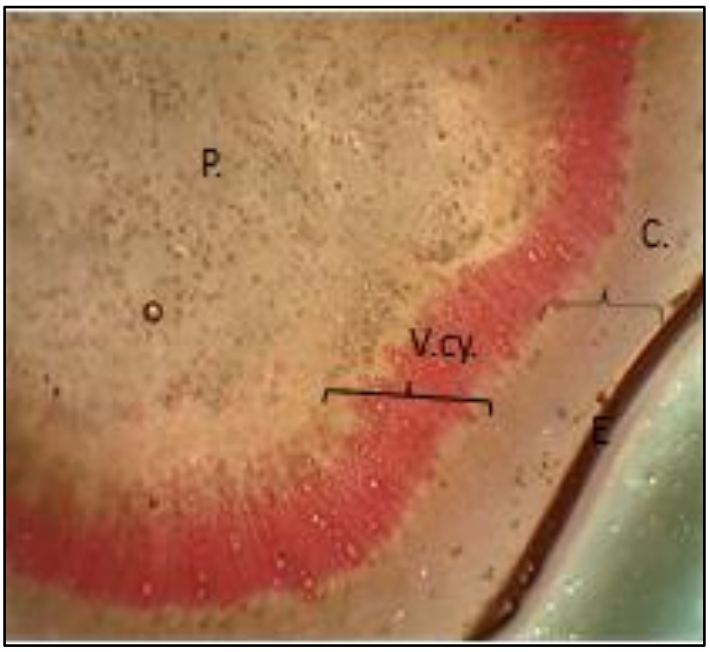

Figure1. *Transverse cross-section of sweet pepper stem (X40).*

Transverse cross- sections of the stem of the two cultivars treated with different concentrations of seaweed extracts and amino acids and their combination showed clear changes in the thickness of cortex, pith, and vascular cylinder in addition to the diameter of the vascular units. Results of table (4)

indicated that all seaweed extract concentrations used increased significantly the thickness of the cortex. Reaching their highest values; 387.64 and 356.96 µm for Flavio F1 and California wonder cultivar, respectively, using a concentration of 6 ml. L^{-1}. The least thickness was 306.15 and 250.85 µm for both cultivars, respectively, which was obtained for control plants.

Table4. *Effect of seaweed extract and amino acids concentrations and their interaction on cortex thickness (µm) of stem of two sweet pepper (Capsicum annuum L.) cultivars.*

Seaweed extract conc.(ml. L^{-1})	Flavio F1			mean	California wonder			mean
	Amino acids conc.(m.L^{-1})				Amino acids conc.(ml.L^{-1})			
	0	400	800		0	400	800	
0	287.81	293.34	337.31	306.15	124.36	257.11	281.09	250.85
3	312.55	367.57	383.44	354.52	281.33	300.05	327.38	302.92
6	352.01	388.92	422.00	387.64	340.07	363.66	367.14	356.96
mean	317.46	349.94	380.92		278.59	306.94	325.20	

LSD p<0.05	seaweed extract	amino acids	interaction
Flavio F1	9.39	9.39	21.37
California wonder	6.09	6.09	12.82

The results also showed that the use of amino acids caused significant differences in the thickness of the cortex, where the higher concentration recorded higher thickness reached 380.92 and 325.20 µm, for both cultivars, respectively. Combination of the two factors consisting of the high concentration of both factors gave a higher thickness of the cortex reached 422.00 µm in Flavio cultivar, and is characterized by its too much superiority from the rest of the other combinations. In California wonder cultivar, the combination treatment consisting of seaweed extract at 6 ml. L^{-1} with amino acids at both concentrations recorded the higher thickness of the cortex reached 363.66 and 367.14 µm for the two combinations, while the least thickness (214.36 µm) was at the control treatment. With respect to the thickness of the vascular cylinder, it was clear that the use of seaweed extract at both concentrations caused a marked increase in the thickness, the increase was gradual as the concentration increased. The 6 ml. L^{-1} gave the higher thickness reached 914.87 and 492.29 µm for the two cultivars; Flavio F1 and California wonder, respectively (Table 5). Also, the use of amino acids at both concentrations resulted in an increase in the thickness of the vascular cylinder.

Table5. *Effect of seaweed extract and amino acids concentrations and their interaction on vascular bundle thickness (µm) of stem of two sweet pepper (Capsicum annuum L.) cultivars.*

Seaweed extract conc.(ml. L^{-1})	Flavio F1			mean	California wonder			mean
	Amino acids Conc.(ml. L^{-1})				Amino acids Conc.(ml. L^{-1})			
	0	400	800		0	400	800	
0	573.35	691.00	703.57	655.97	306.22	333.00	384.60	341.27
3	822.59	931.25	944.11	899.32	367.91	422.32	498.68	429.64
6	838.73	946.98	958.91	914.87	470.00	478.80	528.06	492.29
mean	744.89	856.41	868.86		381.38	411.37	470.45	

LSD p<0.05	seaweed extract	amino acids	interaction
Flavio F1	14.11	14.11	30.66
California wonder	12.36	12.36	25.32

With regard to the effect of the interaction, it was found that the larger thickness of the vascular cylinder has been recorded in the combination treatment of seaweed extract of 6 ml. L^{-1} with amino acids at both concentrations. The least measure of the thickness of the vascular cylinder was recorded at the control treatment for both cultivars. As for vascular units, it has been shown in table (6) that there is a significant effect of the seaweed extract concentrations on the diameter of the units. The 6 ml. L^{-1} of the extract was superior in its effect, which record the larger diameter reached 69.24 and

62.82 µm for Flavio F1 and California wonder, respectively. While there was no significant effect of the amino acids on the diameter of the vascular units. For the effect of the interaction, it was found that the combination consisting of seaweed extract at 6 ml. L^{-1} and amino acids at 800 mg. L^{-1}, increased the diameter reaching 70.93 µm in Flavio F1 cultivar. In California wonder cultivar, it was clear that the use of seaweed extract at 6 ml. L^{-1} with all concentrations of amino acids has increased vascular units diameter dramatically compared to the rest of the combinations. With respect to the thickness of the pith area, results in table (7) indicated that the use of seaweed extract at both concentrations has reduced the thickness progressively with increasing the concentration of the extract. The 6 ml. L^{-1} of seaweed extract recorded the least thickness which reached 713.20 and 374.06 µm in Flavio F1 and California wonder cultivar, respectively. While the control treatment recorded the largest thickness of the pith which was 912.61 µm for Flavio F1 cultivar and 496.85 µm for California wonder cultivar.

Table6. *Effect of seaweed extract and amino acids concentrations and their interaction on diameter of vascular units (µm) of stem of two sweet pepper (Capsicum annuum L.) cultivars.*

Seaweed extract Conc.(ml. L^{-1})	Flavio F1			mean	California wonder			mean
	Amino acids conc.(ml. L^{-1})				Amino acids conc.(ml. L^{-1})			
	0	400	800		0	400	800	
0	46.05	55.05	56.09	52.40	32.55	32.53	32.48	32.52
3	58.57	66.36	68.12	64.35	44.19	44.17	44.09	44.15
6	68.18	68.71	70.93	69.27	62.85	62.82	62.79	62.82
mean	57.60	63.37	65.05		46.53	46.51	46.45	

LSD p<0.05	**seaweed extract**	**amino acids**	**interaction**
Flavio F1	**1.91**	**NS**	**2.13**
California wonder	**2.74**	**NS**	**4.08**

Table7. *Effect of seaweed extract and amino acids concentrations and their interaction on pith thickness (µm) of stem of two sweet pepper (Capsicum annuum L.) cultivars.*

Seaweed extract conc.(ml. L^{-1})	Flavio F1			mean	California wonder			mean
	Amino acids conc.(ml. L^{-1})				Amino acids conc.(ml. L^{-1})			
	0	400	800		0	400	800	
0	827.34	935.88	1021.14	912.61	432.20	489.55	568.81	496.85
3	685.48	732.89	891.31	769.89	400.01	421.10	476.63	432.58
6	651.00	701.12	787.47	713.20	337.95	382.03	402.21	374.06
mean	721.27	789.96	899.64		390.05	430.89	482.55	

LSD p<0.05	**seaweed extract**	**amino acids**	**interaction**
Flavio F1	**18.39**	**18.39**	**44.81**
California wonder	**10.57**	**10.57**	**23.08**

The increase in the concentration of the amino acids led to an increase in the thickness of the pith layer and reached its highest value at the higher concentration in both cultivars. With regard to the interaction it has shown that the thickness was higher when using a combination consisting of seaweed extract of 0 ml. L^{-1} with a higher concentration of amino acids, which recorded 1021.14 µm in Flavio F1 and 568.81 µm in California wonder cultivar. While the combination treatment of 6 ml. L^{-1} of seaweed extract with 0 mg. L^{-1} of amino acids has given less thickness for the pith reached 651.00 and 337.95 µm for both cultivars, respectively, which were lower than that of the other combinations.

4.DISCUSSION

It was clear from the above results that the seaweed extract has increased the plant height and number of its branches in comparison with the control. This is attributed to the composition of the seaweed extract such as natural growth hormones (auxins and cytokinins) that promote plant growth via increasing a number of metabolic events; cell division and enlargement which in turn leading to increase plant height [5,15, 16]. In addition, the extract contains a considerable amount of macro and micro elements which play an important role in the activation of many enzymes and coenzymes which are involved in several biological processes leading to cell division and enlargement [17, 18]. These findings are in agreement with the findings of [19] in cucumber plant. Also, it was noted from the current results that the use of seaweed extract led to an increase in the number of branches in treated plants. This may be due to the role of cytokinins in improving growth in general, and encouraging the growth of lateral buds and vascular tissues, and thus, increase the number of branches [20]. It may also be explained on the basis of the presence of carbohydrates in the extract that have a close relationship to stimulate the lateral buds for growth and differentiation [21]. In addition, the increase in dry weight of shoot and roots may be associated with the increasing in vegetative growth which may reflected in an increase in photosynthesis, and therefore, increase the availability of organic nutrients, which resulted in an increased plant dry weight [22, 23].

Results of the current study also showed that amino acids mixture had an obvious effect on the vegetative characters studied. This may be due largely to the role of amino acids in promotion of metabolic processes leading to stimulate growth as a result of the formation of new types of proteins, enzymes and some essential vitamins [24]. Furthermore, the stimulatory effect may be due to the fact that the amino acids act to increase the supply of nitrogenous materials needed for growth [25]. In addition, amino acids has a role in the biosynthesis of hormones, since the amino acid tryptophan is considered as the precursor for auxin (IAA) synthesis which is important in regulating the process of cell division and elongation. Also, the amino acids phenylalanine and ornithine are known to be involved indirectly in the synthesis of gibberellins, which play an important role in the elongation of internodes and encouraging the initiation and emergence of lateral buds, and thereby increasing plant height and number of the branches [26]. Furthermore, amino acids have an important role in the continuity of the biological processes that lead to the production of organic materials, and thus, increase the accumulation of dry matter in plant body. The increase in shoot size leads to increase the efficiency of photosynthesis and increase the carbohydrates produced and thus the accumulation of dry matter. This result is consistent with the results of [27, 28].

The results has also shown that all combinations used consisting of the high concentration of both seaweed extract and amino acids were more effective than others, suggesting a plant response to these high concentrations rather than low concentration. It was clear from the results regarding anatomical measurements that the positive effect of seaweed extract in increasing the thickness of the cortex may be due to their effects on the number and size of paranchyma cells. Materials involved in the composition of seaweed extract, such as natural hormones, act to stimulate many biological processes including cell division and enlargement [29]. [30] confirmed that auxins action in increasing cell growth and differentiation is due to its effect on the liberation of hydrogen ions and increasing the softening of cell wall to ease cell expansion and then build up proteins and nucleic acids that stimulate cell division and increase cell number.

As for the volume of vascular cylinder, it has been shown that the seaweed extract has increased the size of the vascular cylinder as a result of increasing the number and diameter of vascular units, and this attributed to the action of cytokinins in the extract that promote division of parenchyma cells within the conductance tissue. Then, these cells may differentiate to the carrier cells [31], as well as increasing the cambium activity in xylem and phloem formation. Also, the contents of the seaweed extract lead to stimulate the cambium to form new vascular bundles, resulted in an increase in stem diameter. This result is consistent with the results of [12], who stated that the increase in stem diameter of beans plants treated with seaweed extract was caused by an increase in the thickness of the cortex layer and pith as a result of increasing the parenchyma layers number. Also, this result agrees well with the results of [32] when they studied the histological changes in beans stem treated with extracts rich in cytokinins. However, the negative effects of the seaweed extract in reducing pith thickness is attributable to the increase in the size of the vascular cylinder, which will occupy larger

area of the stem diameter at the expense of the pith area. As for the role of amino acids, the results of the current study has indicated the existence of positive effects in some of the anatomical characteristics of sweet pepper stem. Amino acids clearly increased the thickness of the cortex area and pith. This accounts on the basis of the enlargement of paranchyma cells through the influence of amino acids in softening cell wall. This may be happened as a result of building and motivating some enzymes and formation of new proteins responsible for the construction of synthetic materials used in cell wall structure [33. 34]. It was observed from the current results that amino acids at all concentrations did not have any significant effect on the diameter of vascular units. This may be due to the important role of amino acids in the process of hormonal balance and this may create an opportunity toward reducing vulnerability of the cambium activity, thus ensuring normal growth and differentiation of plant tissues. This result is consistent with the results of [35] on stem beans treated with amino acids. The increase in size of the vascular cylinder using amino acids may be due to the positive role of acids in cell division and expansion. This was confirmed earlier on tomato plant, as noted by [13] who mentioned that the use of amino acids has increased the thickness of the cortex layer, with increasing thickness of the xylem resulting from the increased in number of vascular units. Also the results is consistent with the results of [14] on the tomato plant, too.

From the above mentioned results one can conclude that the seaweed extract and amino acids alone or in combination with each other have positive effects on the vegetative and anatomical characters measured in this research especially at the higher concentration.

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