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THE EFFECT OF LEAF FEEDING ON MARINE ALGAE EXTRACT (IPS) AND NUTRITIOUS SOLUTION CALMAC ON SOME VEGETATIVE AND QUALITY CHARACTERISTICS OF CAULIFLOWER PLANT

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Abstract

An experiment was carried out to investigate the effect of leaf spraying with marine algae extract (IPS) and nutritious solution calmac on some vegetative and quality characteristics of cauliflower plant for the season 2017-2018 at the Faculty of Agriculture, Sumer University, Rifai district, Dhi Qar. The experiment was carried out in accordance with the design of Randomize Complete Block Design (RCBD) with three replicates of 9 experimental units per replicate. The experiment included studying the effect of two factors: first factor was the fertilization of the cauliflower seedlings in three concentrations of marine algae extract IPS (0, 2, 4 ml^{-1} while the second factor was spraying with three concentrates of the nutritious solution calmac (0, 3 and 6 ml^{-1}). The results showed that treatment I_2 was superior by giving the highest ratio of leaves, the largest leaf area, highest relative content of chlorophyll in leaves, the highest percentage of N, Ca and Mg in leaves, the highest weight and diameter of floral disc, and the highest percentage of carbohydrates compared to the I_0. As for the effect of spraying with nutritious solution (Calmac), K_1 was superior by giving the highest diameter of the stem, the highest number of leaves and the highest diameter of the floral disc while K_2 was superior by giving largest leaf area and the highest relative content of chlorophyll in the leaves, the highest weight of the floral disc and the highest percentage of carbohydrates compared to K_0. There was a significant effect in the interaction between the studied factors, where I_2K_2 was higher in most of the studied traits compared with other treatments.

***Keywords*:** Cauliflower plant, Marine Algae, Nutritious solution, Leaf spraying

Introduction

Brassica oleracea var. Botrytis is one of the crops of the Brassicaceae family found in the mediterranean region and Cyprus is believed to be its original home. Cauliflower is cultivated in most of Iraq's provinces as a winter crop for the purpose of acquiring the Curd which is eaten in the stage of flowering buds before opening with its thick swathes. The cauliflower of vegetables is rich in many vitamins such as vitamin A and C as well as carotene, protein, phosphorus, potassium, iron and calcium. It was showed that each 100 g of cauliflower contains 91.7% water, 25 calories, 2.4 g protein, 4.9 g carbohydrates, 72 mg phosphorus, 2.2 mg calcium, 1.1 mg iron and a number of vitamins (Matlop *et al.*, 1989, Jabbar *et al.*, 2013).

The exposure of some mineral elements in most of Iraq's soil to many factors that limited their movement and readiness due to high pH and salinity, which often causes a weakening of the root mass to be absorbed by the soil because they do not dissolve in soil solution (Galeem, 1997). In order to ensure plant nutrient requirements during critical and sensitive stages of growth, it is preferable to add nutrients directly through paper feeding as this method can provide the plant with 85% of its nutrient needs (Abdol, 1988). Paper feeding plays an important role in improving the vegetative growth characteristics of the plant through the contribution of nutrients necessary for growth, especially the major elements in the formation of primary and secondary compounds, which have an interrelated role in the formation of a plant capable of growing in a balanced manner and thus obtaining a good total vegetative and root, and the lack of these factors causes the deterioration of plant growth and possibly death (Peuke *et al.*, 1998, Hamad and Jamaa, 2000.) Plant growth, development and improved productivity are controlled by several factors, including good plant fertilization, and using more environmentally friendly alternatives including the use of processed and naturally extracted organic nutrients as substitutes for chemical fertilizers to provide the plant with its nutrient requirements and to obtain plants free of the toxic effects of chemical fertilizers and the production of a clean crop (Costigan, 2000, Humaidan *et al.*, 2006 and Farhan, 2008). Including the use of marine algae extract and calmic as leaf fertilizer on plant vegetation (Crouch and Vanstaden, 2005). Marine Algae extracts contain many nutrients and some growth regulators such as oxins, gebrilins and amino acids that improve the vegetative growth in plants. Plant treatment with marine algae extracts increases plant strength, absorption of nutrients and increases resistance to disease. Additionally, increase its productivity and improve its quality (Spinelli *et al.*, 2009). In a study on cucumber plants to determine the effect of spraying with nitrogen fertilizer and spraying with marine extracts, Mohammed (2009) demonstrated that there was a positive effect in the improvement of plant growth, especially the treatment of spray with marine algae extract 2 $ml.L^{-1}$ which showed a clear superiority in increasing plant growth and leaf content of chlorophyll. Abdel-Mawgoud *et al.* (2010) detected that using marine algae extract (3 $ml.L^{-1}$)

resulted in an increase in the paper area of the watermelon plant compared with the control treatment that gave the lowest values.

Based on the above, the aim of the study was to study the possibility of producing the cauliflower crop within the methods of organic nutrition based on scientific bases using the marine algae extract and the Calmac solution at different levels and investigate its effect on the growth and quality of the hybrid cauliflower and thus obtaining a healthy biological and a healthy crop for the consumer.

Materials and Methods

A field experiment was carried out to cultivate the hybrid Cauliflower plant in the Faculty of Agriculture - Sumer University - Rifa'i district/Dhi Qar for winter planting season 2017-2018 to study the effect of spraying with marine algae extracts and nutritious solution calmac on some vegetative and quality characteristics and yield traits of cauliflower plant that planted in plastic bags. The RCBD design was used with three replicates each replicate included 9 units and 3 plants per unit (Sahuki and Heib, 1990). Seeds of the hybrid creama were planted on 15 of August 2017 in cork dishes with the appropriate conditions for the seedlings and after formation of four real leaves, they were transferred to plastic bags of 15 kg on 11 of October 2017. Loamy soil with peat moss (2 soil: 1 peat moss) was used in the cultivation of seedlings and the experimental treatments included spraying the total vegetative of the seedlings with two levels of marine algae extract and two levels of calmac in addition to treatment of the comparison as described below:

1. Control treatment (I_0 K_0).
2. Spraying 0 ml.L^{-1} of IPS + 3 ml. L^{-1} of calmac (I_0 K_1)
3. Spraying 0 ml.L^{-1} of IPS + 6 ml.L^{-1} of calmac (I_0 K_2)
4. Spraying 2 ml.L^{-1} of IPS + 0 ml. L^{-1} of calmac (I_1 K_0)
5. Spraying 2 ml.L^{-1} of IPS + 3 ml. L^{-1} of calmac (I_1 K_1)
6. Spraying 2 ml.L^{-1} of IPS + 6 ml. L^{-1} of calmac (I_1 K_2)
7. Spraying 4 ml.L^{-1} of IPS + 0 ml. L^{-1} of calmac (I_2 K_0)
8. Spraying 4 ml.L^{-1} of IPS + 3 ml. L^{-1} of calmac (I_2 K_1)
9. Spraying 4 ml.L^{-1} of IPS + 6 ml. L^{-1} of calmac (I_2 K_2)

The experimental treatment were randomly distributed to the seedlings and the spraying was done every two weeks and for three months using a 10 liter hand spray until full wetness was added with the addition of a liquid substance (0.1 ml. L^{-1}) to reduce the surface tension of the water molecules. Measurements were taken for experimental unit plants and included:

Stem diameter (cm): Stem diameter measured by calculating the diameter of the stem using the Vernier at a height of 1 cm from the soil contact area and then the average number was calculated.

The total number of leaves: The total number of leaves per plant was calculated and then the average number was measured.

The leaf area (ds.plant^{-1}): The leaf area was calculated by taking 10 discs with known area from three leaves and dried in an oven at 65 ° C until the stability of weight, then calculated the leaf area according to the following equation (Watson and Watson, 1953).

Leaf area (dcm^2) = leaf size of discs × Dry weight of plant leaves/ Dry weight of tablets

The relative content of chlorophyll in leaves (SPAD UNIT): The chlorophyll content was estimated by a chlorophyll meter by reading 6 leaves of plants per experimental unit and then averaged (Minnotti *et al.*, 1994) and measured in SPAD UNIT units (Jemison and Williams, 2006). The samples were selected for the fifth and sixth leaves of the three plants and for each experimental unit. The leaves were then washed to remove the dust and dried in an electric oven at 70 °C until the weight stability (Sahaf, 1989). After that, the samples were minced and 0.2 g of the minced sample was taken and digested with 4 ml of sulfuric acid concentrate and 2ml of pyrochloric acid concentrate according to the method of Jones and Steyn (1973).

Nitrogen (N %): The nitrogen percentage was estimated by using the Micro Kjeldahl method according to the method of Jackson 1958.

Calcium (Ca %): Calcium percentage was estimated using a Flame photometer as mentioned in Al-Sahaf, 1989**.**

Magnesium (Mg %): Magnesium percentage was estimated to be calibrated with calcium (Al-Sahaf, 1989).

Weight of disc: The weight of the flower disc was calculated by taking the weights of the floral disc of the experimental unit plants and dividing them by the number of experimental plants. The diameter of the disc was measured by the diameter of the disc from each experimental unit using Vernier from the width area of the head and the average was taken.

The percentage of carbohydrates in the floral discs: The method of Joslyn (1970) was used to estimate the total carbohydrate content of the disc.

Results and Discussion

Stem diameter (cm): The results in Table 1 showed no significant differences between spray treatments with marine algae extract (IPS), although treatment I_2 gave the largest diameter of the stem at 2.416 cm while I_0 treatment gave the lowest diameter of the stem with mean of 2.208 cm. As for the effect of the nutritious solution, it was significantly higher K_1 compared to other treatments, giving the largest value of 2.483 cm, while K_0 recorded the lowest value reached 2.207. The interaction between the fertilizer treatments has resulted in an increase in stem diameter where I_2K_1 recorded the largest value of 2.680 cm while I_0K_0 showed the lowest value with mean of 1.930 cm.

Table 1: Effect of spraying with marine algae extract (IPS) and Calmac solution on the stem diameter of cauliflower plant for the season 2017-2018

Stem diameter (cm)				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	1.930	2.403	2.290	2.208
I_1	2.433	2.367	2.223	2.341
I_2	2.257	2.680	2.310	2.416
Average	2.207	2.483	2.274	
L.S.D 0.05	I		N.S	
	K		0.248	
	Interaction		0.430	

Number of leaves (leaf.plant^{-1}): The results of Table 2 indicated that the spraying with IPS had a significant effect on leaves number where I_2 was significantly superior on the other treatments with highest number of leaves recording 21.44 leaf.plant^{-1} compared with treatment I_0, which gave the lowest number of leaves (18.70 leaf.plant^{-1}). In terms of spraying with the nutritious solution, the K_1 gave the highest number of leaves with 21.07 leaf.plant^{-1} while K_0 showed the lowest number of leaves (18.59 leaf.plant^{-1}). There was a significant interaction between spraying IPS and nutritious solution where I_2K_1 gave the highest number of leaves at 22.44 leaf.plant^{-1} while I_0K_0 recorded the lowest value with mean of 17.34 leaf.plant^{-1}.

Table 2 : Effect of spraying with marine algae extracts (IPS) and Calmac nutritious solution on the number of leaves of cauliflower plants for the season 2017-2018.

Number of leaves (leaf.plant^{-1})				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	17.34	20.55	18.22	18.70
I_1	18.33	20.45	19.67	19.48
I_2	20.11	22.44	22.00	21.44
Average	18.59	21.07	19.96	
L.S.D 0.05	I		1.898	
	K		1.898	
	Interaction		3.287	

Leaf area (dsm^2.plant^{-1}): The results of Table 3 showed that I_2 was superior with mean of 92.7 dsm^2.plant^{-1} followed by I_1 (87.9 dsm^2.plant^{-1}) with insignificant difference between them while the lowest leaf area was recorded in I_0 (80.2 dsm^2.plant^{-1}). As for the effect of spraying with calmac solution, the treatment K_2 was higher with mean of 91.4 dsm^2.plant^{-1} compared to K_0 which gave the lowest leaf area with mean of 83.2 dsm^2.plant^{-1}. Regarding the interaction between spray treatments with IPS and nutritious solution, the obtained result showed that I_2K_2 had a significant effect by giving the largest leaf area with value of 100.0 dsm^2. plant^{-1} while the I_0K_0 recorded the lowest leaf area of 73.9 dsm^2.plant^{-1}.

Table 3 : Effect of spraying with marine algae extracts (IPS) and Calmac nutritious solution on the leaf area of the cauliflower plant for the season 2017-2018

Leaf area (dsm^2.plant^{-1})				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	73.9	81.4	85.4	80.2
I_1	92.0	83.1	88.7	87.9
I_2	83.7	94.5	100	92.7
Average	83.2	86.3	91.4	
L.S.D 0.05	I		7.22	
	K		7.22	
	Interaction		12.49	

Relative content of chlorophyll in leaves (SPAD UNIT): The results of the statistical analysis of Table 4 showed that there were significant differences between the treatments in the leaf content of chlorophyll, where I_2 had the highest ratio of 73.71 SPAD unit, followed by I_1 (71.79 SPAD) while the lowest ratio was recorded in I_0 (68.62 SPAD unit). The effect of spraying with the nutritious solution was significant where K_2 was higher with mean of 72.75 units of SPAD compared to the K0 which gave the lowest content of chlorophyll in the leaves (70.24 SPAD unit). A significant effect of the interaction between the fertilizer treatments was revealed where I_2K_2 gave the highest content of chlorophyll 75.17 SPAD unit compared to the lowest content of chlorophyll in I_0K_0 which was 66.73 SPAD unit.

Table 4 : Effect of spraying on marine algae extract (IPS) and nutritious solution on the relative content of chlorophyll in cauliflower leaves for the 2017-2018 Season

Chlorophyll ratio (SPAD unit)				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	66.73	68.67	70.47	68.62
I_1	71.13	71.63	72.60	71.79
I_2	72.87	73.10	75.17	73.71
Average	70.24	71.13	72.75	
L.S.D 0.05	I		1.757	
	K		1.757	
	Interaction		3.044	

Percentage of nitrogen in leaves%: The results of Table 5 showed a significant positive effect of the spraying treatments on increasing the nitrogen ratio in the leaves. The fertilization treatment of I_2 significantly exceeded the other treatments by giving the highest percentage of 2.85% while the treatment of I_0 gave the lowest value of 1.93%. The K_2 treatment showed significant superiority with the highest nitrogen ratio of 2.48% compared to K_0 which gave the lowest ratio of 1.87%. The interaction between the spraying treatments showed a significant effect where I_2K_2 giving the highest nitrogen ratio of 3.04% compared to the lowest value in I_0K_0 treatment which was 1.87%.

Table 5 : Effect of spraying with marine algae extracts (IPS) and nutritious solution calmac on nitrogen percentage in leaves of cauliflower for season 2017-2018

Nitrogen percentage in leaves %				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	1.87	1.94	1.97	1.93
I_1	2.06	2.25	2.42	2.24
I_2	2.59	2.94	3.04	2.85
Average	2.17	2.38	2.48	
L.S.D 0.05	I		0.15	
	K		0.15	
	Interaction		0.26	

Percentage of calcium in leaves%: The results of Table 6 showed that I_2 had the highest value (1.399%) compared to the lowest value in I_0 (1.029%). The effect of spraying with calmac varied in the ratio of calcium between treatments without significant differences, although the treatment K_2 gave the highest rate of 1.261% while K_0 (without fertilizer) had the lowest ratio with mean of 1.156%. The interaction between the spraying factors was significantly positive where I_2K_2 gave the highest calcium ratio of 1.450% compared to the lowest ratio in I_0K_0 which recorded 1.010%.

Table 6 : Effect of spraying with marine algae extract (IPS) and nutritious solution (calmac) on percentage of calcium in leaves of cauliflower for season 2017-2018

Calcium percentage in leaves %				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	1.010	1.027	1.050	1.029
I_1	1.103	1.217	1.283	1.201
I_2	1.353	1.393	1.450	1.399
Average	1.156	1.212	1.261	
L.S.D 0.05	I		0.113	
	K		N.S	
	Interaction		0.197	

Percentage of magnesium in leaves%: The results of Table 7 showed that I_2 had a significant superiority in the ratio of magnesium in leaves reached 1.476% followed by treatment I_1 with mean of 1.359% while the lowest ratio was given by I_0 which was 1.261%. The obtained result detected that there are significant differences between the spraying treatments in the ratio of magnesium where K_2 recorded the highest percentage (1.530%) while K_0 showed the lowest magnesium percentage (1.123%). The results showed that the interaction between fertilizer and spray treatments was significant and the highest magnesium content was 1.677% in treatment I_2K_2 while I_0K_0 showed the lowest ratio (1.017%).

Table 7 : Effect of spraying with marine algae extract (IPS) and nutritious solution (calmac) on percentage of magnesium in leaves of cauliflower for season 2017-2018

Percentage of magnesium in leaves%				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	1.017	1.360	1.407	1.261
I_1	1.123	1.443	1.513	1.359
I_2	1.230	1.520	1.677	1.476
Average	1.123	1.441	1.530	
L.S.D 0.05	I		0.155	
	K		0.155	
	Interaction		0.268	

Weight of flowering disc (g): The results of Table 8 indicated significant differences between the spraying treatments of the IPS used in the study, noting that the superiority of treatment I_2 by giving the highest weight of the disc (377.1 g) while I_0 treatment showed the lowest weight of the disc (351.5 g). The table shows that the treatment of spray with nutritious solution K_2 gave the highest disc weight (379.6 g) followed by K_1 with a weight (360.5 g) with insignificant difference between them and both treatments showed a significant superiority on treatment K_0 (348.2 g). The interaction of fertilizer was shown to have a significant effect where I_2K_2 gave the highest weight (396.7 g) while I_0K_0 recorded the lowest weight (340.7 g).

Table 8 : Effect of Spraying on Marine Algae Extract (IPS) and Nutritious Solution Calmac on disc weight of Cauliflower for the 2017-2018 Season

Disc weight (g)				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	340.7	348.5	365.3	351.5
I_1	346.8	355.3	376.9	359.7
I_2	357.0	377.6	396.7	377.1
Average	348.2	360.5	379.6	
L.S.D 0.05	I		20.65	
	K		20.65	
	Interaction		43.09	

Diameter of floral disc (cm): The results of Table 9 showed significant differences between treatments that treated with IPS in disc diameter. The I_2 treatment significantly exceeded all treatments by giving the largest value (18.55 cm) followed by treatment I_1 (17.34 cm) while treatment I_0 gave lowest value (15.91 cm). The treatment of K_1 gave the highest mean of 17.54 cm while the lowest diameter was found in K_0 (16.75 cm). The results of the interaction between spraying IPS and the nutritive solution detected a significant superiority in I_2K_1 (19.17 cm) while I_0K_0 gave the lowest disc diameter (15.48 cm).

Table 9 : Effect of Spraying on Marine Algae Extract (IPS) and Nutritious Solution Calmac on disc diameter of cauliflower for the season 2017-2018

Disc diameter (cm)				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	15.48	15.82	16.43	15.91
I_1	17.12	17.64	17.27	17.34
I_2	17.66	19.17	18.82	18.55
Average	16.75	17.54	17.51	
L.S.D 0.05	I		1.611	
	K		1.611	
	Interaction		2.790	

Percentage of carbohydrates in floral discs: The obtained results showed the difference in the percentage of carbohydrates in floral discs (Table 10) due to different levels of spraying of IPS and nutritious solution calmac. The treatment of I_2 was significantly superior on all the treatments giving the highest percentage which was 6.64%, while I_0 (with no fertilization) gave the lowest percentage of carbohydrates (5.47%).As for the effect of spraying with nutritious solution, k_2 was significantly superior (6.21 %) while the lowest percentage of carbohydrate was in k_0 (5.79%). Regarding the interaction between spray treatments, I_2K_2 treatment was the highest ratio (6.82%) while I_0K_0 showed the lowest rate (5.25%).

Table 10 : Effect of Spraying on Marine Algae Extract (IPS) and Nutritious Solution Calmac on percentage of carbohydrates of cauliflower for the season 2017-2018

Percentage of carbohydrates (%)				
Treatments	**K_0**	**K_1**	**K_2**	**Average**
I_0	5.25	5.53	5.64	5.47
I_1	5.77	5.87	6.17	5.94
I_2	6.34	6.75	6.82	6.64
Average	5.79	6.05	6.21	
L.S.D 0.05	I		0.109	
	K		0.109	
	Interaction		0.189	

Plant providing with the nutrients necessary for growth at the early stages plays a positive role in the growth and development of the total vegetative especially plant spraying with the extract of marine algae (IPS) and the nutritious solution calmac. The results showed that the plants were characterized by good vegetative growth which may be due to the fact that the spraying treatments contain essential nutrients for growth such as nitrogen, calcium, magnesium, vitamins, amino acids and organic compounds, which have a wide range in their effect on plant biological activities, activation of amino acid and protein synthesis enzymes as

well as their role in the manufacture of chlorophyll (Table 1), increased number of leaves (Table 2), leaf area (Table 3) and leaf content of chlorophyll (Table 4) as a result of an increase Photosynthesis products (Strik *et al.*, 2003; Don and Curry, 2003; Boise *et al.*, 2006; Khan *et al.*, 2009; Osman *et al.*, 2010 and Martin, 2012). The results of Tables 5, 6 and 7 showed that spraying with the IPS and the nutritious solution calmac had an effect on increasing the percentage of nitrogen, calcium and magnesium elements and may be due to their content of the major and micro nutrients and plant hormones, which are absorbed directly when sprayed on the leaves. The absorbed nitrogen then works indirectly by increasing the absorption and transfer of other elements by entering the formation of chlorophyll pigments and thereby increasing the carbonation and protein-building process, which is of great importance in stimulating plant growth and increasing its efficiency to absorb and accumulate the rest of the elements including calcium and magnesium leading to increase its percentage in the plant, which results in increasing plant activity and growth (Abu Dhahi and Yunis, 1988, Kandil and Gad, 2009). These results were consistent with Al-Khafaji 2010, EL-Awadi *et al.*, 2011, Shaheen *et al.*, (2010). The weight and diameter increasing of the floral disc in the cauliflower plants (Table 8 and 9) when sprayed with IPS and calmac may be due to the role of nitrogen and calcium in the increased leaf area (Table 3) and the chlorophyll content (Table 4) resulted in increasing carbon metabolism products and carbohydrates (Table 10), thereby increasing the production of nutrients needed to form the floral disc as well as its content of the major and minor nutrients that play a role in the transfer of carbonate products to their storage locations, thereby stimulating the formation of floral disc (Patrick *et al.*, 2001) . It was also observed that plant growth and development increased with increasing levels of fertilizer treatments resulting in increased nutrients absorption and increased food manufacturing processes and thus increased plant growth rate, which positively affected the weight and diameter of disc. The positive effect of spraying with IPS + nutritious solution in increasing the percentage of carbohydrates in floral discs may be attributed to their effect on improving carbonate metabolism by increasing the content of the chlorophyll in leaves (Table 4) and the leaf area (Table 3) which led to an increase in the accumulation of carbohydrates, as well as increase the readiness of the elements and the reflection on the increase in its proportion in the plant (Table 5, 6 and 7), which directly and indirectly interfere with the manufacture of chlorophyll and the activation of many photosynthesis enzymes that contribute to increasing the proportion of carbohydrates (Tucker, 1999; Taiz and Zeiger, 2006). The obtained results were agreed with Shaheen *et al.* (2010) and Majid (2010).

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