Plant Archives Vol. 19, Supplement 1, 2019 pp. 1234-1240 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

RESPONSE OF CULTIVATED CABBAGE IN PLASTIC BAGS FOR SPRAYING WITH AMINO ACIDS, FERTILIZATION WITH HUMIC ACID AND ITS EFFECT ON SOME VEGETATIVE AND QUALITY TRAITS

Yasamin, F. Saloom[1] Mohammad, H.A. AL- Hasane[2] and Salah, H.J. AL-Hchami[3]

[1]Soil Sci. & Water Resources Dept., College of Agric., University of Sumer, Iraq
[2]Department of Horticulture, College of Agriculture, University of Karbala, Iraq
[3]Department of Horticulture, College of Agriculture, University of Bagdad, Iraq
Email : yasamen_master@yahoo.com, Salah77_master@yahoo.com

Abstract

A field experiment was conducted to study the effect of the spraying with amino acids and fertilization of humic acid and its effect on some vegetative and quality traits of cultivated Cabbage (*Brassica oleracea* var. capitate) in plastic bags for the 2016-2017 season at the college of Agriculture, Sumer University. The experiment was conducted according to Randomized Complete Blocks Design (R.C.B.D), with three replicates, nine experimental units per replicate, The experiment included studying the effect of two factors, the first factors: Fertilizing the seedlings with three concentrations of humic acid (0, 1.5, 3 $ml.L^{-1}$), The second factor included the spraying with three concentrations of amino acid (0, 2, 4 $ml.L^{-1}$).The results showed the excelling the spraying treatment with amino acids (A_2) by giving them the highest stem diameter, the number of leaves, leaf area, the highest percentage of N, P and K in the leaves, and the highest weight and diameter of the flower disk, compared with the control treatment (A_0).the spraying treatment with humic acid (H_2) was significantly excelled by giving them the highest stem diameter, the number of leaves, leaf area, highest relative content of chlorophyll in leaves ,the highest percentage of N, P and K in the leaves, and the highest weight and diameter of the flower disk, compared with the control treatment (H_0)

***Keywords*:** Cabbage, Amino acid, Humic acid, leaf area.

Introduction

Cabbage (*Brassica oleraceavar* capitata L.) is one of the most important winter leafy vegetables in Iraq belonging to the Cruciferae family. This family includes about 300 genus and 3000 species of plants that are naturally spread in all over the world. The Eastern Mediterranean Sea is an indigenous country, are grown to cultivating to obtain heads that its resulting of leaf curl around the lateral bud and The leaves used fresh or in the manufacture of pickles or in cooking (Al-Mustalem *et al*., 1989; Jabbar *et al*., 2013) It is characterized by high nutritional value for containing vitamin C , vitamin A and carbohydrate as well as some nutrients such as phosphorus, potassium, magnesium and It is a good solvent for fat in the body and also lowers blood cholesterol as well as being few calories and proteins, as well as enzymes and the activated material of metabolism. It also contains high levels of vitamin C and vitamin A and carbohydrates, as well as some nutrients such as phosphorus, potassium, magnesium and iron. It is also characterized by its medicinal benefits because it contains Sulforaphane and Indole compounds that have an effective role in the prevention of cancer, Diabetes mellitus and heart disease (Kirsh *et al*., 2007; Zhao *et al*., 2007 and Boras *et al*., 2011). The availability of nutrients element for plant is an important factor in plant growth Therefore, the researchers turned to find new methods and methods for their adoption in suppling the plant with the necessary nutrients and to achieve qualitative and quantitative improvement in the growth of the yield. (Kathiroson, 2000; Wittwer and Lansing, 2005). As well as the great interest in organic products and to ensure the quality of the food product and obtaining a healthy crop free of pollution and reducing the negative impact on the environment contributed to increasing the use of organic fertilizers by spraying them on the plant or added to the soil to feed the plant and ensure crop sustainability (Halvin, 2005, 2010). Including the used of amino acids spraying on the plant, which has a significant role in stimulating the processes of the physiology and biochemical as they contribute these acids in the construction of proteins and the manufacture of carbohydrates and stimulate the process of photosynthesis and increases the resistance of plants to environmental stresses (El-Sherbeny *et al*., 2007; Singh, 1999). The study also included the addition of humic acid to the soil because of its important role in increasing the growth of the plant through the readiness and absorption of nutrients and increase its ability to represent carbon (Hopkins, Stark, 2003, Suganya and Sivasamy, 2006). Therefore, the research aims to study the extent of the cultivating of the crop in the plastic

bags, to study the Cabbage response when using organic fertilizers at different levels according to scientific bases and testing its effect on the growth and quality of the Cabbage under the local conditions for the southern region.

Materials and Methods

A field experiment was conducted during the 2016-2017 winter season at the college of Agriculture, Sumer University Rifa'i district, to study the effect of the spraying with amino acids and fertilization of humic acid and interaction Between them on some vegetative and quality traits of cultivated Cabbage (*Brassica oleracea* var. capitate) in plastic bags. The experiment was conducted according to Randomized Complete Block Design (R.C.B.D), with three replicates, nine experimental units per replicate, by 3 plants in one experimental unit to be the number of plants in experimental units 81 plants. The seeds of hypred cabbage (Globe Master) were cultivated on 15/8/2013 in seedling trays with continuous care for the seedlings, after emergence of four real leaves, the seedlings were transferred for cultivating. They were transferred to plastic bags of 15 kg on 11/10/2016. In cultivation, a loamy soil was used that added to it the peat moss 2:1, The experiment included the use of two types of fertilizer, the first spraying the vegetative of the seedlings with amino acids in two concentrations in addition to the treatment of the comparison. The second treatment included the addition of humic acid fertilizer to the soil with two concentrations as well as the comparison treatment as explained below:

1. The control treatment which is symbolized by (A0 H0).
2. Spraying the amino acids with a concentration of (0 $ml.L^{-1}$) + adding Humic acid with concentration of (1.5 $ml.seddling^{-1}$), which is symbolized by (A0 H1).
3. Spraying the amino acids with a concentration of (0 $ml.L^{-1}$) + adding Humic acid with concentration of (3 $ml.seddling^{-1}$), which is symbolized by (A0 H2).
4. Spraying the amino acids with a concentration of (2 $ml.L^{-1}$) + adding Humic acid with concentration of (0 $ml.seddling^{-1}$), which is symbolized by (A1 H0).
5. Spraying the amino acids with a concentration of (2 $ml.L^{-1}$) + adding Humic acid with concentration of (1.5 $ml.seddling^{-1}$), which is symbolized by (A1 H1).
6. Spraying the amino acids with a concentration of (2 $ml.L^{-1}$) + adding Humic acid with concentration of (3 $ml.seddling^{-1}$), which is symbolized by (A1 H2).
7. Spraying the amino acids with a concentration of (4 $ml.L^{-1}$) + adding Humic acid with concentration of (0 $ml.seddling^{-1}$), which is symbolized by (A2 H0).
8. Spraying the amino acids with a concentration of (4 $ml.L^{-1}$) + adding Humic acid with concentration of (1.5 $ml.seddling^{-1}$), which is symbolized by (A2 H1).
9. Spraying the amino acids with a concentration of (4 $ml.L^{-1}$) + adding Humic acid with concentration of (3 $ml.seddling^{-1}$), which is symbolized by (A2 H2).

The experiment treatments were randomly distributed to the seedlings. The spraying process was done every two weeks for a period of three months using a backpack sprayer capacity 10 liter, until full wetness with a little addition of the spreading material (Dishwashing Liquid average 0.1 ml^{-1}) to reduce the surface tension of the water molecules.. The measurements were taken for the plants of the experimental unit which included: plant stem diameter (cm): It is measured using the Vernier at a height of (1 cm) from the its contact area with soil and the average was calculated. Number of leaves ($leaf.plant^{-1}$): The total number of leaves per plant of the selected plants was calculated and then and the average was calculated. And the leaf area ($Dcm^2.plant^{-1}$), taking 10 tablets known area of 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). The relative content of chlorophyll (Spad unit): It was estimated by a chlorophyll meter device by taking the reading for 6 leaves of plants for each experimental unit and the average was then calculated (Minnotti *et al*., 1994), it was measured by (Spad unit), depending on (Jemison and Williams, 2006). The nutrients elements were estimated as the fifth and sixth leaves were selected for the three plants each experimental unit. The leaves were washed to remove the dust and dried in an electric oven at 70 °C until the stability of weight (Al-Sahaf, 1989). The samples were then grinded, taken 0.2 g of the grinded sample and digested it by adding 4 mL of concentrated sulfuric acid, 2 ml of concentrated pyrochloric acid according to (Jones and Steyn, 1973). Nitrogen (N%): It was estimated using the Micro Kjeldahl device according to (Jackson, 1958). Phosphorus (P%): It was estimated using ammonium polysaccharides and ascorbic acid with a spectrophotometer and 662 nanometers (Olsen and Sommers, 1982). Potassium (K%):It was estimated by the Flame photometer according to proposed by Haynes (1980). The weight of cabbage head: It was measured by taking the weights of cabbage head for the plants of experimental unit and divided it by the plants number of experimental unit. The diameter of cabbage head: It was measured from each of the experimental units using the Vernier, from the widest area in the head and the average was calculated.

Results and Discussion

Plant Stem Diameter

Table (1) shows that the spraying treatment with amino acid (A2) was significantly excelled on the treatment A0 in the trait of plant stem diameter which amounted of (2.23 cm) for the treatment A2 and (2.03 cm) for the treatment A0. As for the effect of the humic fertilizer, the treatment H2 has excelled on the rest of the treatments where gave the highest plant stem diameter amounted of (2.23 cm), While the lowest plant stem diameter was at the treatment H0 which amounted of (2.03 cm). It is noted from the same table that the interaction of the fertilization treatment has led to obtaining an increase in the stem diameter where the treatment A2H2 gave the highest stem diameter amounted of 2.36 cm followed by treatment A2H1 which gave of (2.22 cm), while the treatment A0H0 gave the lowest stem diameter amounted of 1.97 cm.

Table 1: Effect of Spraying with Amino Acids and Fertilization with humic in the plant stem diameter of the cabbage head for the Season 2017-2018.

The weight of the cabbage head (g)				
Treatments	H_0	H_1	H_2	Average
A_0	1.97	1.98	2.13	2.03
A_1	2.01	2.13	2.21	2.12
A_2	2.12	2.22	2.36	2.23
Average	2.03	2.11	2.23	
LSD 0.05	A	0.098		
	H	0.098		
	For interaction	0.171		

The Number of Leaves

Table (2) shows that the spraying treatment with amino acid and humic fertilizer were significantly excelled on the number of leaves, where the Treatment A2 gave the highest number of leaves in the plant amounted of (29.22 leaf.plant.$^{-1}$), compared with the control treatment which gave the lowest values amounted of (21.78 leaf.plant.$^{-1}$) As for the effect of the humic fertilizer, the treatment H2 has excelled on the rest of the treatments where gave the highest number of leaves in the plant amounted of(31.67 leaf.plant.$^{-1}$), While the lowest plant stem diameter was at the treatment H0 which amounted of (20.67 leaf.plant.$^{-1}$), It is noted from the same table that the interaction of the fertilization treatment has led to obtaining an increase in the number of leaves in the plant where the treatment A2H2 gave the highest values amounted of (34.67 leaf.plant.$^{-1}$), while the treatment A0H0 gave the lowest number of leaves amounted of (16.33 leaf.plant.$^{-1}$).

Table 2: Effect of Spraying with Amino Acids and Fertilization with humic in the number of leaves of the cabbage head for the Season 2017-2018.

The weight of the cabbage head (g)				
Treatments	H_0	H_1	H_2	**Average**
A_0	16.33	22.00	27.00	21.78
A_1	22.67	21.67	33.33	25.89
A_2	23.00	30.00	34.67	29.22
Average	20.67	24.56	31.67	21.78
LSD 0.05	A	1.283		
	H	1.283		
	For interaction	2.223		

The Leaf Area

Table (3) shows that the treatment (A2) was significantly excelled on other treatment in the trait of leaf area (Dcm^2.plant^{-1}) which amounted of (24.52 Dcm^2.plant^{-1})Followed by the treatment A1 which it gave (19.25Dcm^2.plant^{-1}),While the lowest leaf area was at the treatment A0 which amounted of (16.75 Dcm^2.plant^{-1}), As for the effect of the humic fertilizer, the treatment H2 has excelled on the rest of the treatments where gave the highest leaf area amounted of (25.34 Dcm^2.plant^{-1}), While the lowest leaf area was at the treatment H0 which amounted of (15.53 Dcm^2.plant^{-1}). It is noted from the same table that the interaction of the fertilization treatment has led to obtaining an increase in the leaf aera in the plant where the treatment A2H2 gave the highest values amounted of (27.96 Dcm^2.plant^{-1}), while the treatment A0H0 gave the lowest number of leaves amounted of (12.36 Dcm^2.plant^{-1}).

Table 3: Effect of Spraying with Amino Acids and Fertilization with humic in the leaf aera of the cabbage head for the Season 2017-2018.

The weight of the cabbage head (g)				
Treatments	H_0	H_1	H_2	**Average**
A_0	12.36	15.96	21.94	16.75
A_1	14.55	17.09	26.11	19.25
A_2	19.67	25.94	27.96	24.52
Average	15.53	19.66	25.34	16.75
LSD 0.05	A	3.41		
	H	3.41		
	For interaction	5.901		

The relative content of chlorophyll in leaves (Spad unit)

The results showed that there is non-significantly different between the two treatment (A1, A2) in the relative content of chlorophyll in leaves (Spad unit)which amounted of (78.93 and 79.59) Spad unit respectively. As for the effect of the humic fertilizer, the treatment H1 has excelled on the rest of the treatments

where gave the highest the relative content of chlorophyll in leaves (Spad unit) amounted of (79.31 Spad unit), followed by the treatment H2 which it gave (78.91 Spad unit), While the lowest value was at the treatment H0 which amounted of (76.41Spad unit). It is noted from the same table that the interaction of the fertilization treatment has led to obtaining an increase in the stem diameter where the treatment A1H1 gave the highest the relative content of chlorophyll in leaves amounted of (80.43 Spad unit), while the treatment A0H0 gave the lowest the lowest value amounted of (73.93 Spad unit).

Table 4: Effect of Spraying with Amino Acids and Fertilization with humic the relative content of chlorophyll in leaves (Spad unit) of the cabbage head for the Season 2017-2018.

The weight of the cabbage head (g)				
Treatments	**H_0**	**H_1**	**H_2**	**Average**
A_0	73.93	76.33	78.07	76.11
A_1	76.50	80.43	79.87	78.93
A_2	78.80	79.97	80.00	79.59
Average	76.41	78.91	79.31	76.11
LSD 0.05	A	2.181		
	H	2.181		
	For interaction	3.777		

The percentage of Nitrogen in leaves (%)

Table (5) shows the positive and significantly effect for the fertilizers treatments to increase percentage of Nitrogen(%). where the treatment (A2) was significantly excelled on other treatment in the percentage of Nitrogen, which amounted of (2.154 %), compared with the control treatment which gave the lowest values amounted of (1.696%).As for the effect of the humic fertilizer, the treatment H2 has excelled on the rest of the treatments where gave the highest (2.066%), While the lowest the percentage of Nitrogen(%) was at the treatment H0 which amounted of (1.769 %), It is noted from the same table that the interaction of the fertilization treatment has led to obtaining an increase in the number of leaves in the plant where the treatment A2H2 gave the highest values amounted of (2.310%),while the treatment A0H0 gave the lowest number of leaves amounted of (1.557%).

Table 5: Effect of Spraying with Amino Acids and Fertilization with humic the percentage of Nitrogen (%) of the cabbage head for the Season 2017-2018.

The weight of the cabbage head (g)				
Treatments	**H_0**	**H_1**	**H_2**	**Average**
A_0	1.557	1.673	1.857	1.696
A_1	1.740	1.893	2.030	1.888
A_2	2.010	2.143	2.310	2.154
Average	1.769	1.903	2.066	1.696
LSD 0.05	A	0.041		
	H	0.041		
	For interaction	0.071		

The percentage of phosphorus in leaves (%)

Table (6) shows that the spraying treatment with amino acid and humic fertilizer were significantly excelled on the percentage of phosphorus (%), where the treatment (A2) was significantly excelled which (0.604%), compared with the control treatment which gave the values amounted of (0.500%), In the fertilization treatments, the percentage of phosphorus differed between all treatments, which showed superiority on the treatment H0 (without fertilizer), which gave the lowest percentage amounted of (0.511%), while the treatment H2 was characterized by giving it the highest percentage of phosphorus amounted of (0.603%). The interaction of the fertilization treatment has significantly effect on The percentage of phosphorus (%), where the treatment A2H2 gave the highest values amounted of (0.663%), while the treatment A0H0 gave the lowest number of leaves amounted of (0.663 %).

Table 6: Effect of Spraying with Amino Acids and Fertilization with humic the percentage of phosphorus (%) of the cabbage head for the Season 2017-2018.

The weight of the cabbage head (g)				
Treatments	**H_0**	**H_1**	**H_2**	**Average**
A_0	0.447	0.490	0.550	0.500
A_1	0.560	0.590	0.597	0.582
A_2	0.527	0.623	0.663	0.604
Average	0.511	0.568	0.603	0.500
LSD 0.05	A	0.019		
	H	0.019		
	For interaction	0.033		

Percentage of potassium in leaves (%)

Table (7) shows that the A2 treatment was significantly excelled on the other treatments in the increasing the percentage of potassium in the leaves which amounted to (2.37%) followed by A1 treatment which amounted of (2.15%). while the lowest percentage of potassium in the leaves was given by the A0 treatment which amounted of (1.99%). It is clear from the table that there are no significant differences between the fertilization treatments with used humic in the study in the percentage of potassium in the leaves, although the H2 treatment gave the highest percentage of potassium amounted of (2.24%) while the H0 treatment recorded the lowest percentage of potassium amounted of (2.07%). The results showed that the interaction between the fertilization and spraying treatments had a significantly affected, where the A2H2 treatment gave the highest percentage of potassium amounted to (2.51%), while the A0H0 treatment showed the lowest percentage of potassium amounted of 1.96%.

Table 7: Effect of Spraying with Amino Acids and Fertilization with humic in the Percentage of potassium in leaves (%) for the Season 2017-2018.

The diameter of cabbage head (cm)				
Treatments	**H_0**	**H_1**	**H_2**	**Average**
A_0	1.96	2.02	1.99	1.99
A_1	2.04	2.19	2.21	2.15
A_2	2.23	2.36	2.51	2.37
Average	2.07	2.19	2.24	
LSD 0.05	A	0.115		
	H	0.115		
	For interaction	0.200		

The weight of cabbage head (g)

Table 8 indicates that there are significant differences between the used amino acid spraying treatments, it was noted that the superiority of the A2 treatment in the trait of the head weight which amounted of (319.8 g), while the A0 treatment gave the lowest weight of the head amounted of (297.8 g). The table also showed that the treatment of fertilization with humic (H2) was significantly excelled in the weight of the head by giving it the highest weight amounted of (315.2 g). As for The lowest head weight was at H0 treatment which amounted of (294.5 g). The interaction treatments between the spraying treatments with amino acid and the humic fertilization showed its significant effect by excelling the A2H2 treatment, which gave the highest head weight amounted of 9340.6 g) while the A0H0 treatment recorded the lowest weight amounted of (291.5 g).

Table 8: Effect of Spraying with Amino Acids and Fertilization with humic in the weight of the cabbage head for the Season 2017-2018.

The weight of the cabbage head (g)				
Treatments	**H_0**	**H_1**	**H_2**	**Average**
A_0	291.5	297.4	304.7	297.8
A_1	293.9	299.2	300.4	297.9
A_2	298.2	320.5	340.6	319.8
Average	294.5	305.7	315.2	
LSD 0.05	A	12.84		
	H	12.84		
	For interaction	22.24		

The diameter of cabbage head (cm)

Table 9 shows significant differences between the spraying treatments with amino acid in the diameter of cabbage head, where the A2 treatment was significantly excelled on all treatments by giving it the highest the diameter for head amounted of (12.77 cm) while the A0 treatment gave the lowest diameter amounted of (10.71 cm). As for the fertilization treatments with humic, the H2 treatment gave the highest diameter of head amounted of (12.09 cm) while the lowest diameter was found in the H0 treatment (without fertilization) which amounted of (11.16), the results of the interaction between the spraying treatments with amino acids and fertilization with humic, the interaction treatment (A2H2) was excelled, which gave an diameter amounted of (13.31 cm), while the interaction treatments (A0H0) gave the lowest diameter of head amounted of (10.58 cm).

Table 9: Effect of Spraying with Amino Acids and Fertilization with humic in the diameter of cabbage head (cm) for the Season 2017-2018.

The diameter of cabbage head (cm)				
Treatments	**H_0**	**H_1**	**H_2**	**Average**
A_0	10.58	1.62	10.93	10.71
A_1	10.80	11.27	12.03	11.37
A_2	12.08	12.92	13.31	12.77
Average	11.16	11.60	12.09	
LSD 0.05	A	0.315		
	H	0.315		
	For interaction	0.546		

The above results show that the amino acid and the humic acid spraying treatments were excelled in most of the measured vegetative growth Indicators for cabbage plant, especially the A2H2 treatment (Spraying the amino acids with a concentration of (4 $ml.L^{-1}$) + adding Humic acid with concentration of (3 $ml.seddling^{-1}$), which is symbolized by (A2 H2)). This may be due to their role in improving the traits of vegetative growth as shown in Table (2) and leaf area as shown in Table (3) through increasing the availability of many nutrient elements, especially organic nitrogen, which have an important role in stimulating the physiological and biological processes within the plant, such as increasing the formation of proteins and nucleic acids and increase the composition of DNA and RNA necessary for the division of cells as well as their role in the carbon fixation and provide the energy necessary to create new cells, which increases the growth and development of the plant as well as stimulate the cells division, their elongation and increase their size, which lead to an increase in the number of leaves and their area, which reflects positively on the growth of vegetative growth (Arnout, 2001; Taiz and Zeiger, 2006). These results agree with (Devlin and Witham, 2001) found that plants supplied with abundant amounts of nitrogen tend to increase the number of leaf cells and increase their size, thus increase the leaf area, they also agree with (Fajinmi and Odbode, 2009; Al-Mharib, 2014). The results of tables (5, 6, 7) showed that spraying with amino acids and fertilization with humic had an effect on increasing the percentage of nitrogen, phosphorus and potassium elements and may be due to their content of the macro and micronutrient elements and plant hormones, which are absorbed directly when sprayed on the leaves. The

absorbed nitrogen then indirectly work on increases the speed of absorption and transfer of the rest of the elements by entering the formation of chlorophyll pigments as well as the formation of amino acids that entering in the formation of green plastids, which is positively reflected in increasing the chlorophyll content in the leaves as shown in Table (4), and then increase the carbon fixation process and building proteins, which are very important in stimulating the growth of the plant, increase its efficiency to absorb and accumulate the rest of the elements, thus increase their percentage in the plant, so the growth and plant activity will increase (Yasin, 2001; Kandil and Gad, 2009). These results agree with (Al-Khafaji, 2010; EL-Awadi *et al*., 2011). As well as the role of humic in the provision of phosphorus through the formation of chelated compounds that protect the phosphorus from the fixation and to prolong the period of its availability throughout the plant growth. Humic acid also increases the potassium permeability for the plant through increasing the permeability of living cell membranes, which increases potassium absorption (Malcolm, Vaughan, 1979; Taiz and Zeiger, 2006). These results agrees with (Salman *et al*., 2005; Abdel-Mawgoud *et al*., 2007; Verlinden *et al*., 2009) who confirmed the role of hemic acid in increasing the percentage of nitrogen, phosphorus and potassium in plants. As well as the role of potassium in the transferring the products of carbon fixation to the places of storage, thus stimulating the formation of flower stalks. The increase in the weight and diameter of the flower stalks as shown in Table (8, 9) may be due to cell expansion and increase its size due to the accumulation of potassium in cells leading to the stabilization the pH of cytoplasm, as well as the conservation and regulation of Osmotic pressure of cells leading to increased cell size (Marschner, 1997; Patrick *et al*., 2001).

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