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Effect of Nitrogen and Organic Fertilization on Growth and Yield of Two Cabbage Varieties *Brassica oleracae* Var. Capitata

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Abstract. The experiment was conducted at the vegetable field of Department of Horticulture and Landscape / College of Agriculture and Forestry / University of Mosul during the growing season 2019/2020 to study the effect of three factors: the first, two varieties of cabbage (Copenhagen market and Cherman), the second, three levels of nitrogen fertilizer (0, 200 and 400 kg. ha^{-1}), and the third: two concentrations of humic acid (0 and 6 ml. L^{-1}), by using the split-split plots system within randomized complete blocks design RCBD with three replications. The results were as follows(please discussion the first factor and 2nd and 3rd and interaction between two and three factors: The treatment of Copenhagen market cultivar and fertilizer 400 kg N. ha^{-1} with humic 6 ml.L^{-1} were significantly superior in all studied traits represented in head circumference 58.50 cm and the number of unwound outer leaves 20.83 leaves. $Plant^{-1}$, the number of inner-coiled 35.00 leaves. $Plant^{-1}$, stem weight, stem length and total head weight 2918 g, and marketing head weight 1774 g, total and marketable yield of heads 121.581 and 73.901 t. ha^{-1}, respectively, and percentage of dry matter in leaves 10.03% compared to the other treatments.

Keywords: nitrogen, humic, fertilizer, cabbage

Introduction

Cabbage (*Brassica oleracae* var. Capitata) is a winter leafy vegetable crop in Iraq and belongs to the Brassicaceae family; it is cultivated to obtain the heads resulting from wrapping the leaves around the enlarged terminal bud, the leaves are used either fresh or in making pickles or salads (Matlob*etal.*, 1989). It is considered one of the important vegetable crops in food,each 100 gm of fresh leaves contains 88.8-93.9% moisture, 6.1-11.2% dry matter, 3-5.4% carbohydrates, 1-2% proteins, 0.2% fats and 0.05% thiamine (Borras *et al.*, 2011). The growth of the plant is affected by several factors, the most important of which is the variety due to the influence of genetic factors and their response to different environmental conditions in the regions of the world. Masarirambi (2011) found that there were significant differences between 10 cultivars of Havana, where Green Coronet gave the highest values in head height cm and number of leaves leaf $plant^{-1}$ has a head diameter cm, and the K-K-Cross cultivar has a total head yield. Hassan and Suleiman (2012) observed that Atlas-70 variety gave higher value in head height and head diameter, but Autumn-60 variety superior in number of leaves per plant.Abdl-Rahman and Ramadan (2015) mentioned that the Copenhagen market and Sakata cultivar was significantly superior in head length compared to Blue Jays, and the Sakata cultivar was gave the lowest nitrate content in leaves, and no significant difference was observed between the cultivars in head diameter. Saeed and Abdel-Rahman (2016) mentioned in their study of three varieties of Copenhagen market, Sakata and Blue Jays that the variety Sakata was significantly superior in the marketable plant yield, while no significant effect was observed between the varieties in head length, head diameter and the total yield of the plant. Manea (2017) found that the Copenhagen market cultivar was significantly superior in head diameter, total head weight, marketable head weight, and the yield of marketable heads and the percentage of dry matter in leaves compared to Ramso cultivar. Al-Khikani (2019) noticed that the green Globe cultivar of cabbage was significantly superior in stem length, stem diameter, and the number of outer leaves (uncirculated) per plant,

number of inner leaves (coiled) per plant, head diameter, head length, total head weight, market head weight, total head yield and the marketing yield of heads compared to Roza cultivar, which was significantly superior in the percentage of dry matter in leaves .

Nitrogen is one of the most nutrients that plants need, especially leafy ones, after carbon, hydrogen and oxygen, but the plant's percentage ranges between 2-5% of the dry matter and its protein percentage is 16%, and its importance for plants is no less than the importance of water necessary for growth and plant efficacy (Al-Musli, 2013).Nitrogen enters the formation of nucleic acids, RNA and DNA, energy compounds ATP, NADPH2, NADH2, and amino acids to form proteins, it also enters as a basic component in protoplasm and cell membranes and enters in the formation of enzymes and some vitamins such as vitamins B and H (Abu Dhahi and Younis, 1988). Manea (2017) reported that a urea 46% N fertilizer was sprayed at a concentration of 1 g L^{-1}, humic acid and Maxinim liquid organic fertilizer at a concentration of 5 ml L^{-1} of cabbage plants caused significant superiority in head diameter, yield of marketable heads and the percentage of dry matter in leaves compared to the control treatment. Mohammed and Manea (2018) found that fertilization of cabbage plants at a rate of 300 t ha^{-1} NPK fertilizer caused a significant increase in stem length, stem diameter, number of coiled leaves per plant, head diameter and market head weight compared to the control treatment. Abdul Rasoul and Majeed (2020) found that the addition of urea fertilizer 46% N with an amount of 146 kg ha^{-1} for cabbage plants of Globe Master cultivar, by making grooves next the plants at a depth of 5 cm, caused a significant increase in head weight, number of outer leaves (uncirculated) and the total yield of heads.

The organic matter improves the biological, physical and chemical properties of the soil, supplies the soil with nutrients, improves the porosity of the soil, regulates the movement of water, air and gas exchange, increases the soil's ability to hold water and increases the cation exchange capacity (CEC) (Al-Hadithi, 2002). It lowers the soil pH by releasing chelated compounds from organic acids and CO_2 that lower the pH of the soil and affect the solubility of nutrients and their ease of absorption by plant roots (Lehmann and Kleber, 2015). The addition of various organic materials increases the amount of N and P available to the plant and increases the efficiency of the roots to absorb water and nutrients dissolved in the soil (Al-Nuaimi, 1999).The organic matter causes an increase in the biological activity of the soil, such as the enzymatic activities such as the enzyme urease, which is a guide to the microbial activity in the soil, which converts urea to ammonium carbonate and the enzyme phosphatase and invertase that decompose the organic matter and accumulate organic carbon in the soil (Jingjing *et al*., 2015). Abbas and Hammad (2016) found that the addition of humic acid at a concentration of 200 mg L^{-1} caused a significant increase in the number of inner leaves (coiled), total head weight and the total head yield as measured at 0 and 100 mg L^{-1} concentration. Al-Zaidi and Al-Ubaidi (2017) observed that spraying the red cabbage plants of Raissa F1 variety with the organic nutrient Vegeamino containing 24% free amino acids, 4.77% organic nitrogen and 0.04% nitrogen in the form of ammonia at a concentration of 1 ml L^{-1} caused a significant increase in head height, head diameter, head weight, number of outer leaves (uncoiled) and the total yield of heads compared to the comparison treatment. Al-Shammari *et al*. (2018) reported that spraying plants of three cultivars of cabbage with Grow More at a concentration of 0, 0.05, 1, and 1.5 ml L^{-1} contains N (ammonia) 3.9%, nitrate 5.9%, urea 10.2%, phosphorous 20%, potassium 20%, calcium 0.05%, magnesium 0.1% and sulfur 0.2% that the concentration is 1.5 ml L^{-1} caused a significant increase in the number of outer (unwrapped) leaves, concentration 1 ml L^{-1} caused a significant increase in head length, head diameter, total head weight, marketing head weight, total yield of heads and the percentage of dry matter in the inner leaves. AL-Bayati (2019) noted that the addition of humic acid at a concentration of 5 ml L^{-1} of soil for cauliflower plants White Cloud variety caused a significant increase in plant height, number of leaves per plant, curd diameter, curd weight, total yield of curds and percentage of dry matter in curds, as measured by the addition of urea and liquid organic fertilizer Higroamin and Maxinim. This study aims to find the appropriate variety of cabbage for the conditions of Nineveh Governorate, the appropriate level of nitrogen fertilization (urea), and the best concentration of humic acid for addition to the soil.

Materials and Methods

The experiment was carried out at the vegetable field/Department of Horticulture and Landscaping/ College of Agriculture and Forestry/University of Mosul during the growing season 2019-2020, to study the effect of nitrogen and organic fertilization on growth and yield of two cabbage varieties *Brassica oleracae* var. Capitata,

Copenhagen market and Cherman. The soil of the field was prepared by plowing, smoothing and leveling it with a triple-turn plow. The experimental land was cut into three replicates with a width of 1.2 m, leaving a distance of 1 m between one bench and another.Cabbage seeds of the two cultivars were planted in seedling trays using peat moss on 26/8/2019, and after the seedlings reached the stage of 2-3 true leaves, they were transferred to the field on 6/10/2019 and planted on the terraces with two lines on each terrace, the distance between them is 0.6 m between one seedling and another. 0.4 m, and two weeks later a grafting operation was performed for the seedlings that failed. The number of plants in the experimental unit is 10 plants. Follow the drip irrigation system in the experiment to study the following factors:

The first factor is two varieties of cabbage: which was Copenhagen market and Cherman. The second factor wasThree levels of nitrogen fertilizer (urea 46% N): 0 (comparison) , 200 kg ha^{-1}. and 400 kg ha^{-1}.

The nitrogen fertilizer was added in two batches to the soil, the first one after a month of sowing and the second one a month after the first. The third factor was the addition of humic acid (ticamine max), which contains, without humic acid and Humic acid at a concentration of 6 ml L^{-1}. It was added to the soil next to the plants and in two batches after a month of transplanting, in an amount of 100 ml for each plant, and a month after the first, in an amount of 200 ml for each plant.

The Split-Split plots system was used with in RCBD design with three replications. The cultivar factor was placed in the main plots, the nitrogen fertilizer factor in the split plots, and the humic factor in the sub-sub plots twice and three timesrepeaters. After the plants reached the stage of harvesting and on date 25/1/2020, heads were harvested for both varieties and for all transactions, and the following characteristics were taken: Head circumference (cm), Number of unwound outer leaves (leaf $plant^{-1}$) , Number of coiled inner leaves (leaf $plant^{-1}$),

Stem weight (g), Stem length (cm) , Total head weight (kg), Marketable head weight (kg). Three plants were taken from each experimental unit (treatment) for the above traits and the average was extracted , total yield of heads (t ha^{-1}) , and yield of marketable heads (t ha^{-1}).

All plants in the experimental unit were weighed to calculate the above two traits in a proportional manner. Percentage of dry matter in the inner leaves. After recording the data, it was analyzed using the SAS system, 2000, according to the used design, under the level of 0.05 (Al-Rawi and Khalaf Allah, 2000).

Results and discussion

The results of table (1) showed that the Copenhagen market cultivar significantly outperformed and gave the highest values in head circumference, weight and stem length 47.50 cm, 82.16 g and 9.27 cm, respectively, compared to Cherman cultivar, and it gave the most number of unrolled outer leaves 16.44 leaf $plant^{-1}$, butCherman cultivar gave the most number of inner coiled leaves 29.88 leaf $plant^{-1}$, significantly different from Copenhagen market.

The addition of of nitrogen fertilizer at 400 kg ha^{-1} caused a significant increase in head circumference, number of outer uncoiled leaves, number of inner curled leaves, and weight and length of stems 48.83 cm and 17.79 leaf $plant^{-1}$ and 33.20 leaf $plant^{-1}$, 96.37 g and 9.50 cm, respectively, with significant differences with the two treatments of 200 kg ha^{-1} and the comparison which gave the lowest values for the above traits. Humic acid at 6 ml L^{-1} caused a significant increase in head circumference,number of outer uncoiled leaves, number of inner curled leaves, weight and length of stems 43.88 cm and 15.77 leaf $plant^{-1}$, 30.63 leaf $plant^{-1}$, 78.25 g and 8.55 cm, respectively, compared to without humic treatment.

Table 1. Effect of study factors on vegetative characterictics.

Variety	Head circumference (cm)	Nu. of unwrapped leaves (leaf $plant^{-1}$)	Nu. of wrapped leaves (leaf $plant^{-1}$)	Stem Weight (gm)	Stem length (cm)
Copenhagen market	47.50 a	16.44 a	29.00 b	82.16 a	9.27 a
Cherman	37.27 b	13.72 b	29.88 a	61.55 b	6.94 b
Nitrogen fertilizer: (kg ha^{-1}):					
0 (control)	35.91 c	12.20 c	26.08 c	48.66 c	6.62 c
200	42.41 b	15.25 b	29.04 b	70.54 b	8.20 b
400	48.83 a	17.79 a	33.20 a	96.37 a	9.50 a
Humic acid: (6 ml. L^{-1})					
Without humic	40.88 b	14.38 b	28.25 b	65.47 b	7.66 b
Humic	43.88 a	15.77 a	30.63 a	78.25 a	8.55 a

The average with same letter for each factor is non-significant according to Duncan's multiple range tests under level 0.05.

The results in table (2) indicated the interaction between the variety and the nitrogen fertilizer that the treatment of the interaction of the variety Copenhagen market with 400 kg ha^{-1} nitrogen fertilizer gave the highest significant values in head circumference 56.58 cm and number of unwound outer leaves 19.41 leaf $plant^{-1}$, number of inner coiled leaves 33.41 leaf $plant^{-1}$, stem weight 116.33 gm, stem length 11.16 cm, and significantly different with all treatments.

Result from the interaction between variety and humic acid that the variety Copenhagen market with humic 6 ml L^{-1} gave the highest significant values in head circumference 49.61 cm and the number of outer leaves 7.27 leaf $plant^{-1}$, stem weight 91.27 gm., and stem length 9.94 cm, significantly different with all treatments, while Cherman cultivar with humic acid 6 ml L^{-1} had gave the highest significant value in the number of inner coiled leaves 31.05 $leafplant^{-1}$ and significantly different with all treatments, and the lowest values of these traits were in the treatment of Cherman variety with without addition of humic except for the characteristic of the number of inner leaves, where it was noted that the lowest value was in the treatment of Copenhagen market with no addition of humic.

The interaction between nitrogen and humic fertilizer, the treatment of 400 kg ha^{-1} with the addition of humic 6 ml L^{-1} gave the highest significant values in head circumference, number of outer unrolled leaves, number of inner curled leaves, stem weight and stem length, which were 50.08 cm and 18.91 leaf $plant^{-1}$ and 34.91 leaf $plant^{-1}$, 106.50 g and 10.08 cm, respectively, and they differed significantly with all treatments, and the lowest values for these traits were in the comparison treatment with without humic.

Table 2. Effect of double interaction between the study factors on vegetative charactericts.

Interaction between variety and nitrogen fertilizer:

Variety	Nitrogen fertilizer (kg ha^{-1})	Head circumference (cm)	Nu. of unwrapped leaves (leaf $plant^{-1}$)	Nu. of wrapped leaves (leaf $plant^{-1}$)	Stem Weight (gm)	Stem length (cm)
	0	39.16 d	13.00 d	25.16 e	49.41 d	7.08 d
Copenhagen	200	46.75 b	16.91 b	28.41 c	80.75 b	9.58 b
market	400	56.58 a	19.41 a	33.41 a	116.33 a	11.16 a
	0	32.66 e	11.41 e	27.00 d	47.91 d	6.16 e
Cherman	200	38.08 d	13.58 d	29.66 b	60.33 c	6.83 d
	400	41.08 c	16.16 c	33.00 a	76.41 b	7.83 c

Interaction between variety and humic acid (6 ml. L^{-1}):

Variety	Humic acid					
Copenhagen market	Without humic	45.38 b	15.61 b	27.77 d	73.05 b	8.61 b
	Humic	49.61 a	17.27 a	30.22 b	91.27 a	9.94 a
Cherman	Without humic	36.38 d	13.16 d	28.72 c	57.88 c	6.72 d
	Humic	38.16 c	14.27 c	31.05 a	65.22 cb	7.16 c

Interaction between nitrogen fertilizer (kg ha^{-1}) and humic acid (6 ml. L^{-1}):

Nitrogen fertilizer (Kg ha^{-1})	Humic acid (ml L^{-1})					
	Without humic	34.08 f	11.66 f	24.91 f	42.00 e	6.25 e
0 (control)	Humic	37.75 e	12.75 e	27.25 e	55.33 d	7.00 d
	Without humic	41.00 d	14.83 d	28.33 d	68.16 c	7.83 c
200	Humic	43.83 c	15.66 c	29.75 c	72.91 c	8.58 b
	Without humic	47.58 b	16.66 b	31.50 b	86.25 b	8.91 b
400	Humic	50.08 a	18.91 a	34.91 a	106.50 a	10.08 a

The average with same letter for each factor is non-significant according to Duncan's multiple range tests under level 0.05.

The interaction betweenthe triple factors results table (3) that the treatment of Copenhagen market with 400 kg ha^{-1} nitrogen fertilizer with addition of humic 6 ml L^{-1} gave the highest significant values in head circumference, number of outer uncoiled leaves, number of inner curled leaves, stem weight, stem length 58.50 cm and 20.83 leaf $plant^{-1}$, 35.00 leaf $plant^{-1}$, stem weight 129.66 gm and 12.00 cm, respectively, and they differed significantly with all treatments.

The results from table (4) show that the Copenhagen market cultivar gave the highest

significant values in the total and marketable head weight, total and marketing yield of the heads, amounting to 1838 gm, 1058 gm and 76.591 t ha^{-1} and 44.103 t ha^{-1} respectively, compared to Cherman cultivar which gave the highest significant value in the percentage of dry matter in leaves 9.00%.

Table 3. Effect of third interaction between study factors on vegetative characterictics.

Variety	Nitrogen fertilizer (kg ha^{-1})	Humic acid (6 ml l^{-1})	Head circumference (cm)	Nu. of unwrapped leaves (leaf $plant^{-1}$)	Nu. of wrapped leaves (leaf $plant^{-1}$)	Stem Weight (gm)	Stem length (cm)
Copenhagen market	0 (control)	Without humic	36.50 f	12.33 fg	24.00 i	39.16 g	6.50 gh
		Humic	41.83 e	13.66 e	26.33 gh	59.66 ef	7.66 de
	200	Without humic	45.00 d	16.50 c	27.50 fg	77.00 cd	9.00 c
		Humic	48.50 c	17.33 bc	29.33 de	84.50 c	10.16 b
	400	Without humic	54.66 b	18.00 b	31.83 b	103.00 b	10.33 b
		Humic	58.50 a	20.83 a	35.00 a	129.66 a	12.00 a
Cherman	0 (control)	Without humic	31.66 g	11.00 h	25.83 h	44.83 g	6.00 h
		Humic	33.66 g	11.83 gh	28.16 ef	51.00 fg	6.33 gh
	200	Without humic	37.00 f	13.16 ef	29.16 de	59.33 ef	6.66 gh
		Humic	39.16 ef	14.00 e	30.16 cd	61.33 ef	7.00 fg
	400	Without humic	40.50 e	15.33 d	31.16 bc	69.50 de	7.50 ef

The average with same letter for each factor is non-significant according to Duncan's multiple range tests under level 0.05.

In the effect of nitrogen fertilizer, it is noted that the level 400 kg ha^{-1} gave the highest significant values in total head weight of 1864 gm, marketing head weight of 1175 gm, total head yield 77.661 t ha^{-1}, the marketing yield of the heads is 48.940 t ha^{-1} and the percentage of dry matter in leaves 9.73% compared to the other treatments, and the lowest values for these traits were in the comparison treatment.

The humic treatment at 6 ml L^{-1} gave the highest significant values in the characteristics of the studied yield, represented total and marketing head weight, the total and marketing yield of the heads, and the percentage of dry matter in the leaves, which amounted to 1527 gm, 925 gm, 63.626, 38.534 t ha^{-1} and 9.17%, respectively, compared to the treatment without humic.

Table 4. Effect of study factors on yield characterictics.

Variety	Total plant head weight (gm)	Marketable plant head weight (gm)	Total head yield (t ha^{-1})	Marketable head yield (t ha^{-1})	Leaves dry matter%
Copenhagen market	1838 a	1058 a	76.591 a	44.103 a	8.67 b
Cherman	935 b	590 b	38.953 b	24.578 b	9.00 a
Nitrogen fertilizer: (kg. ha^{-1})					
0(control)	968 c	522 c	40.332 c	21.731 c	7.83 c
200	1328 b	776 b	55.321 b	32.350 b	8.95 b
400	1864 a	1175 a	77.661 a	48.940 a	9.73 a
Humic acid: (6 ml. L^{-1})					
Without humic	1246 b	724 b	51.918 b	30.147 b	8.50 b
Humic	1527 a	925 a	63.626 a	38.534 a	9.17 a

The average with same letter for each factor is non-significant according to Duncan's multiple range tests under level 0.05.

The results in table (5) in the interaction between the variety and nitrogen fertilizer that the Copenhagen market variety with the fertilizer 400 kg N ha^{-1} gave the highest significant values in the total head weight of 2604 gm, weight of the marketing head 1601 gm, total and marketing yield of heads 108.498 and 66.693 t ha^{-1} with significant differences with the rest of the treatments, and the lowest value of these traits was found in the treatment of the variety Cherman with the comparison, while the treatment of the cultivar Cherman with 400 kg N ha^{-1} gave the highest significant value in the percentage of dry matter in leaves 9.87%, and the lowest value for

this trait was treated with Copenhagen market cultivar with comparison.

The interaction of Copenhagen market with humic 6 ml L^{-1} had gave the highest significant values in the total and marketing head weight and the total and marketing yield of heads 2072 gm, 1221 gm, 86.341 and 50.878 t ha^{-1}, respectively, compared to the other treatments, and the lowest values for these traits were found in the treatment of Cherman cultivar with without humic, while the treatment of Cherman cultivar with humic 6 ml L^{-1} gave the highest significant value in the dry matter percentage in leaves 9.87%.

In the interaction between nitrogen and humic fertilizers, a treatment of 400 kg N ha^{-1} with 6 ml L^{-1}humic gave the highest significant values in yield characteristics represented in total and marketable head weight, total and marketable yield of heads and the percentage of dry matter in leaves 2045 gm, 1281 gm, 85.193 and 53,381 t ha^{-1} and 10.03%, respectively, with significant differences with all treatments, and the lowest values for these traits were found in the comparison treatment with without humic.

Table 5. Effect of double interaction between the study factors on yield charactericts.

Interaction between variety and nitrogen fertilizer:

Variety	Nitrogen fertilizer (kg ha^{-1})	Total plant head weight (gm)	Marketable plant head weight (gm)	Total head yield (t ha^{-1})	Marketable head yield (t ha^{-1})	Leave dry matter%
	0 (control)	1207 c	610 d	50.297 c	25.437 d	7.60 d
Copenhagen	200	1703 b	964 b	70.977 b	40.179 b	8.83 b
market	400	2604 a	1601 a	108.498 a	66.693 a	9.60 ab
	0 (control)	729 f	433 e	30.367 f	18.027 e	8.08 c
Cherman	200	952 e	588 d	39.666 e	24.520 d	9.08 ab
	400	1124 d	748 c	46.825 d	31.187 c	9.87 a

Interaction between variety and humic acid (6 ml L^{-1}):

Variety	Humic acid					
Copenhagen	Without humic	1604 b	896 b	66.841 b	37.327 b	8.27 c
market	Humic	2072 a	1221 a	86.341 a	50.878 a	9.07 b
	Without humic	888 c	551 c	36.994 c	22.967 c	8.73 c
Cherman	Humic	982 c	629 c	40.911 c	26.189 c	9.28 a

Interaction between nitrogen (kg. ha^{-1}) and humic acid (6 ml L^{-1}):

Nitrogen fertilizer	Humic acid					
0	Without humic	799 e	420 e	33.312 e	17.520 e	7.40 d
(control)	Humic	1136 d	623 d	47 353 d	25.944 d	8.27 c
	Without humic	1255 cd	682 d	52.311 cd	28.422 d	8.68 c
200	Humic	1400 c	871 c	58.332 c	36.277 c	9.23 b
	Without humic	1683 b	1068 b	70.130 b	44.499 b	9.44 b
400	Humic	2045 a	1281 a	85.193 a	53.381 a	10.03 a

The average with same letter for each factor is non-significant according to Duncan's multiple range tests under level 0.05.

In the triple interaction of the studied factors, it is noted from the results of table (6) that the treatment of Copenhagen market variety with fertilizer is 400 kg N ha^{-1} with 6 ml L^{-1}humic gave the highest significant values in the total head weight 2918 gm, marketing head weight 1774 gm, total and marketing head weight 121.581 and 73.901 t ha^{-1}, respectively and with significant differences with all treatments, and the lowest values of these traits were found in the Cherman cultivar treatment in comparison with without humic. Moreover, the two treatments gave Copenhagen market and Cherman cultivars with 400 kg ha^{-1} with humic 6 ml L^{-1} had given the highest value in the dry matter percentage in leaves 10.03 and 10.04%, respectively, the lowest value for this trait was found in Copenhagen market cultivar treatment in comparison with without humic.

The superiority of the Copenhagen market cultivar in the characteristics of head circumference, stem weight, stem length, total and marketing head weight, the total yield of heads and the marketing yield of heads, giving it the least number of unwound outer leaves, and the superiority of the Cherman variety in the number of wrapped inner leaves and the percentage of dry matter in leaves to the variation of genetic traits Between the two types, and this is consistent with what was mentioned by Manea (2017) and Al-Khiykani (2019) that there are differences between the types of cabbage in these characteristics. The moral superiority of nitrogen fertilization has been re-published to the effect

that the nitrogen element works to increase the stimulation and formation of morphophyll, amino acids and coenzymes, the activation of vital processes in the plant, in addition to the entry of nitrogen into the composition of amino acids in the plant body (Al-Sahaf, 1989).Nitrogen enters into us some growth regulators, such as auxins and gibberellins, which encourage cell division and cell elongation, and thus increase vegetative growth (Sharaki and Khader, 1985 and Al Rais, 1987). The significant increase when adding humic acid may be due to its role in increasing soil fertility with increasing soil water retention and thus increasing the availability of nutrients to the plant (Lee and Bartlette, 1976).It may be due to the role of humic acid in increasing the physiological activities of the plant and its reflection on the growth of the plant and its nutrient content, as well as the role of humic acid as a cofactor for the movement of enzymes in the plant, which plays an important role in respiration and photosynthesis encouraging the effective formation of nucleic acids and plant hormones (Goatley and Schmidt, 1990), or perhaps the increase in the characteristics is due to the role of humic acid in increasing the percentage of elements absorbed by the plant such as nitrogen, phosphorous and potassium in the decomposition of organic matter in the soil and then providing the important elements easily absorbed by the roots of plants (Al-Nuaimi, 1999).

Table 6. Effect of third interaction between study factors on yield characteristic.

Variety	Nitrogen fertilizer (kg ha^{-1})	Humic acid (6 ml L^{-1})	Total plant head weight (gm)	Marketable plant head weight (gm)	Total head yield (t ha^{-1})	Marketable head yield (t ha^{-1})	Leave dry matter%
Copenhagen market	0 (control)	Without humic	951 fg	464 fg	39.624 fg	19.332 fg	7.02 e
		Humic	1463 d	757 d	60.971 d	31.541 d	8.17 d
	200	Without humic	1572 d	796 d	65.484 d	33.165 d	8.63 d
		Humic	1835 c	1133 c	76.470 c	47.193 c	9.03 c
	400	Without humic	2290 b	1428 b	95.415 b	59.485 b	9.18 bc
		Humic	2918 a	1774 a	121.581 a	73.901 a	10.03 a
Cherman	0 (control)	Without humic	648 h	377 g	27.000 h	15.708 g	7.78 de
		Humic	810 gh	488 fg	33.735 gh	20.347 fg	8.37 d
	200	Without humic	939 fg	568 ef	39.138 fg	23.679 ef	8.73 d
		Humic	965 fg	609 ef	40.193 fg	25.360 ef	9.43 b
	400	Without humic	1076 ef	708 de	44.846 ef	29.513 de	9.70 b
		Humic	1171 e	789 d	48.804 e	32.860 d	10.04 a

The average with same letter for each factor is non-significant according to Duncan's multiple range tests under level 0.05.

Conclusions

The Copenhagen market cultivar, nitrogen fertilization at a level 400 kg ha^{-1}, addition of humic acid at a concentration 6 ml L^{-1} and the interaction between them caused a significant increase in all studied traits

References

[1] Abbas, N.A.H. and H.S.Hammad.(2016) The effect of vernalization, gibberellinsand fertilization by humic acid on the growth and production of cabbage (*Brassica oleracea* var. capitata). Diyala Journal of Agricultural Sciences, 8 (2): 255-268.(In Aarbic)

[2] Abdl-Rahman, H.B. and H.F. Ramadan. (2015) Effect of Organic and ChemicalFertilizationon Growth and Yield of Three Cabbage (*Brassica oleracea* var. capitata) Varieties. Tikrit Journal for Agricultural Sciences, 15 (3): 38-49. (In Arabic)

[3] Abdul Rasoul, Q. and R. R. H. Majeed. (2020) Effect of adding mineral fertilizers, soil conditioners and methods of addition in reducing ammonia volatility on growth and yield of *Brassica oleracea* var. capitata. Diyala Journal of Agricultural Sciences, 12 Special Issue: 50-64.(In Arabic)

[4] Abu-Dahi Y. M. and M. A. AL-Younis (1988) Plant Nutrition Evidence. Ministry of Higher Education and Science Research, Baghdad University, Iraq.

[5] AL-Bayati, H.J.M. (2019) Growth and Yield of Cauliflower as Affected by Boron and Fertilizer Type. International Journal of Agricultural Statistical Sciences, 5 (2): 595-599.

[6] Al-Hadithi, B.A. J. A. H. (2002) Enzymatic activity of *Trichodermaharzianum* insoil in growth and yield of tomato. PhD thesis, College of Agriculture, University of Baghdad, Iraq. (In Arabic)

[7] Al-Khikani, S. A. K. M. (2019) Effect of intercropping, organic matter and chemical

fertilizer on growth and yield of two *Brassica oleracea* var. Capita. Master Thesis, College of Agriculture, Al-Qasim Green University, Iraq. (In Arabic)

[8] Al-Musli, M. A. (2013) Soil Fertility and Plant Nutrition. Dijla Dar. First Edition, Jordan. (In Arabic)

[9] AL-Nuaimi S. A. (1999) Soil Fertility and Fertilizers. Second Edition, Ministry ofHigher Education and Science Research, Dar of Printed and Publication, Mosul University, Iraq. (In Arabic)

[10] Al-Rais, A. H. J. (1987) Pant Nutrition. Part one, aspects of plant nutrition. College of Agriculture, University of Baghdad, Ministry of Higher Education and Scientific Research, Iraq.

[11] AL-Rawi, K. H. M. and A. A. M. Khalaf Allah (2000) Design and Analysis of Agricultural Experiment. Mosul University. Ministry of Higher Education and Scientific Research. National Library. Iraq.(In Arabic)

[12] AL-Sahaf F. H. (1989) Applied Plant Nutrition. Ministry of Higher Education and Science Research, Higher Education Press, Iraq.

[13] Al-Shammari, A.M.A., N. A. H. Abbas., S. H. Muhammad and G. J. Hamdi. (2018) Effect of foliar feeding with Grow More on the growth and yield of three cultivars. The Third International Scientific Conference for Agricultural Sciences - Postgraduate Studies - University of Kirkuk. Special Issue: 392-398.

[14] AL-Zaidi, A.K.N. and R.M.AL-Ubaidy (2017) Effect of adding wheat peat and Yield of red cabbage. The Iraqi Journal of Agricultural Sciences, 48 (2):429-438.

[15] Borras, M., B.A.Turabi and I. Al-Basit. (2011) Production of vegetable crops. Theoretical part, Alajouni Press, Syria. (In Arabic)

[16] Goatley, J. M. and R.E. Schmidt. (1990) Anti-Senescence activity of chemical applied to Kentucky bluegrass. Journal of American Soc. Hort. Sciences, 115: 57-61.

[17] Hasan, M.R. and A.H.M. Solaiman. (2012) Efficacy of organic and inorganic fertilizer on the growth of (*Brassica oleracea*L.) Cabbage. International Journal of Agriculture and Crop Sciences, 4 (3): 128-138.

[18] Jingjing, S., Z. Mijia., Y. Xiaoqia., Z. Chi and Y. Jun. (2015) Microbial, urease activities and organic matter responses to nitrogen rate in cultivated soil. Open Biotechnology Journal, 9: 14-20.

[19] Lee, Y.S. and R.J. Bartlette. (1976) Stimulation of plant growth by humic substances. Soil Sciences of American Journal, 40: 876-879.

[20] Lehmann, J. and M. Kleber. (2015) The contentious nature of soil organic matter. Nature, 528 (60): 75-80.

[21] Manea, A.I. (2017) Fertilizer Type on Cabbage Growth and Yield. International Journal of Vegetable Science, 23 (6): 567-574.

[22] Masarirambi, M.T. (2011) Effect of plant spacing on the performance of hybrid cabbage (*Brassica oleracea* var. Capitata) varieties. B.J. Agri. Res., 36 (3): 495-506.

[23] Matlob A. N., E. Sultan and K. S. Abdul (1989) Vegetable Production. Part 1. Dar AL-Kutub Publication. Mosul University, Iraq. pp 680.(In Arabic)

[24] Mohammed, S.A.K. and A.I. Manea. (2018) Response of two Cabbage cultivars (*Brassica oleracea* var. Capitata) to organic and chemical fertilization. Euphrates Journal of Agriculture Sciences, 10 (3): 141-153.(In Arabic)

[25] Saeed, A.H. and H.B. Abdul-Rahman (2016) Effect of mulching and varieties on some growth charities and yield of cabbage *Brassica oleracea* var. capitata. Tikrit Journal for Agricultural Sciences, 16 (2): 99-105.

[26] SAS, (2017) Statistical Analysis System User's Guide. Version 15, Statistical Analysis System Institute, Cary Inc., North Carolina, USA.

[27] Sharaki,M. M. and A. A. Khader (1985) Plant Physiology (Translator). Cairo, Egypt: The Arab Publishing Group. Spraying with its extract and organic nutrient vegeamino on growth and Tikrit University Journal of Agricultural Sciences, 16 (2): 99-105.