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RESPONSE OF ENDIVIA (*CICHORIUM ENDIVIA*) PLANTS TO ORGANIC AND CHEMICAL FERTILIZATION

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Abstract

A field experiments was implemented at vegetables field, Department of Horticulture and Landscape, Faculty of Agricultural and forestry, Mosul University, Iraq, during winter season of 2012-2013 to investigate the effect of foliar spray with 3 conc. of nitrogen (0, 100, and 200 mg. L^{-1}), foliar spray of seaweed (Alga 600) by 3 conc. (0, 2, 3 ml. L^{-1}) and applied Humic acid to the soil by 4 conc. (0, 1, 2, 3 gr.L^{-1}). All the three fertilizer were applied four times, the first one after 15 days of seedlings transplanting and the other at 15 days intervals. The experiment included 36 treatments (3X3X4) arranged in Complete Randomized Block Design with three replicates. The results indicated that foliar spraying with nitrogen (200 mg. L^{-1}), alga 600 (3 ml. L^{-1}) and soil application with humic acid (3 gr.L^{-1}) significantly increased plant length, number of leaves, head diameter, head weight, total yield, Chlorophyll content, N% , P%, and K% of endivia plant as compared with control treatment . Also the combination treatments between nitrogen, alga 600 and humic acid revealed a significant effect on all parameters of endivia plant. The simple correlation coefficient between each two pair of studied characters showed that there is a highly positive and significant correlation between total yield with plant height, number of leaves, head diameter, head circumference, dry weight of vegetative growth and nitrogen percentage. Analysis of path coefficients revealed that the dry weight of plant had the best positive direct effect on the endivia plants yield.

Key words : Nitrogen, Spray, Alga 600, Humic acid, Endivia

Introduction

Endivia (*Cichorium endivia* L.) is a leaf vegetable which belongs to *Asteraceae* family, nearly unknown in Iraq, Endivia is widely spread species in the west and south of Europe. It has achieved popularity due to its nutritional value and bitter taste caused by presence of sesquiterpene lactones (Koudela and Petrikova 2007). The edible part of endivia is leaf rosette. There are two botanic cultivars within this species which differ in leaf anatomical structure – escarole (*Cichorium endivia* L. var. *latifolium*) with smooth, wide leaves, smooth-margins and curly endivia (*Cichorium endivia* L. var. *crispum*) with narrow and strongly frilled leaves (Ryder 1999; Papetti *et al.,* 2002; Koudela and Petrikova 2007; Adamczewska-Sowi ska and Ukla ska 2010). Preparations stimulating plant growth and development commonly called biostimulators are applied in modern horticulture in the whole world. These preparations are obtained from fishes and plant products, e.g. waterweeds (Potin *et al*., 2002). Apart from organic components they also contain mineral components. Out of 2000 species of brown algae the most commonly applied in agriculture are *Ascophyllum nodosum*, *Fucus* spp., *Laminaria* spp., *Sargassum* spp. and *Turbinaria* spp. They are used as a source of organic matter, nutritional components, as components of biostimulators and biofertilizers.

Extracts from algae show their activity even in solutions diluted to 1:1000 (Khan *et al*., 2009). Some organic-mineral fertilizers are recommended to be applied together with other fertilizers, others should be used instead of mineral fertilizers (Edmeades, 2002).

Preparations containing algae extract are destined to be applied both on the leaves and into the soil. They positively affect physico-chemical and biological properties of soil, favour the development of soil microorganisms and mycorrhizal fungi (Kohler *et al*., 2007). They improve the growth and development of the root system facilitating the intake of water and mineral components and causing the increase of the leaf surface and the increase of the intensity and efficiency of photosynthesis which results in a plant resistance to stress (Khan *et al*., 2009; Przybysz *et al*., 2010).

Organic-mineral fertilizers have stimulated and increase secondary metabolism products such as flavonols and anthocyanins, which are widely distributed in plants and seem to play many different roles. Polyphenols (flavonols and anthocyanins) have been described to have grater antioxidant activity than vitamins C and E (Rice-Evans *et al*., 1997). They are involved in protection mechanism against insects and pathogens, UV light damage, and in the regulation of plant growth and development (Cooper-Driver and Bhattacharya 1998). Fawzy, 2010 found that there were significant differences in the leaves number, leaves dry weight, average head weight and total yield of head lettuce among the foliar spray with humic acid also the leaves content of N , P ,K Fe , Zn and Mn increased significantly compared with the control. AL-hubaity and Al–Juboori (2013) found that foliar spray with humic acid (1, 2 ml. L^{-1}) increased significantly plant high but without effect on number of leaf per plant, leaf area, head diameter, head weight and marketable yield of endivia . Khalel and Al-hubaity (2013) found that spray lettuce plants with humic acid (2 ml.L^{-1}) and alga 300 (1.5 ml. L^{-1}) increased leaves number, head weight, and total yield.

The aim of present investigation was determination of the effect of foliar spray with nitrogen, alga 600 and humic acid on growth and yield and chemical composition of cultivars of endivia (*Cichorium endivia* L.).

Materials and Methods

The field experiments was implemented at vegetables field, Department of Horticulture and Landscape, Faculty of Agricultural and Forestry, Mosul University, Iraq, during winter season of 2012-2013. The aim of this study was to investigate the effect of foliar spray with 3 conc. of nitrogen

as pure urea (100 % N) (0, 100, and 200 mg. L^{-1}), foliar spray of seaweed (Alga 600) produced from *Ascophyllum nodosum* fungus by 3 conc. (0, 2, 3 ml. L^{-1}), and applied Humic acid produced by Humin Tech. company to the soil by 4 conc. (0, 1, 2, 3 gr.L^{-1}). All the three fertilizer was applied four times, the first one after 15 days of seedlings transplanting and the other at 15 days intervals.

The experiment included 36 treatments (3X3X4) arranged in Complete Randomized Block Design with three replicates.

Endivia seeds were planted in pots in plastic house at 18 Oct. 2012, and seedlings transfer to the field at 27 Nov. on 75 cm. furrow width at 30 distance between plants at one side of furrow.

Recorded Data :

1. Plant length (cm.).
2. Leaves number per plant.
3. Dry weight % .of leaves.
4. Head circumference (cm.)
5. Head diameter (cm.)
6. Head weight (g)
7. Total yield (ton.ha^{-1})
8. Chlorophyll content was measured as SPAD units using Minolta Chlorophyll Meter (Model SPAD 502)
9. Mineral content in leaves (N, P, K %).

The mineral contents were estimated using the wet ash procedure for the dry powdered.

Nitrogen was determined using modified micro-Kjeldahl according to method of Huphries (1965). Potassium contents were determined using flame photometer according to methods of Brown and Lilland (1964). Phosphorus was determined by modified spectrophotometer method according to Rowell, (1993).

Statistical Analysis: The results were statistically analysis according to the statistical analysis system (SAS) (SAS 1998) and compared with the means by Duncan multiple rang test at 0.05 level (Al-Rawy and Kalaf, 2000)

Results

Table (1) shows the effect of plant spraying with nitrogen and seaweed extract (Alga 600) and the addition of humic acid to the soil in the characteristics of plant height, number of leaves and percentage of dry matter in leaves of endivia plants. Nitrogen spraying with concentrations of 100 and 200 ml.L^{-1} significantly increased the plant length and leaves number compared to the control treatment (without spraying). While spraying with Alga 600 at a concentration of 2 and 3 ml.L^{-1} showed a significant effect than the control treatment of plant height and leaves number, but no significant effect was found in the percentage of dry matter. Addition of humic acid to the soil with 3 ml.L^{-1} concentration give the highest values of plant length, leaves number, and dry matter %.

Table 1 : Effect of organic and chemical fertilization on plant length, leaves number, and dry matter % of endivia plant.

Treatments	Plant length (cm.)	Leaves number per plant	Dry matter % of leaves
Nitrogen			
0 mg. L^{-1}	21.9778 b	30.9500 c	23.8639 a
100 mg. L^{-1}	26.2333 a	37.0611 b	24.2722 a
200 mg. L^{-1}	26.8972 a	42.3861 a	23.9769 a
Alga 600			
0 ml. L^{-1}	24.2528 b	33.5722 b	23.9478 a
2 ml. L^{-1}	25.0944 ab	38.0722 a	24.0728 a
3 ml. L^{-1}	25.7611 a	38.7528 a	24.0925 a
Humic acid			
0 gr.L^{-1}	22.6481 c	31.5667 d	22.8378 b
1 gr.L^{-1}	24.1630 b	35.9963 c	24.1211 a
2 gr.L^{-1}	26.2593 a	38.6444 b	24.5404 a
3 gr.L^{-1}	27.0741 a	40.9889 a	24.6515 a

Means followed with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Table (2) illustrated the effect of interaction between the three types of fertilizers in plant height, number of leaves and percentage of dry matter in leaves. Where the highest plant height was 30.800 cm from the treatment of the interaction between 100 mg. L^{-1} nitrogen, 2 ml. $^{L-1}$Alga, and 2 gr.L^{-1} humic acid and the lowest height 18.067 cm. from of the comparison treatment without any fertilization. The highest number of leaves per plant was 47.967 was obtained from interaction treatment between 200 mg. L^{-1} nitrogen, 3 ml. L^{-1} Alga and 2 gr. L^{-1} humic acid and the lowest number of leaves 22.567 from the comparison treatment. The highest percentage of the dry matter in the leaves 26.060 was from the treatment of the interference between 0 mg. L^{-1} nitrogen, and 0 ml. L^{-1} Alga and 3 gr. L^{-1} humic acid and the lowest percentage 21.860 was from the comparative treatment.

Table 2 : Effect of combination treatments between organic and chemical fertilization on plant length, leaves number , and dry matter % of endivia plant.

Treatment	Plant length (cm.)	Leaves number per plant	Dry matter % of leaves
N_0 A_0 H_0	18.067 k	22.567 p	21.860 h
N_0 A_0 H_1	20.600 ijk	24.633 op	23.023 d-h
N_0A_0 H_2	22.267 g-j	27.667 m-p	24.576 a-f
N_0 A_0 H_3	24.067 d-i	34.500 g-l	26.060 a
N_0 A_1H_0	18.533 jk	25.267 op	22.016 gh

$N_0A_1 H_1$	18.967 jk	28.800 l-o	23.980 a-f
$N_0 A_1H_2$	23.800 d-i	33.100 j-n	24.643 a-f
$N_0 A_1H_3$	25.533 b-g	40.567 c-g	24.823 a-f
$N_0 A_2 H_0$	20.467 ijk	28.867 l-o	22.703 fgh
$N_0 A_2 H_1$	21.033 h-k	33.267 j-n	23.620 b-h
$N_0A_2 H_2$	24.700 c-h	34.900 g-l	24.830 a-f
$N_0 A_2 H_3$	25.700 b-g	37.267 e-k	24.230 a-f
$N_1 A_0 H_0$	21.933 g-k	27.167 nop	22.970 d-h
$N_1A_0 H_1$	22.967 f-i	33.100 j-n	23.640 b-h
$N_1A_0 H_2$	27.033 a-e	33.833 h-m	24.506 a-f
$N_1A_0 H_3$	28.300 abc	40.200 c-h	24.583 a-f
$N_1A_1 H_0$	23.700 e-i	33.433 i-m	22.833 e-h
$N_1A_1 H_1$	26.933 a-f	36.467 f-k	24.350 a-f
$N1A_1 H_2$	25.767 b-g	41.433 b-f	24.946 a-e
$N_1A_1 H_3$	28.633 abc	43.233 a-e	25.223 abc
$N_1A_2H_0$	21.967 g-k	35.967 f-k	23.603 b-h
$N_1A_2H_1$	28.333 abc	39.667 c-i	25.646 ab
$N_1A_2H_2$	28.433 abc	39.500 c-i	24.683 a-f
$N_1A_2 H_3$	30.800 a	40.733 c-g	24.280 a-f
$N_2A_0 H_0$	23.900 g-i	32.467 k-n	22.756 fgh
$N_2A_0 H_1$	24.967 b-g	39.433 c-j	24.473 a-f
$N_2 A_0 H_2$	27.867 a-e	42.033 a-f	24.630 a-f
$N_2 A_0 H_3$	29.067 ab	45.267 abc	24.293 a-f
$N_2 A_1H_0$	26.633 a-f	38.400 d-k	23.153 c-h
$N_2 A_1 H_1$	27.900 a-d	45.667 abc	23.830 b-h
$N_2 A_1 H_2$	27.967 a-d	47.367 ab	24.066 a-g
$N_2 A_1 H_3$	26.767 a-f	43.133 a-e	25.006 a-d
$N_2A_2 H_0$	28.633 abc	39.967 c-g	23.643 b-h
$N_2 A_2 H_1$	25.767 b-g	42.933 a-e	24.526 a-f
$N_2 A_2 H_2$	28.500 abc	47.967 a	23.980 a-g
$N_2A_2 H_3$	24.800 c-h	44.000 a-d	23.363 c-h

Means followed with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels. Table (3) shows the effect of chemical and organic fertilizers on the head circumference, head diameter, head weight and total yield of endivia plant. Nitrogen spraying with 200 and 100 ml.L^{-1} significantly increased the four parameters compared to the control treatment. In addition, the spray with seaweed extract (Alga600) by 2 and 3 ml.L^{-1} was superior than control treatment for the four parameters. The highest circumference of the head was 52.26 and the head diameter was 35.66, the head weight was 176.664 and the total yield was 7.843. The addition of humic acid to the soil with 2 and 3 gr.L^{-1} concentrations gave significant effect for the four traits compared to the control and 1 gr.L^{-1} concentration treatments.

Table (4) displays the effect of interaction between the three types of fertilizers in head circumference, head diameter, head weight, and total yield of endivia plant. Where the highest head circumference (66.367 cm.), head diameter (39.567 cm.), head weight (237.8 g.) and total yield (10.558 ton. H^{-1}) was obtained from the treatment of interaction between 200 mg. L^{-1} nitrogen, 3 ml.L^{-1} Alga , and 2 ml.$L.^{-1}$ humic acid, while the lowest value of the four parameters were 31.833 cm., 21.233 cm., 93.600 g, and 4.155 ton. H^{-1} respectively was obtained) was obtained from the control treatment.

Table 3: Effect of organic and chemical fertilization on head circumference, head diameter, head weight, and total yield of endivia .

Treatments	Head circumference (cm.)	Head diameter (cm.)	Head weight (gm.)	Total yield Ton. h^{-1}
Nitrogen				
0 mg. L^{-1}	42.76 c	30.93 c	129.139 c	5.733 c
100 mg. L^{-1}	46.79 b	34.14 b	158.022 b	7.016 b
200 mg. L^{-1}	56.71 a	36.46 a	204.128 a	9.063 a
Alga 600				
0 ml. L^{-1}	45.19 c	31.36 c	145.519 c	6.461 c
2 ml. L^{-1}	48.80 b	34.51 b	169.106 b	7.508 b
3 ml. L^{-1}	52.26 a	35.66 a	176.664 a	7.843 a
Humic acid				
0 gr.L^{-1}	42.26 c	30.21 c	146.252 c	6.494 c
1 gr.L^{-1}	47.34 b	33.07 b	159.559 b	7.083 b
2 gr.L^{-1}	52.99 a	36.11 a	173.874 a	7.720 a
3 gr.L^{-1}	52.41 a	35.99 a	175.367 a	7.786 a

Means followed with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Table 4 : Effect of combination treatments between organic and chemical fertilization on head circumference , head diameter , head weight and total yield of endivia plant.

Treatment	Head circumference (cm.)	Head diameter	Head weight (gm.)	Total yield
N_0 A_0 H_0	31.833 p	21.233 m	93.600 q	4.155 q
N_0 A_0 H_1	37.333 no	26.867 l	103.433 pq	4.590 pq
N_0 A_0 H_2	42.133 k-n	27.933 kl	117.333 op	5.210 op
N_0 A_0 H_3	44.567 h-m	32.367 e-j	129.533 no	5.751 no
N_0 A_1H_0	39.767 mno	27.833 kl	131.733 mno	5.849 mno
N_0 A_1 H_1	36.933 o	30.467 i-l	128.333 no	5.698 no
N_0 A_1H_2	45.533 g-l	34.933 b-g	135.033 lmn	5.994 lmn
N_0 A_1 H_3	43.767 h-m	36.400 a-d	147.200 klm	6.535 klm
N_0 A_2 H_0	42.433 j-n	28.900 jkl	130.833 mno	5.809 mno
N_0 A_2 H_1	46.333 f-k	32.100 f-j	140.833 k-n	6.253 k-n
N_0A_2 H_2	51.600 ef	36.167 a-e	147.900 klm	6.566 klm
N_0 A_2 H_3	50.933 f	35.967 a-f	143.900 k-n	6.388 k-n
N_1 A_0 H_0	40.667 m-o	27.167 l	127.333 no	5.653 no
N_1A_0 H_1	42.233 k-n	29.700 i-l	138.800 k-n	6.162 k-n
N_1A_0 H_2	47.567 f-j	35.133 b-g	141.800 k-n	6.295 k-n
N_1A_0 H_3	46.567 f-k	34.733 b-g	154.433 jk	6.857 jk
N_1A_1 H_0	41.333 k-o	30.567 i-l	138.633 k-n	6.156 k-n
N_1A_1 H_1	46.533 f-k	33.500 d-i	152.900 jk	6.788 jk
N_1 A_1H_2	50.267 fg	37.200 a-d	167.800 ij	7.450 ij
N_1 A_1H_3	48.233 f-h	37.867 abc	175.900 ghi	7.809 ghi
N_1 A_2H_0	41.867 k-o	31.733 g-k	149.800 kl	6.650 kl
N_1 A_2H_1	48.867 fgh	36.633 a-d	174.233 hi	7.736 hi
$N_1A_2H_2$	51.233 f	37.633 abc	182.433 f-i	8.100 f-i
N_1A_2 H_3	56.133 de	37.900 abc	192.200 efg	8.533 efg
N_2 A_0H_0	43.367 i-m	30.733 h-l	166.333 ij	7.392 ij
N_2 A_0H_1	51.333 f	35.600 a-g	185.800 e-h	8.249 e-h
N_2 A_0H_2	56.300 de	37.700 abc	197.233 def	8.757 def
N_2 A_0H_3	58.433 cd	37.200 a-d	190.600 e-h	8.462 e-h
N_2 A_1H_0	48.300 f-i	37.100 a-d	184.500 e-h	8.191 e-h
N_2 A_1H_1	57.367 cd	34.500 c-h	200.800 cde	8.915 cde
N_2 A_1H_2	65.933 ab	38.767 ab	237.533 a	10.547 a
N_2 A_1H_3	61.667 abc	35.000 b-g	228.900 ab	10.162 ab
N_2 A_2H_0	50.833 f	36.633 a-d	193.500 ef	8.591 ef
N_2 A_2H_1	59.200 cd	38.300 abc	210.900 cd	9.362 cd
N_2 A_2H_2	66.367 a	39.567 a	237.800 a	10.558 a
N_2 A_2H_3	61.433 bc	36.500 a-d	215.633 bc	9.574 bc

Means followed with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Table (5) shows the effect of chemical and organic fertilizers of chlorophyll content and N, P, K percentage in endivia leaves. Spraying of nitrogen 200 mg. L^{-1} concentration significantly increased the chlorophyll content and the percentage of N and K, while the P % did not affected significantly. The spraying with Alga 600 by 3 ml. L^{-1} concentration showed a significant increase in chlorophyll content and N, P, and K percentage. The addition of humic acid to the soil at a concentration of 3 gr.L^{-1} gave a significant increase in chlorophyll content, N, P, K percentage.

Table (6) displays the effect of interaction between the three types of fertilizers in Chlorophyll content, N%, P% and K% in endivia leaves .we found that the highest chlorophyll content (56.20 SPAD) was obtained from the treatment of interaction between 100 mg. L^{-1} nitrogen, 2 ml.L^{-1} Alga and 1 ml.$L.^{-1}$ humic acid, the highest percentage of N (1.006%) was obtained from the treatment of interaction between 100 mg. L^{-1} nitrogen, 2 ml.$L.^{-1}$ Alga and 3 ml. L^{-1} humic acid, the highest percentage of P (0.503%) was obtained from the treatment of interaction between 200 mg. L^{-1} nitrogen, 3 ml.$L.^{-1}$ Alga and 3 ml. L^{-1} humic acid and, the highest percentage of K (5.433%) was obtained from the treatment of interaction between 200 mg. L^{-1} nitrogen, 2 ml.L^{-1} Alga and 3 ml. L^{-1} humic acid, while the lowest value of the four parameters were 36.40, 0.601, 0.302 and3.210 respectively was obtained from the control treatment.

Simple coefficient correlation between the studied traits:

Table (7) displays the simple correlation coefficient between each two pair of studied characters. The total yield exhibited a highly positive and significant correlation with each of the plant height, number of leaves, head diameter, head circumference, dry weight of vegetative growth and nitrogen percentage. The highest correlation was found between the total yield and dry weight of vegetative growth

registered 0.981, followed by the total yield with head circumference and number of leaves (0.873, 0.817) respectively. Number of leaves revealed a highly positive and significant correlation with dry weigh of vegetative growth and head diameter. On other hand, head circumference was significantly and highly correlated with dry weight and nitrogen percent.

Path coefficient analysis for some traits affected in the total yield of endivia:

Analysis of path coefficients was done between the total yield and variables affecting on it into direct and indirect effects to determine the higher traits affecting increasing the yield. Data reported in table (8) illustrate that the dry weight of plant had the best positive direct effect on the endivia plants yield, hence it revealed a high indirect effect through the path of most studied trait specially through head circumference, number of leaves per plant, head diameter and nitrogen percentage.

Table 5 : Effect of organic and chemical fertilization on Chlorophyll content, N%, P% and K% of endivia plant.

Treatments	Chlorophyll content	N %	P %	K %
Nitrogen				
0 mg. L^{-1}	43.35 c	0.746 c	0.395 a	3.924 c
100 mg. L^{-1}	47.74 b	0.809 b	0.411 a	4.358 b
200 mg. L^{-1}	49.34 a	0.883 a	0.406 a	4.535 a
Alga 600				
0 ml. L^{-1}	44.43 c	0.790 b	0.392 b	4.155 b
2 ml. L^{-1}	47.27 b	0.813 a	0.402ab	4.130 b
3 ml. L^{-1}	48.73 a	0.834 a	0.418 a	4.531 a
Humic acid				
0 gr.L^{-1}	45.23 c	0.750 d	0.352 d	3.665 c
1 gr.L^{-1}	46.96 b	0.797 c	0.389 c	4.084 b
2 gr.L^{-1}	46.58 b	0.832 b	0.421 b	4.575 a
3 gr.L^{-1}	48.48 a	0.871 a	0.454 a	4.766 a

Means followed with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Table 6 : Effect of combination treatments between organic and chemical fertilization on Chlorophyll content, N%, P% and K% of endivia plant.

Treatment	Chlorophyll content	N %	P %	K %
N_0 A_0 H_0	36.400 l	0.601 n	0.302 i	3.210 m
N_0 A_0 H_1	39.200 kl	0.680 lm	0.350 f-i	3.675 j-m
N_0A_0 H_2	44.600 f-j	0.703 klm	0.427 a-f	5.125 a-d
N_0 A_0 H_3	42.300 h-k	0.778 g-k	0.435 a-e	4.068 f-k
N_0 A_1H_0	42.400 h-k	0.642 mn	0.341 ghi	3.401 lm
N_0A_1 H_1	41.500 ijk	0.700 klm	0.446 a-d	3.642 j-m
N_0 A_1H_2	43.400 hij	0.798 f-j	0.366 d-i	3.595 j-m
N_0 A_1H_3	43.500 hij	0.819 d-i	0.421 a-g	4.056 g-l
N_0 A_2 H_0	43.800 hij	0.755 i-l	0.394 c-h	3.424 klm
N_0 A_2 H_1	45.400 e-i	0.797 f-j	0.410 b-h	3.642 j-m
N_0A_2 H_2	46.200 e-h	0.828 d-j	0.410 b-h	4.563 d-i
N_0 A_2 H_3	51.600 bcd	0.850 c-h	0.435 a-e	4.688 b-h
N_1 A_0 H_0	41.100 jk	0.763 h-l	0.336 hi	3.438 klm
N_1A_0 H_1	43.400 hij	0.793 f-j	0.384 c-i	3.713 j-m
N_1A_0 H_2	45.500 e-i	0.808 e-j	0.429 a-f	4.101 f-l
N_1A_0 H_3	51.300 bcd	0.825 c-j	0.455 abc	5.263 a-d
N_1A_1 H_0	46.033 e-h	0.746 jkl	0.344 f-i	3.968 i-l
N_1A_1 H_1	51.200 bcd	0.780 g-k	0.382 c-i	4.203 e-j
$N1A_1$ H_2	48.600 def	0.841 c-i	0.410 b-h	4.693 b-h
N_1A_1 H_3	48.033 d-g	0.843 c-i	0.459 abc	4.572 c-i
$N_1A_2H_0$	50.700 cd	0.763 h-l	0.380 c-i	3.751 klm
$N_1A_2H_1$	46.200 e-h	0.795 f-j	0.390 c-h	4.011 h-l
$N_1A_2H_2$	56.200 a	0.849 c-h	0.460 abc	5.246 a-d
N_1A_2 H_3	44.700 f-j	0.906 bcd	0.503 a	5.338 ab
N_2A_0 H_0	42.933 h-k	0.818 d-i	0.351 e-i	3.581 j-m
N_2A_0 H_1	48.900 cde	0.855 c-g	0.341 ghi	4.125 f-k
N_2 A_0 H_2	49.033 cde	0.911 bc	0.410 b-h	4.851 a-e
N_2 A_0 H_3	48.600 def	0.950 ab	0.490 a	4.715 b-g
N_2 A_1H_0	50.700 cd	0.825 c-j	0.346 f-i	3.523 j-m
N_2 A_1 H_1	55.100 ab	0.900 bcd	0.396 c-h	4.751 a-g
N_2 A_1 H_2	52.900 abc	0.864 c-g	0.453 abc	3.731 j-m
N_2 A_1 H_3	43.900 jhi	1.006 a	0.456 abc	5.433 a
N_2A_2 H_0	43.033 abc	0.835 c-j	0.376 c-i	4.688 b-h

N_2 A_2 H_1	51.800 bcd	0.879 b-f	0.400 c-h	4.995 a-d
N_2 A_2 H_2	50.800 cd	0.890 b-d	0.423 a-g	5.268 abc
N_2A_2 H_3	44.400 g-j	0.861 c-g	0.435 a-e	4.765 a-f

Means followed with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Table 7 : The simple coefficient correlation between the studied traits .

Traits	Total yield ton.donm^{-1}	K%	P%	N%	Dry weight of vegetative growth	Chlorophyll %	Head circumference	Head diameter	Number of leaves. plant^{-1}
Plant height (cm)	*0.623	0.562	0.415	0.632	*0.642	0.559	*0.620	*0.698	*0.732
Number of leaves.plant^{-1}	**0.817	0.522	0.410	*0.700	**0.820	*0.581	**0.801	**0.768	
Head diameter (cm)	**0.716	0.475	0.435	*0.661	**0.734	*0.594	**0.730		
Head circumference (cm)	**0.873	0.559	0.440	**0.735	**0.854	0.329			
Chlorophyll %	0.566	0.436	0.235	0.448	0.561				
Dry weight of vegetative growth (g)	**0.981	0.533	0.383	*0.704					
N%	**0.715	0.545	0.359						
P%	0.340	0.487							
K%	0.506								

*,** Significant at 0.05 and 0.01 respectively.

Table 8 : Path coefficient analysis for some traits affected in the total yield of endivia .

Traits	Plant height	Number of leaves.plant^{-1}	Dry weight of vegetative growth	Head diameter	Head circumference	Chlorophyll %	Dry matter %	N%
Plant height (cm)	0.0020	0.0015	0.0013	0.0014	0.0012	0.0011	0.0008	0.0013
Number of leaves plant^{-1}	- 0.0013	- 0.0018	- 0.0015	- 0.0014	- 0.0015	- 0.0011	- 0.0007	- 0.0013
Dry weight of vegetative growth (g)	0.6718	0.8576	1.0454	0.7680	0.8928	0.5873	0.4971	0.7363
Head diameter (cm)	0.0057	0.0063	0.0060	0.0081	0.0059	0.0048	0.0034	0.0054
Head circumference (cm)	0.0099	0.0128	0.0136	0.0117	0.0160	0.0085	0.0044	0.0117
Chlorophyll %	0.0087	0.0090	0.0087	0.0092	0.0082	0.0155	0.0040	0.0070
Dry matter %	- 0.0799	- 0.0755	- 0.1001	- 0.0875	- 0.0575	- 0.0542	- 0.2105	- 0.0607
N%	0.0067	0.0074	0.0075	0.0070	0.0078	0.0047	0.0031	0.0106
Trait correlation with yield	0.623	0.817	0.981	0.716	0.873	0.566	0.3015	0.710

The shadow diameter numbers are resemble the direct of trait on the yield.

Discussion

The increase in plant growth, yield and mineral composition of endivia plants as a result of nitrogen, Alga 600, and humic acid treatments may be due to the role of this fertilizer in plant biological process. Organic-mineral fertilizers have stimulated secondary metabolism products such as flavonols and anthocyanins, which are widely distributed in plants and seem to play many different roles. Polyphenols (flavonols and anthocyanins) have been described to have grater antioxidant activity (Rice-Evans *et al*., 1997). Alga 600 have a positive effect on physico-chemical and biological properties of soil, favour the development of soil microorganisms and mycorrhizal fungi (Kohler *et al*., 2007). They improve the growth and development of the root system which increase the intake of water and mineral components and causing the increase of the leaf area and intensity and efficiency of photosynthesis which results in a plant resistance to stress (Khan *et al*., 2009; Przybysz *et al*., 2010). The role of seaweed (Alga 600) in improving the growth and productivity of Endivia plants may be due to its components of many essential elements (N, P and K) which stimulate plant growth and development through its effect on activation of physiological processes such as photosynthesis, which is reflected positively in the characteristics of vegetative growth, as well as the inclusion

of the alga 600 of micro nutrients such as zinc which contributes to the manufacture of amino acid tryptophan which necessary for produce Auxin (Indole acetic acid) (Abd EL-Motty *et al*., 2010).

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