Middle East Journal of Agriculture Research
Volume: 10 | Issue: 04| Oct. – Dec.| 2021

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2021.10.4.76
Journal homepage: www.curresweb.com
Pages: 1116-1129

Adaptation of Coriander Plants by Different Types of Fertilizers with Foliar Spraying of Boron to Improve Growth and Productivity

Rania M.R. Khater [1] and Salama Y.A.M [2]

[1]*Medicinal and Aromatic Plants Department, Desert Research Center, Cairo, Egypt.*
[2]*Plant Adaptation Unit-Genetic Resource Department, Desert Research Center, Cairo, Egypt.*

Received: 20 Sept. 2021 **Accepted:** 20 Oct. 2021 **Published:** 05 Nov. 2021

ABSTRACT
This investigation was carried out at North of Sinai, Egypt D.R.C. during two successive seasons i.e. 2017/ 2018 and 2018/2019, to study the effect of different types of fertilizers, boron and their interactions on the growth, yield and essential oil of *Coriandor sativum* plants. The design of the experiment was split plot included 12 treatments and 3 replicates, main plot included adding organic matter , sub-plot using Boric acid H_3BO_3 (17 % B) as foliar spray Results regarding the effect of adding organic matter treated plants with the organic matter humic acid plus Bio-fertilizer, together the best results were given for all growth characteristics. On the other hand, the results indicated that the effect of spraying with different concentrations of boron led to a significant increase when foliar spraying of boron 10 mg/l it gave increase in values all characteristics under studied during the first and second season on the other hand, the interaction between organic matter and foliar application of boron resulted in a significant increase in the characteristics of growth (plant height, number of branches and weight of fruits / plant) and in the yield parameters (fruit weight / feddan, oil percentage, oil content / plant and feddan) Where recorded treatment (humic acid + bio-fertilizers) plus foliar application of boron 10 mg / l the best values in both seasons. Otherwise, sabinene, β-terpenine and geranyle acetate were absent when the plant was treated with humic acid with 20 mg/l of boron, while linaly acetate and geranyle acetate did not appear when the plant was treated with biofertilization alone, as well as in both sabinene and borneol compounds were not present in Biofertilizer with10 mg/l. β-cymene was not present in both treatments (humic acid with Biofertilizer) + 10 mg/l of boron and (humic acid, Biofertilizer with 20 mg/l of boron. In addition, the highest amounts of essential oil components such as linalool, geraniol and limonene that recorded the values of 55.56 %, 26.65 % and 5.31 %, respectively.

Keywords: *Coriandor sativum*, Humic acid, Bio-fertilizer, Organic matter, Boron

1. Introduction

Coriander (*Coriandrum sativum,*) belongs to family Apiaceae. Coriander is considered one of the most famous and widespread spices in the world used either as a well-known green herb or dry seeds (Wafaa *et al.,* 2021). Coriander cultivation is prevalent in India, some countries of South America, southern Europe, Tunisia, Algeria, Morocco, Egypt and Iran. Green leaves and dry fruits are used for coriander as a spice and flavored for food (Arslan *et al.,* 2002).

Moreover, it has medical benefits such as lowering cholesterol levels and blood sugar levels, preventing high blood pressure and arteriosclerosis, it has an important role in regulating digestion and expelling gases and treating fungal infections and contributing to the treatment of anemia, diarrhea and the treatment of colds and Gout is also included in the treatment of rheumatism because it contains calcium (Erdogdu, 2012). Coriander contains 1.4% essential oil and the main components of the essential oil are linalool, geraniol, citronella, thymol, α-pinene, β-cymol (Nofal and Menisi, 2019). The essential oil is used in many industries such as the perfume and pharmaceutical industry (Wafaa *et al.,* 2021)

Corresponding Author: Rania M.R. Khater, Medicinal and Aromatic Plants Department, Desert Research Center, Cairo, Egypt.
Email: dr.raniakhater@yahoo.com & Orcid Id: 0000-0002-6510-5642

Middle East J. Agric. Res., 10(4): 1116-1129, 2021
EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2021.10.4.76*

Organic agriculture in Egypt is about 290 thousand feddan, most of which follow the investment sector and export 95% of its production and 5% to the local market. The productivity of organic farming is not low compared to traditional agriculture, especially with the advent of modern technologies in agriculture Wafaa, *et al.,* (2021) on *Coriandrum sativum* L. and Rania, (2010 on Nicotiana glauca)

Moreover, many countries converted the farming system to organic farming. Organic agriculture in Egypt, it is very important to maintain the health of citizens to prevent diseases. Also, the world began using organic agriculture to dispense with chemicals, pesticides and fertilizers to be replaced by organic matters Rania, and Abd El-Azim, (2016) on *Plantago psyllium,* and Elham and Rania, (2015) on *Hibiscus sabdariffa,*,.

Humic acid is a natural compound that has many physiological and biological benefits to plants. It activates and accelerates germination of seeds and encourages the formation of natural oxides, thus encouraging the growth of root principles. Also, it considered a natural chelating substance that facilitates elements in the soil, such as Fe, Z, Cu, P, Ca, Mg and Mn turns it into a soft image of the plant that is easy to absorb. In addition, it activates the action of enzymes and energy compounds within plants, which activates the internal cytokinin and increases the division and elongation of cells (Abdul Hafiz, 2012).

Bio-fertilizers are an inexpensive alternative to using expensive mineral fertilizers that have an impact on environmental pollution, whether it is soil or water when wasteful in their use. These fertilizers are produced from microorganisms that fix atmospheric nitrogen, which provides about 25% of nitrogenous fertilizers, and another that dissolves organic phosphates and converts them from an invalid image to an image that can be absorbed by the plant. It provides about 50% of phosphate fertilizers Abd El-Azim *et al.,* (2017) on *Foeniculum vulgare,* Mill., Amal *et al.,* (2017) on *Mentha viridis*, L. It is added to the agricultural soil and works to restore the balance of microbes with the soil and stimulate the vital processes in it, rationalize the use of mineral fertilizers to reduce environmental pollution, increase crop productivity and produce high quality plants free of chemicals and residues Ibrahim, *et al.,* 2019 on black cumin and Rania *et al.,* (2020) on *Carum carvi*, L.

Boron is a micronutrient, it is important for plant growth. Boron has great importance in organization cell membranes and the formation of carbohydrates, proteins and phenols Aref, (2011). In addition to transferring sugars from their formation sites to different growth regions (Gupta, 1979), research has shown that 85% of the plants' need of nutrients can be given through foliar fertilization Rania and Wafaa (2017) on *Ocimum basilicum* plants

This study aimed to produce coriander plants under organic agriculture conditions with the effect of boron spray to improve growth, productivity and increase of active ingredients.

2. Material and Methods

This experiment was carried out at Baluza Research Station, Desert Research Center located at North of Sinai, Egypt during two successive seasons (2017/ 2018 and 2018/2019). The aim of this study was to investigate the effect of organic matter, boron and their interactions on the growth, yield and essential oil of *Coriandor sativum*.

Coriander seeds were procured from the Research Center for Medicinal and Aromatic plants, Dokki, Giza. Seeds were sown on row 60 cm apart and in hills 25 cm apart. Coriander seeds were sown directly in the soil during the second week of October and mid-October in the first and second seasons, respectively, a month after sowing, plants were thinned to one plant per hill. Number of plants totaled 28000 per feddan (4200 m^2). The mechanical and chemical properties of the used soil are shown in Table (1) according to Page *et al.,* (1984). The experimental field was drip irrigated and all agricultural practices of growing coriander plants were done according to the recommendations of ministry of agriculture, Egypt.

Table 1: Physical and chemical properties of soil used in this study.

Particle size distribution (%)			Texture class	EC dSm^{-1}	PH	Soluble ions (meq/l)								Available nutrients (ppm)		
						Cations				Anions						
Sand	Silt	Clay				Ca^{+2}	Mg^{+2}	Na^{+1}	K^{+1}	CO^{-3}	HCO^{-3}	SO^{-4}	Cl^{-1}	N	P	K
90	5	5	Sand	1.37	8.20	1.8	2.1	1.5	0.09	-	3.5	0.84	1.51	60	3.65	144

The design of the experiment was split plot included 12 treatments and 3 replicates, main plot included adding organic matter to the soil as [control (without organic matter) – humic acid (H) – bio-fertilizer (Bio) - humic acid plus Bio-fertilizer (H+Bio.)]. Sub-plot using boric acid H_3BO_3 (17 % B) as foliar spray with two concentrations (10 and 20 mg/l B) and control (without boric acid)

The treatments were conducted as follows:

1.	Control	**7.**	Bio-fertilizer
2.	10 mg/l boric acid	**8.**	Bio-fertilizer + 10 mg/l
3.	20 mg/l boric acid	**9.**	Bio-fertilizer + 20 mg/l
4.	Humic acid	**10.**	Humic acid + bio-fertilizer
5.	Humic acid + 10 mg/l boric acid	**11.**	Humic acid + bio-fertilizer + 10 mg/l boric acid
6.	Humic acid + 20 mg/l boric acid	**12.**	Humic acid + bio-fertilizer + 20 mg/l boric acid

The Humic acid was applied 30 days after planting , Bio-fertilizer was applied by mixing the seeds before planting and spraying with Boron 35 days from sowing at the tillering stage and 70 days from sowing at the booting stage, while the control treatments was sprayed with tap water. Plants were harvested 160 days after sowing for the two seasons.

2.1. The following data were recorded:

I. Vegetative growth parameters

1. Plant height (cm)
2. Number of umbels
3. Fruit weight per plant (g)
4. Fruit weight per feddan (kg).

II. Yield parameters

1. Oil percentage (%)
2. Oil content per plant (ml)
3. Oil content per feddan (Liter)
4. Oil chemical constituents by G.L.C.

The fruit weight per feddan (kg) was calculated as follows: Fruit yield per feddan = fruit yield per plant × 28000 for all treatments. Volatile oil determination was carried out by steam distillation according to Guenther (1961). Volatile oil yield per plant (ml) was calculated as follows: oil percentage × fruit weight per plant (g)/100. Volatile oil yield / feddan (L) was calculated as follows: fruit weight per plant (g) × number of plants per feddan (28000 plants).

Oil samples were analysis by G.L.C. technique to know the constituents of the oil and the differences between the treatments at the Medicinal and Aromatic Plants Laboratory - Vegetables and Medicinal and Aromatic Plants Research Department - Horticulture Institute - Agricultural Research Centre. Data was recorded and were statistically analyzed according to Snedecor and Cochran (1980) by using computer program of Statistix version[9] (Analytical software, 2008).

3. Results

3.1. Effect of organic matter

In general, the analysis of variance showed that growth and production of coriander were significantly affected by the difference in the addition of organic matter, as did the foliar interaction of boron and the significant interaction between these two factors in both seasons.

The effect of organic matter on coriander growth shows in Table, (2) there is a significant difference between the treatments, where the application of humic acid + bio-fertilizer together-gave the highest significant increase compared to the treatments and control. The vegetative growth parameters such as plant height (cm), number of umbels, and plant weight per plant (g) were significantly affected when applying humic acid + bio-fertilizer, which gave the highest value for plant height 76.77cm and 79.88 cm and number of umbels 14.81 and 15.22 and plant weight per plant 27.37g and 27.66g for the first and second seasons, respectively. The difference between treatments and the control was significant for the two seasons.

Also, data showed that, a significant difference between the application of humic acid alone or the application of biofertilizer alone, but the best values were plant height was 56.34 cm and 60.97 cm, the number of umbels was 12.54 and 13.00, and plant weight per plant 21.16 g and 21.01 g. for the 1st and 2nd seasons, respectively. All treatments observed that, significant differences between them that led to an increase in values of vegetative growth compared to the control.

Table 2: Effect of organic matter on growth characters.

Treatments \ Parameters	Plant height (cm)		No. of umbels	
	Season 1	Season 2	Season 1	Season 2
Control	31.50^{D}	35.37^{D}	7.84^{D}	8.14^{D}
Humic acid	56.34^{B}	60.97^{B}	12.54^{B}	13.00^{B}
Bio-fertilizer	43.87^{C}	45.79^{C}	9.52^{C}	10.03^{C}
Humic acid + Bio-fertilizer	76.77^{A}	79.88^{A}	14.81^{A}	15.22^{A}
Treatments \ Parameters	**Fruit weights (g/plant)**		**Fruit (kg/ feddan)**	
	Season 1	**Season 2**	**Season 1**	**Season 2**
Control	12.88^{D}	13.77^{D}	360.64^{D}	385.56^{D}
Humic acid	21.16^{B}	21.01^{B}	592.48^{B}	588.28^{B}
Bio-fertilizer	17.37^{C}	18.66^{C}	486.36^{C}	522.48^{C}
Humic acid + Bio-fertilizer	27.37^{A}	27.66^{A}	766.36^{A}	774.48^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level. Control (without organic matter), humic acid (H), bio-fertilizer (Bio) and humic acid + Bio-fertilizer (H+Bio)

Control (without boric acid), 10 mg/l boric acid (10 mg/l B) and 20 mg/l boric acid (20 mg/l B)

In connection with yield parameters, there was a direct relationship between growth and yield parameters for coriander plants such as fruit weight per feddan (kg), oil percentage, oil content per plant (ml) and feddan (L). The same treatment of humic acid + bio-fertilizer combined are shown in table (3) gives the highest value for fruit weight per feddan 766.36 kg and 774.48 kg, oil percentage 1.06 % and 1.07 % and oil content 0.29 ml and 0.30 ml per plant and fruit per feddan 21.46 l and 21.69 l during in the seasons 2017/2018 and 2018/1019; respectively compared to the inoculated plants and the other treatments.

Likewise, data showed that, a significant difference between the application of humic acid alone or the application of biofertilizer alone, but the best values were fruit weight per feddan 592.48 kg and 588.28 kg, oil percentage 0.98% and 1.00 % and oil content 0.21 ml and 0.21ml per plant and 16.59 L and 16.47 L per feddan during 1st and 2nd seasons, respectively. All treatments observed that, significant differences between them that led to an increase in values of vegetative growth compared to the control.

Table 3: Effect of organic matter on oil percentage and oil content per plant (ml) and feddan (L)

Treatments \ Parameters	Oil %		Oil content (ml/ plant)		Oil content (L/feddan)	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control	0.83^{D}	0.83^{D}	0.11^{D}	0.11^{D}	10.10^{D}	10.80^{D}
Humic acid	0.98^{B}	1.00^{B}	0.21^{B}	0.21^{B}	16.59^{B}	16.47^{B}
Bio-fertilizer	0.93^{C}	0.94^{C}	0.16^{C}	0.18^{C}	13.62^{C}	14.63^{C}
Humic acid + Bio-fertilizer	1.06^{A}	1.07^{A}	0.29^{A}	0.30^{A}	21.46^{A}	21.69^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.
Control (without organic matter), humic acid (H), bio-fertilizer (Bio) and humic acid + Bio-fertilizer (H+Bio.)
Control (without boric acid), 10 mg/l boric acid (10 mg/l B) and 20 mg/l boric acid (20 mg/l B)

As for oil chemical constituents by GLC data in figure (1) revealed that, α-Pinene and limonene were increased in the components of coriander oil when adding biofertilizer + humic acid together to

5.98% and 6.87% compared to control 2.07% and 1.25%, respectively. Sabinene decreased when adding biofertilizer + humic acid together to 2.38% compared to 15.20% in control.

Alternatively, the percentage of β-terpenine when adding biofertilizer + humic acid together decreased to 1.43% compared to 2.06% of untreated plants, while the best value of β-terpenine when adding biofertilizer only 2.94%. Myrcene had the highest value when adding humic acid alone 6.12%, followed by biofertilizer + humic acid together with 4.75%, then adding biofertilizer alone 2.47% compared to control which recorded 1.83%.

Also, β-cymene had the highest value when adding biofertilizer + humic acid together 5.02%, followed by humic acid alone 3.85%, then adding biofertilizer alone 1.34%, compared to control plants 10.88 %. Linalool is the largest component of the essential oil of the coriander plant, where it scored the highest value in all treatments compared to the daughters of control, where the addition of bio-fertilization and humic acid together scored 53.32%, the best value of Linalool compound compared to the untreated plants 31.82%.

Geraniol is the second main compound in coriander oil, where the addition of biofertilizer + humic acid together recorded 26.65% compared to control 5.68%. Borneol compound when adding biofertilizer + humic acid together increased 7.58%, followed by adding biofertilizer alone 3.56%, then adding humic acid alone 2.99% compared to control 0.99%, which recorded the lowest value for Borneol compound.

Moreover, the lowest percentage of Linaly Acetate when adding biofertilizer + humic acid together was 1.64% compared to 10.84% of untreated plants. While, the highest percentage of geranyle acetate was recorded when adding biofertilizer + humic acid together 3.69% compared to 2.52% of untreated plants.

Furthermore, adding bio-fertilization alone recorded the highest value for Nerol compound 16.44%, followed by adding bio-fertilization and humic acid together 5.27%, followed by control plants 3.50%, then adding humic acid alone 2.42%. Otherwise, linaly acetate and geranyle acetate did not appear when adding the biofertilizer only, but it was present in all the treatments under study, including the control treatment.

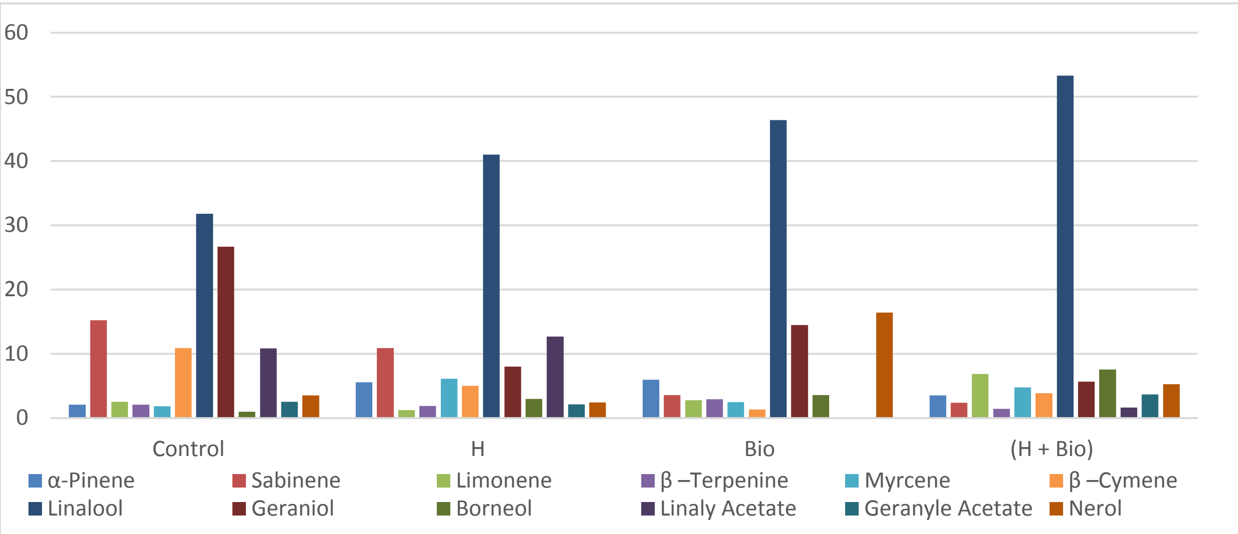

Fig. 1: Effect of organic fertilizer on the chemical compounds.

3.2. Effect of foliar application of boron

In general, it was observed that there is a direct relationship between the increase in the concentration of boron and the increase in vegetative growth and the production of the crop from fruits and oil, as the higher the concentration of boron, the higher the production in all the characteristics of the coriander plant.

The statistical data in Table (4) indicate a significant effect of foliar application of boron concentrations on coriander plants the best treatment was when the biofertilizer and humic acid were added together, given the highest values of vegetative growth parameters like plant height 56.03 cm and 60.17 cm, number of umbels 11.89 and 12.35 and fruit weight per plant 21.83 g and 22.08 g in both seasons, respectively. The increase was significant in all characteristics when compared to the control. Compared to the control, which recorded the lowest values in both plant height 47.74 cm and 51.13 cm and number of umbels 10.49 and 10.83 and fruit weight per plant 17.58 g and 18.55 g during the first and second seasons, respectively.

Table 4: Effect of foliar application of boron on growth characters.

Parameters / Treatments	Plant height (cm)		No. of umbels	
	Season 1	Season 2	Season 1	Season 2
Control	47.74^{C}	51.13^{C}	10.49^{C}	10.83^{C}
10 mg/l B	56.03^{A}	60.17^{A}	11.89^{A}	12.35^{A}
20 mg/l B	52.58^{B}	55.20^{B}	11.15^{B}	11.62^{B}
Parameters / Treatments	**Fruit weights (g/plant)**		**Fruit weights (kg/feddan)**	
	Season 1	**Season 2**	**Season 1**	**Season 2**
Control	17.58^{C}	18.55^{C}	492.24^{C}	519.40^{C}
10 mg/l B	21.83^{A}	22.08^{A}	611.24^{A}	618.24^{A}
20 mg/l B	19.67^{B}	20.18^{B}	550.76^{B}	565.04^{B}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.
Control (without organic matter), humic acid (H), bio-fertilizer (Bio) and humic acid + Bio-fertilizer (H+Bio.)
Control (without boric acid), 10 mg/l boric acid (10 mg/l B) and 20 mg/l boric acid (20 mg/l B)

Concerning yield parameters, the data in Table (5) indicated that the foliar application of boron gives a significant effect on all production traits, as 10 mg/l B recorded the highest values for the yield parameters, namely, Fruit per feddan 611.24 kg and 618.24 kg, oil percentage 0.98 % and 0.99 %, oil content per plant 0.21ml and 0.22 ml and oil content per feddan 17.11 and 17.31 l in 2017/2018 and 2018/2019, respectively. Compared with the control, which recorded the lowest values in the Fruit per feddan of 492.24 kg and 519.40 kg, oil percentage of 0.92 % and 0.94 %, oil content per plant 0.16 ml 0.17 ml and oil content per feddan of 13.78 l and 14.54 l during 2017/2018 and 2018/2019 respectively.

Table 5: Effect of foliar application of boron on fruit per feddan (kg), oil %, and oil content per plant (ml) and feddan ~~(l)~~

Parameters / Treatments	Oil %		Oil content (ml/ plant)		Oil content (L/feddan)	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control	0.92^{C}	0.94^{C}	0.16^{C}	0.17^{C}	13.78^{C}	14.54^{C}
10 mg/l B	0.98^{A}	0.99^{A}	0.21^{A}	0.22^{A}	17.11^{A}	17.31^{A}
20 mg/l B	0.96^{B}	0.96^{B}	0.19^{B}	0.19^{B}	15.42^{B}	15.82^{B}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.
Control (without organic matter), humic acid (H), bio-fertilizer (Bio) and humic acid + Bio-fertilizer (H+Bio.)
Control (without boric acid), 10 mg/l boric acid (10 mg/l B) and 20 mg/l boric acid (20 mg/l B)

With regard to oil chemical constituents by GLC data in figure (2) showed that, Linalool and Geranyle Acetate recorded the best values of 38.27% and 14.25% when spraying 20 mg/l B compared to control 31.82% and 26.65%. β-cymene compound recorded the lowest value of 0.14% when spraying 10 mg/l B, while it was not present in the control treatment.

On the other hand, α-Pinene, β-Terpenine, Myrcene, Borneol, Geranyle Acetate, Nerol increased significantly, as the highest values of these compounds were recorded at 7.77%, 3.05%, 7.28%, 8.37%, 3.49% and 3.78% compared to the control in which the percentage of these compounds decreased, where it recorded 2.07%, 2.06%, 1.83% and 0.99% 2.52% and 3.5%, respectively .

Whereas, limonene, Sabinene and Linaly Acetate recorded the lowest values in the proportion of coriander essential oil components 1.24%, 3.81% and 10.8%, while the percentage of these compounds in untreated plants increased by 2.52%, 15.2% and 10.84%, respectively.

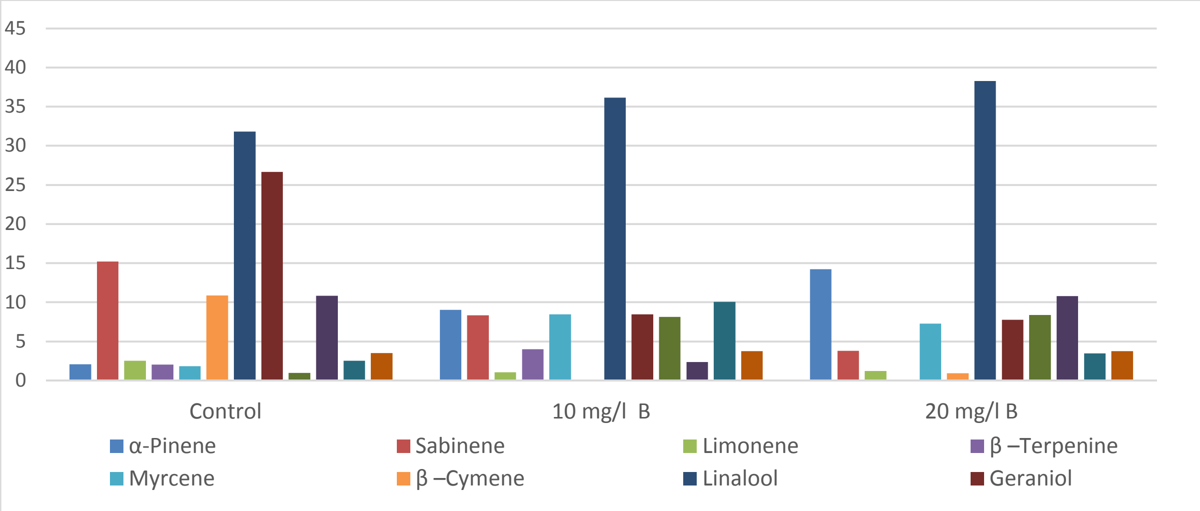

Fig. 2: Effect of foliar application of boron on the chemical compounds.

3- Effect of interaction

Data in table (6) show that, vegetative growth parameter of coriander plants were significantly influenced by the interaction between organic matter and boron concentrations at both seasons. Humic acid + bio-fertilizer treatment combined with 10 mg/l boron element affected significantly the following: plant height 80.60 cm and 83.83 cm, number of umbels 15.76 and 16.05 and fruit weight per plant 30.57 g and 31.13 g during first and second seasons, respectively.

Table 6: Effect of interaction between organic matter and foliar application of boron on growth characters.

Treatments	Parameters	Plant height (cm)		No. of umbels		Fruit weights (g/plant)		Fruit (kg/ feddan)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control	Control	26.87L	32.17J	7.48L	7.76 J	10.40J	11.53K	291.20J	322.84J
	10 mg/l B	34.93J	39.57I	8.19J	8.48 I	15.33H	15.63I	429.24H	437.64H
	20 mg/l B	32.7K	34.37J	7.86K	8.19 I	12.90I	14.13J	361.20I	395.64I
H	Control	52.03F	54.97F	11.43F	11.90 E	19.23F	20.00F	538.44F	560.00F
	10 mg/l B	59.87D	66.93D	13.62D	14.00C	23.00D	22.27D	644.00D	623.56D
	20 mg/l B	57.13E	61.00E	12.57E	13.10 D	21.23E	20.77E	594.44E	581.56E
Bio	Control	39.57I	41.77I	9.05I	9.33 H	16.27G	18.10H	455.56H	506.80H
	10 mg/l B	48.73G	50.33G	10.00G	10.86 F	18.43F	19.30F	516.04F	540.40F
	20 mg/l B	43.30H	45.27H	9.52H	9.90 G	17.40G	18.57G	487.20G	519.96G
H + Bio	Control	72.50C	75.63C	14.00C	14.33 C	24.40C	24.57C	683.20C	687.96C
	10 mg/l B	80.60A	83.83A	15.76A	16.05 A	30.57A	31.13A	855.96A	871.64A
	20 mg/l B	77.20B	80.17B	14.67B	15.29 B	27.13B	27.27B	759.64B	763.56B

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.
Control (without organic matter), humic acid (H), bio-fertilizer (Bio) and humic acid + Bio-fertilizer (H+Bio.)

Control (without boric acid), 10 mg/l boric acid (10 mg/l B) and 20 mg/l boric acid (20 mg/l B)

Regarding to the yield parameters effect of interaction between organic matters and spraying with boron, Table (7) showed that the yield parameters increased significantly from the coriander compared to the untreated in the two successive seasons. It was found that receiving coriander plants (humic acid and bio-fertilization together) + application of foliar spray with boron at a rate of 20 mg / liter gave the highest values in the yield parameters i.e. fruit weight per feddan 855.96 kg and 871.64 kg; oil percentage 1.09 % and 1.09 % and oil content per plant 0.33 ml and 0.34 ml and oil content per feddan 23.97 l and 24.41 l of those obtained by controlling the first and second seasons, respectively.

Table 7: Effect of interaction between organic matter and foliar application of boron on oil percentage and oil content per plant (ml) and feddan (L)

Treatments	Parameters	Oil %		Oil content (ml/ plant)		Oil content (l/feddan)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control	Control	0.78^{K}	0.80^{L}	0.08^{K}	0.09^{K}	8.15^{L}	9.04^{L}
	10 mg/l B	0.88^{I}	0.86^{J}	0.13^{I}	0.13^{I}	12.02^{J}	12.25^{J}
	20 mg/l B	0.84^{J}	0.83^{K}	0.11^{J}	0.12^{J}	10.11^{K}	11.08^{K}
H	Control	0.96^{F}	0.98^{F}	0.18^{F}	0.20^{F}	15.08^{F}	15.68^{F}
	10 mg/l B	1.01^{D}	1.02^{D}	0.23^{D}	0.23^{D}	18.03^{D}	17.46^{D}
	20 mg/l B	0.98^{E}	1.00^{E}	0.21^{E}	0.21^{E}	16.64^{E}	16.28^{E}
Bio	Control	0.91^{H}	0.91^{I}	0.15^{H}	0.16^{H}	12.76^{I}	14.19^{I}
	10 mg/l B	0.95^{F}	0.96^{G}	0.18^{F}	0.19^{F}	14.45^{G}	15.13^{G}
	20 mg/l B	0.93^{G}	0.95^{H}	0.16^{G}	0.18^{G}	13.64^{H}	14.56^{H}
H + Bio	Control	1.03^{C}	1.05^{C}	0.25^{C}	0.26^{C}	19.13^{C}	19.26^{C}
	10 mg/l B	1.09^{A}	1.09^{A}	0.33^{A}	0.34^{A}	23.97^{A}	24.41^{A}
	20 mg/l B	1.07^{B}	1.08^{B}	0.29^{B}	0.29^{B}	21.27^{B}	21.38^{B}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.
Control (without organic matter), humic acid (H), bio-fertilizer (Bio) and humic acid + Bio-fertilizer (H+Bio.)
Control (without boric acid), 10 mg/l boric acid (10 mg/l B) and 20 mg/l boric acid (20 mg/l B)

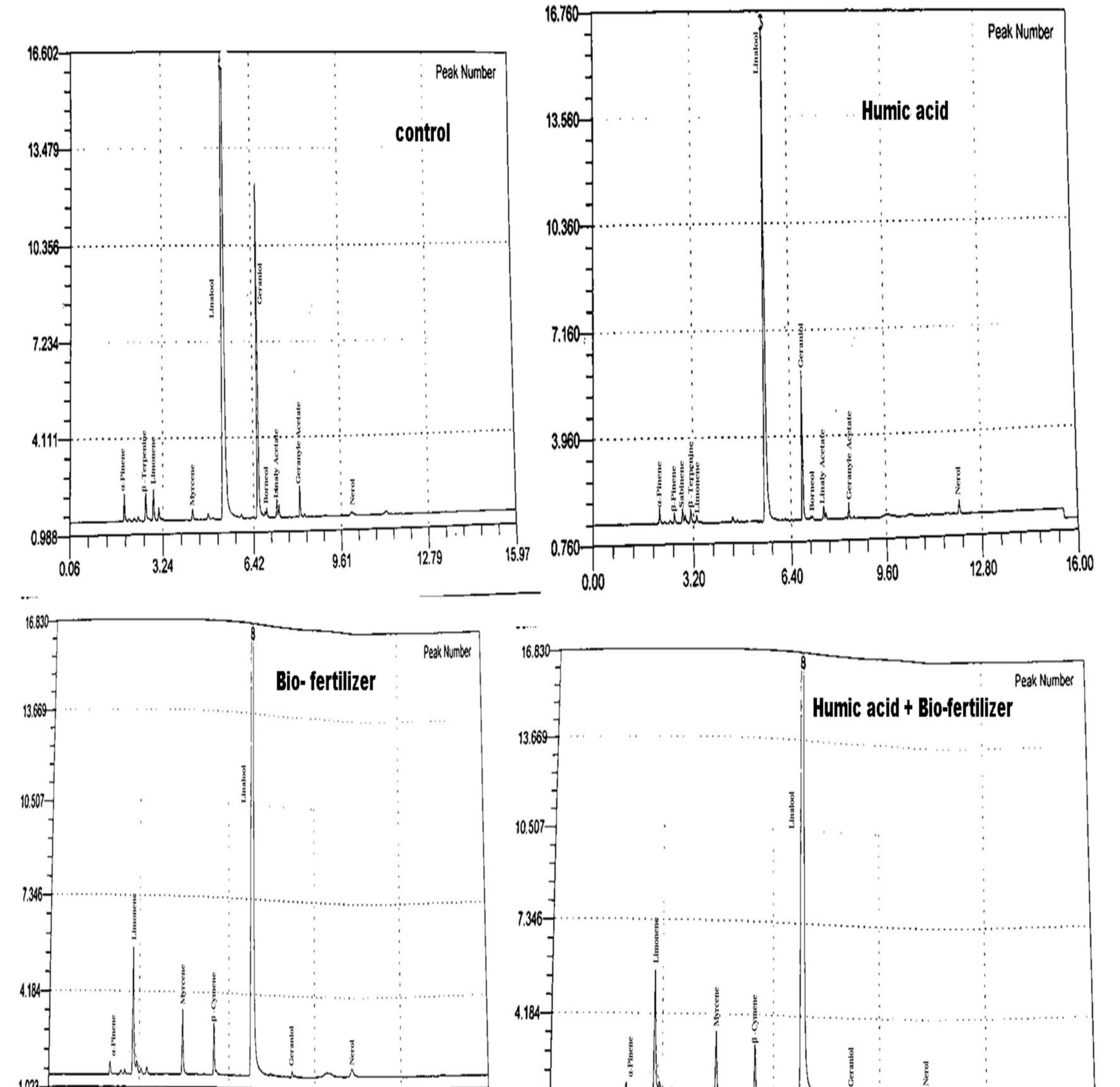

Fig. 3: G.L.C. analysis of extract coriander oil in organic matter treatments in season 2018/2019.

Middle East J. Agric. Res., 10(4): 1116-1129, 2021
EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2021.10.4.76*

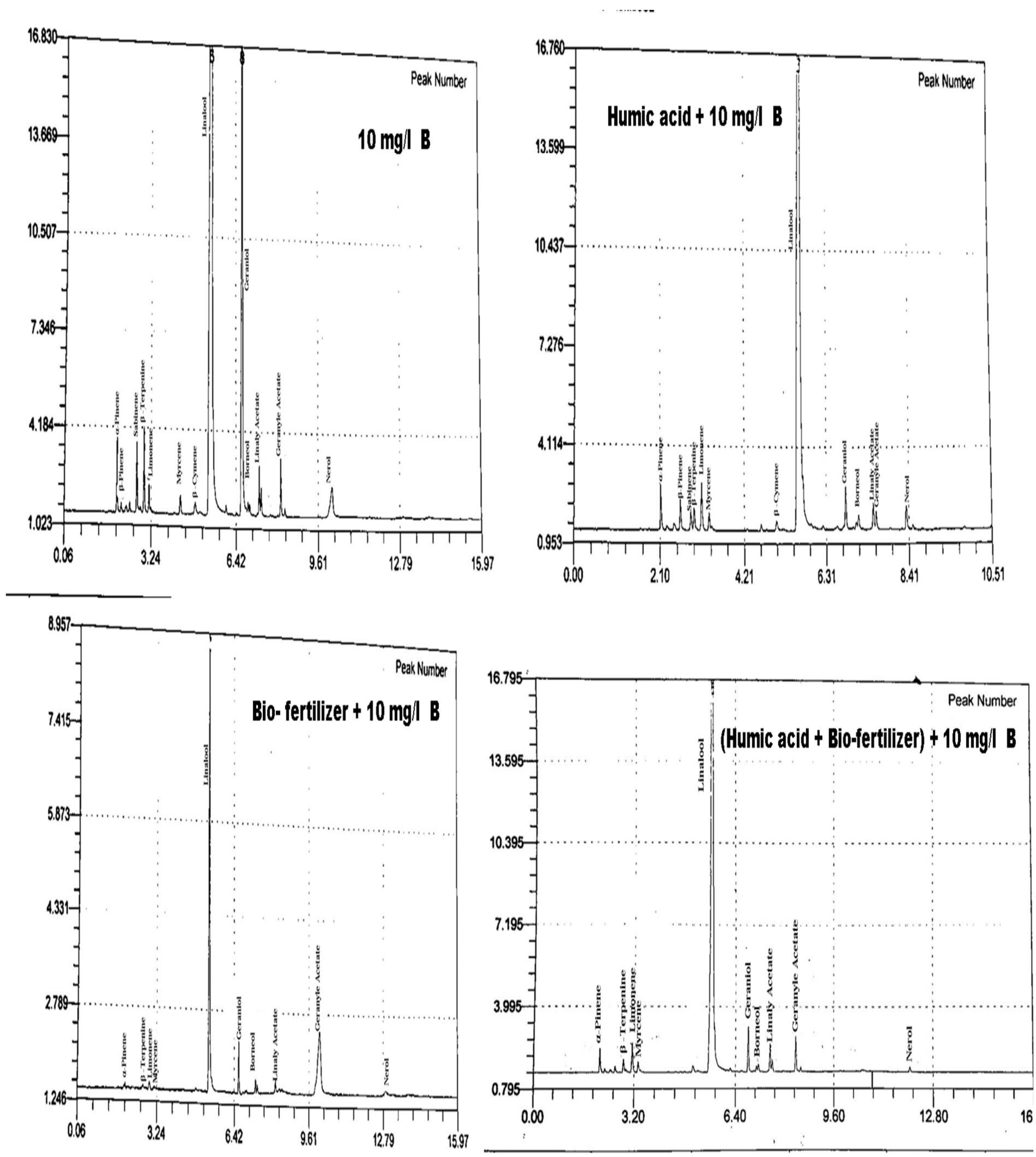

Fig. 4: G.L.C. analysis of extract coriander oil in foliar application 10 mg/l with organic matter treatments in season 2018/2019.

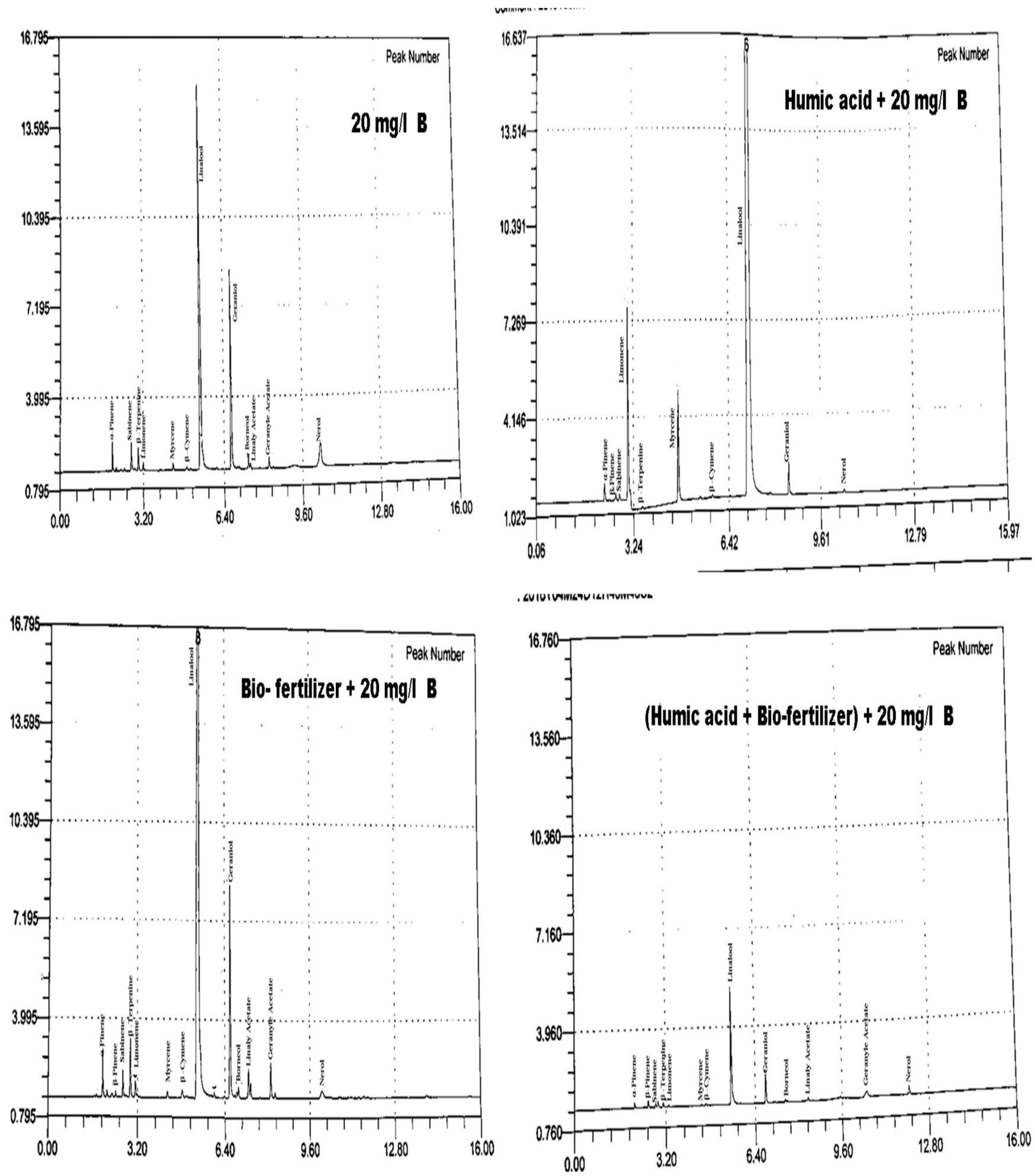

Fig.5: G.L.C. analysis of extract coriander oil in foliar application 20 mg/l with organic matter treatments in season 2018/2019.

Table 8: Effect of interaction between organic matter and foliar application of boron on the chemical compounds of essential oil.

Treatments \ Compounds	A-Pinene	Sabinene	Limonene	B –Terpenine	Myrcene	B –Cymene	Linalool	Geraniol	Borneol	Linaly acetate	Geranyle acetate	Nerol
Control	2.07	15.2	2.52	2.06	1.83	10.88	31.82	15.77	0.99	10.84	2.52	3.5
10 mg/l B	9.04	8.33	1.07	3.99	8.45	0.14	36.17	8.48	8.12	2.37	10.07	3.77
20 mg/l B	14.25	3.81	1.24	3 .05	7.28	0.94	38.27	7.77	8.37	10.8	3.49	3.78
H	5.54	10.9	1.25	1.9	6.12	5.02	41.01	8	2.99	12.7	2.15	2.42
H + 10 mg/l B	7.49	2.04	1.37	3.15	6.12	1.6	41.37	9.17	10.52	2.6	2.51	12.06
H + 20 mg/l B	0.15	-	1.96	-	10.25	0.83	44.62	9.75	9.03	4.35	-	19.06
Bio	5.98	3.58	2.8	2.94	2.47	1.34	46.39	14.5	3.56	-	-	16.44
Bio + 10 mg/l B	0.63	-	3.09	1.03	2.31	2.01	52.24	14.84	-	2.48	3.57	17.8
Bio + 20 mg/l B	3.79	2.57	4.25	4.43	0.49	0.64	52.6	15.99	2.8	2.25	4.71	5.48
(H + Bio)	3.54	2.38	6.87	1.43	4.75	3.85	53.32	15.68	7.58	1.64	3.69	5.27
(H + Bio) +10 mg/l B	3.53	2.53	3.24	1.04	1.4	-	55.56	26.65	2.66	2.92	3.22	4.55
(H + Bio) + 20 mg/l B	3.58	1.25	5.31	0.22	1.09	-	54.14	20.77	2.74	3.02	0.37	0.21

Control (without organic matter), humic acid (H), bio-fertilizer (Bio) and humic acid + Bio-fertilizer (H+Bio.)
Control (without boric acid), 10 mg/l boric acid (10 mg/l B) and 20 mg/l boric acid (20 mg/l B)

4. Discussion

Data in Tables (2,3,4,5,6,7 and 8) and figures (1,2,3 and 4) shows that, effect of evaluate the adaptation and foliar application of boron and their interaction between them to improve the growth and productivity of coriander plants due to the organic matter and boron element play an important role in biological processes within the plant. The increase in vegetative growth and yield parameters is due to the combined effect of organic matter and boron spraying and their interaction.

Statistical analysis of data in tables indicated that, effect of adding organic matter on the growth, fruits and oil of the coriander plant The significant increase in vegetative growth parameter due to the role played by humic acid in improving plant growth and increasing the efficiency of the roots to absorb water and dissolved nutrients in the soil Fageria *et al.,* (2011). Likewise, it stimulates the activity of microbes in the soil was reflected in an increase in vegetative growth that led to a significant increase in the yield as well. Fruits and plants Mohamed, (2012).

The increase in the vegetative growth and yield parameters resulting from the use of treatment humic acid + bio-fertilization, as the use of organic matters and their mixing with the soil increased the nitrogen readiness in the soil. Shahram and Ordookhani, (2011).

Also, humic acid and bio-fertilizer treatment play a role in increasing growth indicators because it has a positive effect on various biological processes such as respiration, photosynthesis and protein synthesis. These results are in agreement with Sharifirad, (2018) on *Coriandrum sativum*, L , Tuncay, *et al.,* (2019) on Parsley and El-Sayed *et al.,* 2015) on *Ocimum sp.*

The organic matter also helps in improving the properties of the soil by activating the beneficial microorganisms of the soil, which in turn converts non-absorbable foodstuffs into easily absorbable substances through the organic mineral process, which increases the ability of the soil to absorb and control the acidity of the soil, in addition to improving the ability of the soil to Water retention, which creates the conditions for the plant to absorb the nutrients needed for the plant's biological processes . The aforementioned results of organic matter was in parallel with those obtained by Abd El-Azim, *et al.,* (2017) on *Foeniculum vulgare*, Mill., Amal *et al.,* (2017) on *Mentha viridis*, Rania, and Abd El-Azim, (2016) on *Plantago psyllium*, and Elham and Rania, (2015) on *Hibiscus sabdariffa*, l.

The organic matter also helps in improving the properties of the soil by activating the beneficial microorganisms of the soil, which in turn converts non-absorbable nutrients into simple materials that are easily absorbed through the process of mineralizing organic materials, which contributes to increasing their absorption capacity, adjusting their acidity and improving its water system Akinci, (2011). Also provides the right and ideal circumstance for consuming nutrients by plants. This result corresponds to the opinion these results are in agreement with Wafaa *et al.,* 2021 on *Coriandrum sativum*, L.

On the other hand, the use of foliar spraying of boron led to a significant effect on all characteristics of coriander plants, where spraying of boron 10 mg/l led to a significant increase in the characteristics of urban growth, fruit growth and volatile oil production of coriander plants, may be due to the availability of the boron element, that facilitates the transfer of nutrients from the leaves to the all parts plant and improves its growth and flowering, so it is reflected by increasing the plant height (cm) and fruits of weight per plant (g) and feddan (kg) Gupta, and Gezgin and Hamurcu, (2006). Tables (2, 3, 4, 5, 6, 7and 8) and figures (1, 2, 3 and 4).

In addition, boron role in activation of nitrate reductase enzyme, which transports nitrogen in leaves to fruits, which led to an increase in fruit yield per plant (g) and feddan, which led to an increase in volatile oil content per plant (ml) and feddan. These results are similar to those found by Aref, (2011).

Moreover, the absorption of nitrogen increases and increases the vegetative system, which is an increase in the number of branches resulting in an increase in the number of flowers on the inflorescences of the plant as a result of the role of boron in pollination and fertilization processes and has an encouraging role in pollen germination and the growth of the vaccine tube Hosseini, *et al.,* (2007) and Lacey and Davies, (2009). Which led to improved growth of fruits, which was reflected in an increase in the yield of plants and feddan.

While the negative effect of the use of boron at a rate 20 mg/l due to the appearance of toxicity on plants such as yellowing of leaves and the small size of plants and fruits compared to the control, which was reflected in a decrease in the amount of fruit and oil production These results are in consistent with those obtained by Hamurcu, and Gezgin, (2007) on *Phaseolus vulgaris*, L. and Sabah, *et al.,* (2019) on *Vicia faba*.

5. Conclusion

To produce coriander with clean organic agriculture is the addition of humic acid and bio-fertilizer together to reduce add chemical fertilizers with foliar application of boron at 20 mg/l. also, supports the Egypt 2030 plan for the sustainable development of production healthy food, by reducing chemical fertilizers, pesticides and replacing them with safety fertilizers.

Reference

Abd El-Azim, W.M., Rania M. Khatefr and M.Y.M. Badawy, 2017. Effect of bio-fertilization and different licorice extracts on growth and productivity of *Foeniculum vulgare,* Mill. Plant. Middle East J. of Agriculture Research, 6 (1): 1-12.

Abdul Hafiz, A.A., 2012. The uses of humic lion to improve the growth, performance, and quality of horticultural crops. Faculty of Agriculture, Ain Shams University, Egypt.

Akinci, S. 2011. Humic acids plant growth and nutrient uptake. Marmara Univ. Fen Bilimleri Dergisi., 23(1):46-56.

Amal M. Omar, Rania M. Khater and M.I. Sherif, 2017. Using rhizobacteria and some growth promoting substances for improving of *Mentha viridis* productivity and its antioxidants. Egypt. J. of Appl. Sci., 32 (1): 17-40.

Analytical software, 2008. Statistix Version[9], Analytical Software, Tallahassee, Florida, USA.

Aref, F., 2011. Concentration of zinc and boron in corn leaf as affected by zinc sulfate and boric acid fertilizers in a deficient soil. Life Science Journal, 8:26-31.

Arslan, N., B. Gurbuz and A. Gumuscu, 2002. The Nomenclature of Medicinal Plants. Publication No. 1530, Ankara University, Faculty of Agriculture, Ankara.

Elham, M. Attia and Rania M. Khater, 2015 Effect of different planting dates and organic matters treatments on growth and yield of *Hibiscus sabdariffa,* l. plants. . Egypt. J. of Appl. Sci., 65 (1):153-170.

El-Khyat, L.A.S., 2013. Effect of chemical and bio fertilizer on growth and chemical composition of rosemary plants. M.Sc. Thesis Fac. Agric. Moshtohor, Benha Univ. Egypt.

El-Sayed A.A., S.H. El-Hanafy and R.A. El-Ziat 2015 Effect of Chicken Manure and Humic Acid on Herb and Essential Oil Production of *Ocimum sp.* American-Eurasian J. Agric. & Environ. Sci., 15 (3): 367-379.

Erdogdu, Y., 2012. The effect of different doses of nitrogen on yield, yield charecteristics and essential oil content of coriander (*Coriandrum sativum,* L.). Master Thesis, Namik Kemal University, Graduate School of Natural and Applied Sciences, Department of Field Crops, Tekirdag.

Fageria, N.K., V.C. Baligar, and C.A. Jones, 2011. Growth and mineral nutrition of field crops, 3rd edition. CRC Press, Boca Raton

Gezgin, S. and M. Hamurcu, 2006. The importance of the nutrient elements interaction and the interactions between boron with the other nutrients elements in plant nutrition. Selçuk University, Yearbook of the Faculty of Agriculture, 24-31 (In Turkish).

Gupta U.C. 1979. Boron nutrition of crops. Advance in agronomy: 273-307.

Gupta, U.C., 2006. Chapter 8. Boron. In: Hand book of plant nutrition. Barker AV, Pilbeam DJ (Eds) CRC Press, Boca Raton, FL, USA, 241-277.

Hamurcu, M. and S. Gezgin 2007. [Effect of boron and zinc applications on biomass values of dwarf bean (*Phaseolus vulgaris L.*) genotypes]. Selçuk Üniversitesi Ziraat Fakültesi Dergisi, 21(41):11-22.

Hosseini, S.M., M. Maftoun, N. Karimian, A. Rounaghi, and Y. Emam, 2007. Effect of zinc × boron interaction on plant growth and tissue nutrient concentration of corn. Journal of Plant Nutrition, 30:773-781.

Ibrahim, Heba A.K., Rania M.R. Khater, and Rehab H. Hegab, 2019. Evaluate the effect of compost tea and some chelated micronutrients forms on black cumin productivity. SN Applied Sciences, 1:28.

Lacey, A. and S. Davies, 2009. Boron toxicity in WA soils. WA Department of Agriculture and Food Farmnote, 388/2009. Government of Western Australia

Mohamed, H., 2012. Effects of humic acid and calcium forms on dry weight and nutrient uptake of maize plant under saline condition. Australian Journal of Basic and Applied Sciences, 6(8):597-604.

Nofal, I.M.S. and F.A. Menisi, 2019. Essential oils and their plants. Academic Library, Part 1.

Page, A.L., R.H. Miller and D.R. Keeney, 1984. Methods of Soil Analysis. Part 2: Chemical and Microbiological Properties. Second edition. Agronomy J. 9: 2, Am. Soc. Agron. Inc., Soil Sci. Soc. Am. Inc. Pub. Madison, Wisconsin, USA.

Rania, M. Khater and Wafaa H.A. Abd-Allah, 2017. Effect of some trace elements on growth, yield and chemical constituents of *Ocimum basilicum* plants. Egyptian J. Desert Res., 67 (1): 1- 23.

Rania M. Khater, Wafaa H.A. Abd-Allah and R.M.M. El Shafa, 2020. Effect of organic fertilization and spraying *Aloe vera* extract on the growth and productivity of *Carum carvi*, L. plant under Shalateen conditions in Egypt. *Plant Archives,* 20 (2): 4959-4971.

Rania, M. Khater and W.M. Abd El-Azim, 2016. Effect of fertilization and humic acid treatments on seeds production of *Plantago psyllium,* L. Egyptian J. Desert Res., 66 (1): 95-114.

Rania, M.R., Khater, 2010. Effect of some agriculture treatments on the growth and active ingredients of Nicotiana glauca under Sinai conditions. Ph.D. Thesis. Zagazig Univ. Egypt.

Sabah, L.A., T. Mohameed, and K.A. Hameed, 2019. Effect of Foliar Application of Boron and Seed Scarification on Some Vegetative Growth and Yield of Broad Bean *Vicia Faba* L. Local Var. Journal of University of Babylon for Pure and Applied Sciences, 27: (5).

Shahram, S. and K. Ordookhani, 2011. Organic and bio fertilizers as a good substitute for inorganic matters in medicinal plants farming. Australian Journal of Basic and Applied Sciences, 5(12): 1330-1333.

Sharifirad, M., 2018. Effect of different levels of humic acid on growth and physiological parameters of Coriander *(Coriandrum sativum, L.).* M.S. Thesis, University of Zabol, Iran.

Snedecor, G.W. and W.G. Cochran, 1980. In "Statistical Methods". 7th Ed. Iowa State Univ., Press, Amer., Iowa, USA.

Tuncay, T., A. Şener and B. Esin 2019. Determination of the Effect of Humic Acid on Growth and Development Parameters of Parsley (*Petroselinum sativum* Hoffm.) Grown in Boron Soil. Not. Bot. Horti. Agrobo., 47(1):183-193. DOI: 10.15835/nbha47111222.

Wafaa, H.A. Abd-Allah, Rania, M.R. Khater and R.M.M. El-Shafay, 2021. Effect of spraying with extracts of plants and amino acids on growth and productivity on *Coriandrum sativum* L. plants under Shalateen condition. Plant archives, 21(1): 300-307.