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Comparative study for the effect of spraying with blue green algae extract on some Russian dill varieties under El-Maghara region - North Sinai conditions

Toaima WIM, Osman YAH and Hamed ES

Abstract
A field experiment was carried out during the two successive seasons of 2012/2013 and 2013/2014 in North Sinai Governorate, Egypt to evaluate the seed productivity and quality of some Russian dill varieties by using organic farming practices. The experiment was conducted in split plot design. The main plots included foliar spray of various concentrations of blue-green algae extract of *Spirulina platensis* (0, 0.5, 1 and 1.5 liter extract/200 liter water/feddan). The sub-plots included sowing of five different dill varieties (local, Superdukat OE, Max, Salute Bush "Fireworks" and Aurora). The interaction results indicated that cultivation of Aurora variety combined with foliar spray of 1.5 liter of blue-green algae extract produced significantly maximum seed yield per plant and per feddan, volatile oil yield per plant and per feddan in addition to obtaining the highest d-limonene concentration as an important aroma impact component in seed volatile oil over control treatment (cultivation of local type without foliar spray of algae extract) which recorded the lowest parameters.

Keywords: Dill, varieties, *Spirulina platensis*, seed, volatile oil, d-limonene

Introduction
Dill (*Anethum graveolens* L.) has a very long history of herbal use going back more than 2,000 years. The seeds of dill are a common and very effective household remedy for a wide range of digestive problems. An infusion is especially efficacious in treating gripe in babies and flatulence in young children. The seed is aromatic, carminative, mildly diuretic, galactogogue, stimulant and stomachic. Used either it as infusion, or by eating the seed whole, the essential oil in the seed relieves intestinal spasms and griping, helping to settle colic. Chewing the seed improves bad breath. Dill will also help to increase the flow of milk in nursing mothers and will then be taken by the baby in the milk to help prevent colic. Dill seeds are used whole or ground as a condiment for flavoring meats, sauces, stews, breads, vinegars, pastries, and vegetable. Principal dill production areas are India and Pakistan, but Egypt, Mexico, the Netherlands, the United States, Hungary, Germany and Holland also have commercially productive areas [1, 2, 3].
In Egypt, introducing new foreign varieties of medicinal and aromatic plants for cultivation based on its increasing global markets demand is considered necessary today for increasing Egyptian exports of herbs and spices. In this way, the point of the present paper was to evaluate the seed productivity and quality of some Russian dill varieties under El-Maghara region conditions, North Sinai Governorate by using organic farming practices.

Materials and Methods
This field experiment was conducted during the two successive seasons of 2012/2013 and 2013/2014 in newly reclaimed arid land in the Agricultural Experimental Station of the Desert Research Center at El-Maghara region (30.71º N and 33.33º E), North Sinai Governorate, Egypt to study the effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on *Anethum graveolens* L. seed quantity and quality. The experiment was designed in a split plot design with three replications. The main plots were consisted of four foliar spray concentrations of blue-green algae extract of *Spirulina platensis* as follows:- 0, 0.5, 1 and 1.5 liter extract/200 liter water/feddan. The sub-plots included sowing of five different dill varieties (local, Superdukat OE, Max, Salute Bush "Fireworks"

and Aurora). Compost manure was added to the sandy soil before sowing at the rate of 10 m^3 per feddan. The seeds of the local dill variety were obtained from the Egyptian Ministry of Agriculture and Land Reclamation while the seeds of Russian dill varieties were obtained from both of Gavrish Group Company (www.seeds.gavrish.ru) and Agrofirma Search Company (www.semenasad.ru) at Moscow. Sowing was done on October 1st for both seasons under drip irrigation system in rows 75 cm apart and 30 cm between hills. After germination the plants were thinned at two plants per hill (37333 plants/feddan). The blue-green algae extract was obtained from Algae Production Unit at the National Research Center, Egypt. It was an extract of *Spirulina platensis* algae. The algae extract was applied as foliar application twice per season after 60 and 90 days of sowing date. Plants were harvested on 1st of May in both seasons. L.S.D. test at 0.05 was used to compare the average means of treatments according to [4]. The following data were recorded:-

A- Growth and seed yield parameters: Plant height (cm), herb dry weight (g/plant), number of umbels per plant, seed yield / plant (g) and seed yield / feddan (ton).

B- Active constituent's parameters

1. Determination of essential oil percentage: Essential oil percentage was determined in the air dried seed by hydrodistillation for 3 hours using a Clevenger type apparatus [5].

2. Determination of volatile oil yield per plant (ml) as follows: Oil percentage x seed dry weight per plant /100

3. Determination of essential oil yield per feddan (L) as follows: Oil yield per plant x number of plants/feddan.

4. Determination of essential oil components: The essential oil samples of the second season were analyzed by using Gas Chromatography-Mass Spectrometry instrument (GC-MS analysis) at the Laboratory of Medicinal and Aromatic Plants, National Research Center, Egypt with the following specifications. Instrument: a TRACE GC Ultra Gas Chromatographs (THERMO Scientific Corp., USA), coupled with a THERMO mass spectrometer detector (ISQ Single Quadrupole Mass Spectrometer). The GC-MS system was equipped with a TR-5MS column (30 m x 0.32 mm i.d., 0.25 µm film thickness). Analyses were carried out using helium as carrier gas at a flow rate of 1.3 ml/min at a split ratio of 1:10 and the following temperature program: 80ºC for 1 min; rising at 4ºC/min to 300ºC and held for 1min. The injector and detector were held at 220 and 200ºC, respectively. Diluted samples (1:10 hexane, v/v) of 1 µL of the mixtures were always injected. Mass spectra were obtained by electron ionization (EI) at 70 eV, using a spectral range of m/z 40-450. The separated components of the essential oil were identified by matching with the National Institute of Standards and Technology (NIST) published.

The soil, water, compost manure and *Spirulina platensis* algae extract samples were analyzed at the laboratories of Desert Research Center and Soils, Water and Environment Research Institute, as shown in Tables (A, B, C, D and E).

Table (A): The mechanical analysis of the experimental soil area.

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Soil texture
0-30	95.00	4.00	1.00	Sandy

Table (B): The chemical analysis of the experimental soil area.

pH	E.C. (ds/m)	O.M. (%)	Soluble anions (meq/l)				Soluble cations (meq/l)			
			CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+
7.9	2.8	0.5	-	1.0	20.0	7.0	6.0	8.0	12.6	1.4

Table (C): The chemical analysis of irrigation water.

pH	E.C.	Soluble anions (meq/l)				Soluble cations (meq/l)			
	ppm	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+
7.32	2547.15	-	4.26	23.59	11.44	11.45	9.64	17.31	0.89

Table (D): The chemical analysis of used compost manure**.**

pH	EC (ds/m)	O.M. (%)	C/N ratio (%)	N (%)	P (%)	K (%)	Fe (%)	Mn (mg/kg)	Zn (mg/kg)	Cu (mg/kg)
8.8	4.6	20.5	11.85	1.03	0.22	2.04	3.43	606.8	85.65	43.60

Table (E): The chemical analysis of used *Spirulina platensis* algae extract.

Macro elements (%)			Micro elements (%)			
N	P	K	Fe	Zn	Mn	Cu
4.30	2.15	0.10	2.11	2.42	3.04	0.75

Results and Discussion

I-Effect of foliar spray of blue-green algae (*Spirulina platensis*) extract

According to the results presented in Tables (1, 2, 3, 4 and 5) there was a positive relationship between increasing algae extract concentration and the increments in growth and yield parameters. The highest concentration of 1.5 liter /feddan increased significantly plant height, herb dry weight per plant, number of umbels per plant, seed yield per plant and per feddan over control plants (without algae treatment) which recorded lowest parameters. Also, increasing concentration of algae extract increased significantly essential oil percentage of seed, essential oil yield per plant as well as per feddan. The maximum increments were detected by 1.5 liter /feddan (Tables 6, 7 and 8).

In both seasons, the stimulatory effect of foliar spray with *Spirulina platensis* extract could be due to its high content of macro and micro elements (Table E), as well as its high

content of free amino acids. Also, it contains the whole spectrum of natural mixed carotene and xanthophyl phytopigments which is considered as the richest natural source of vitamin B-12. In addition to the presence of high levels of various plant hormones such as auxin and cytokinin, which is considered an important and vital for raising the plant production and increasing the capacity of plant to withstand various stress conditions. Moreover, it is non-polluting, inexpensive and utilizable renewable resource. So, *Spirulina platensis* is recommended to be used as a successful organic fertilizer and is considered one of the recent trends in bio-fertilization [6-10].

II-Effect of dill variety type

Data presented in Tables (1, 2, 3, 4 and 5) and Figs. (1 and 2) revealed that in both seasons, all Russian varieties super passed significantly the local variety in most growth and yield parameters except the Superdukat OE which had less vegetative and yield parameters than local type. The Aurora variety had significantly heaviest dry weight per plant, seed yield per plant and per feddan. In addition, the Aurora variety produced significantly maximum oil yield per plant and per feddan over local one. Concerning the effect of variety type on essential oil percentage, the Russian varieties recorded lower values than local variety except Superdukat OE which recorded significantly highest oil percentage over local type (Tables 6, 7 and 8). These results coincided with those reported by [11] who found differences between dill varieties according to the yield and crop quality.

III-Effect of the interaction

Data presented in Tables (1, 2, 3, 4, 5, 6, 7, 8 and 9) showed that the significantly superior treatment was cultivation of Aurora dill variety combined with foliar spray of 1.5 liter of algae extract/fedaan which produced significantly heaviest dry weight per plant, seed yield per plant as well as per feddan over control treatment (cultivation of local type without spray of algae extract). Regarding the effect of interaction treatments on essential oil percentage, the highest significant value was detected by cultivation of Superdukat OE variety combined with foliar spray of 1.5 liter of algae extract/ feddan.

The GC-MS analysis of seed volatile oils (Table 9) proved the presence of carvone and d-limonene as the main dominant components in seed volatile oils composition. Moreover, results indicated that seed volatile oil of Egyptian variety had higher carvone content while seed volatile oils of Russian varieties had higher d-limonene contents. Also, the foliar spray of *Spirulina platensis* algae extract increased d-limonene content while decreased carvone content. These results can be discussed as follows:-

For seed volatile oil of Egyptian variety without algae application its composition was (carvone 49.43% and d-limonene 12.89%) while with algae application its composition was (carvone 44.73% and d-limonene 31.60%). As for seed volatile oil of Superdukat OE variety without algae application its composition was (carvone 51.86% and d-limonene 34.66%) while with algae application its composition was (carvone 42.66% and d-limonene 43.96%). For seed volatile oil of Max variety without algae application its composition was (carvone 39.06% and d-limonene 46.54%) whereas with algae application the composition was (carvone 34.98% and d-limonene 48.59%). Regarding seed volatile oil of Salute Bush (Fireworks) variety without algae application the composition was (carvone 54.47% and d-limonene 33.75%) but with algae application the composition was (carvone 40.31% and d-limonene 38.29%). With respect to seed volatile oil of Aurora variety without algae application its composition was (carvone 40.86% and d-limonene 43.68%) on the other side with algae application the composition was (carvone 37.70% and d-limonene 44.23%).

From the aforementioned results, it is obvious that applying of *Spirulina* algae extract improved the quality of seed yield through increasing its contents of d-limonene concentrations as both of limonene (responsible for seed pleasant fresh odor) and carvone (responsible for seed spicy odor) are aroma impact compounds in dill seed, and therefore increasing its benefits in food and medicinal industries [12, 13]. This may be attributed to *Spirulina platensis* algae extract which acted as a natural source for antioxidants [14]. Moreover, the obtained carvone content was over the minimum acceptable level of carvone (30%) in the world trade [15]. The analyses of dill seed oils were in harmony with those reported by [16, 17, 18].

As a final point, one of the major problems encountered by organic farmers was found to be initial lower yields [19], therefore it is recommended for organic farmers to choose cultivation of high productivity varieties of medicinal and aromatic plants and fertilization with high nutrients come from natural sources especially under arid poor lands conditions.

Tables of growth parameters

Table 1: Effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on plant height (cm) during the two successive seasons of 2012/2013 and 2013/2014.

Dill varieties / Algae extract concentrations	Local	Superdukat OE	Max	Salute Bush (Fireworks)	Aurora	Mean
0 liter / 200 liter water	111.71	74.67	108.38	100.38	105.10	100.05
0.5 liter / 200 liter water	114.90	114.39	112.71	105.83	110.56	111.68
1 liter / 200 liter water	124.25	117.22	120.10	110.50	114.22	117.26
1.5 liter / 200 liter water	134.71	118.67	122.67	125.25	125.71	125.40
Mean	121.39	106.24	115.97	110.49	113.90	
LSD 0.05						
Algae concentrations	10.12					
Variety	6.53					
Algae concentrations x variety	13.07					

* Values are means of two seasons.

Table 2: Effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on herb dry weight (g/plant) during the two successive seasons of 2012/2013 and 2013/2014.

Dill varieties / Algae extract concentrations	Local	Superdukat OE	Max	Salute Bush (Fireworks)	Aurora	Mean
0 liter / 200 liter water	85.61	69.37	96.49	97	121.31	93.96
0.5 liter / 200 liter water	103.20	75.94	110.03	146.86	187.53	124.71
1 liter / 200 liter water	101.25	94.02	131.02	195.13	237.51	151.79
1.5 liter / 200 liter water	152.75	124.05	168.04	232.00	297.79	194.93
Mean	110.70	90.85	126.40	167.75	211.04	
LSD 0.05						
Algae concentrations	13.33					
Variety	11.92					
Algae concentrations x variety	23.83					

* Values are means of two seasons.

Tables of yield parameters

Table 3: Effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on number of umbels per plant during the two successive seasons of 2012/2013 and 2013/2014.

Dill varieties / Algae extract concentrations	Local	Superdukat OE	Max	Salute Bush (Fireworks)	Aurora	Mean
0 liter / 200 liter water	14.10	9.33	10.00	12.00	14.00	11.89
0.5 liter / 200 liter water	19.44	10.75	12.17	13.67	18.50	14.91
1 liter / 200 liter water	26.34	12.50	16.00	20.23	23.42	19.70
1.5 liter / 200 liter water	30.83	17.76	20.00	23.00	29.00	24.12
Mean	22.68	12.59	14.54	17.23	21.23	
LSD 0.05						
Algae concentrations	1.68					
Variety	2.37					
Algae concentrations x variety	4.74					

* Values are means of two seasons.

Table 4: Effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on seed yield / plant (g) during the two successive seasons of 2012/2013 and 2013/2014.

Dill varieties / Algae extract concentrations	Local	Superdukat OE	Max	Salute Bush (Fireworks)	Aurora	Mean
0 liter / 200 liter water	19.11	18.15	22.76	23.03	27.61	22.13
0.5 liter / 200 liter water	26.09	19.26	25.95	27.09	36.54	26.99
1 liter / 200 liter water	31.03	23.73	33.73	37.95	45.00	34.29
1.5 liter / 200 liter water	35.54	25.15	38.11	41.75	53.79	38.87
Mean	27.94	21.57	30.14	32.46	40.74	
LSD 0.05						
Algae concentrations	3.20					
Variety	2.79					
Algae concentrations x variety	5.59					

* Values are means of two seasons.

Table 5: Effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on seed yield / feddan (ton) during the two successive seasons of 2012/2013 and 2013/2014.

Dill varieties / Algae extract concentrations	Local	Superdukat OE	Max	Salute Bush (Fireworks)	Aurora	Mean
0 liter / 200 liter water	0.71	0.68	0.85	0.86	1.03	0.83
0.5 liter / 200 liter water	0.97	0.72	0.97	1.01	1.36	1.01
1 liter / 200 liter water	1.16	0.89	1.26	1.42	1.68	1.28
1.5 liter / 200 liter water	1.33	0.94	1.42	1.56	2.01	1.45
Mean	1.04	0.81	1.13	1.21	1.52	
LSD 0.05						
Algae concentrations	0.12					
Variety	0.10					
Algae concentrations x variety	0.21					

* Values are means of two seasons.

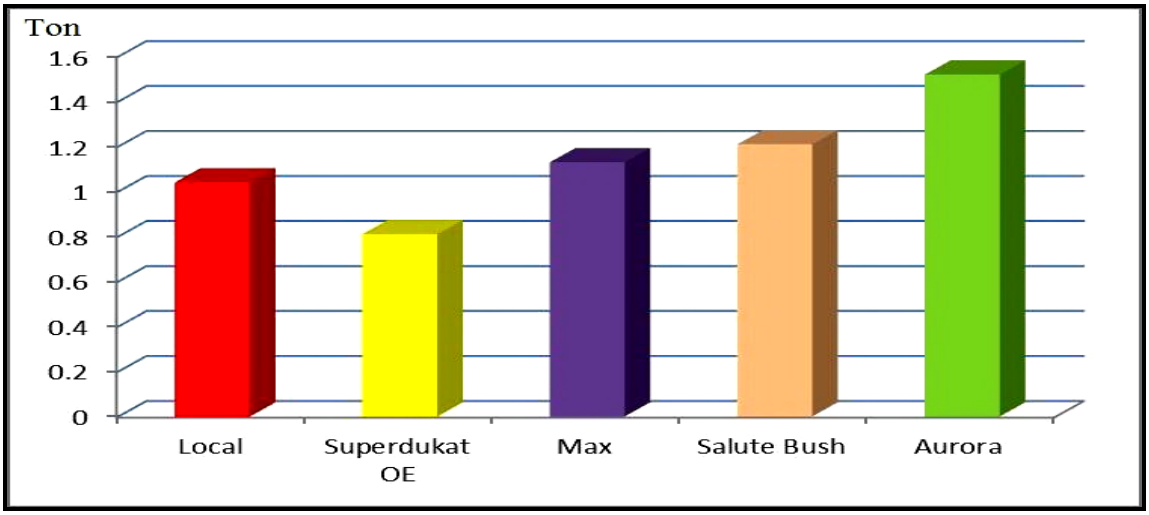

Fig 1: Effect of dill variety type on seed yield / feddan (ton).

Tables of active constituents parameters

Table 6: Effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on seeds essential oil percentage during the two successive seasons of 2012/2013 and 2013/2014.

Dill varieties / Algae extract concentrations	Local	Superdukat OE	Max	Salute Bush (Fireworks)	Aurora	Mean
0 liter / 200 liter water	1.86	2.04	1.27	1.40	1.79	1.67
0.5 liter / 200 liter water	2.12	2.14	1.34	1.49	1.83	1.78
1 liter / 200 liter water	2.16	2.14	1.50	1.63	1.95	1.88
1.5 liter / 200 liter water	2.28	2.42	1.64	1.83	2.05	2.04
Mean	2.11	2.19	1.44	1.59	1.91	
LSD 0.05						
Algae concentrations	0.06					
Variety	0.05					
Algae concentrations x variety	0.10					

* Values are means of two seasons.

Table 7 : Effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on essential oil yield per plant (ml) during the two successive seasons of 2012/2013 and 2013/2014.

Dill varieties / Algae extract concentrations	Local	Superdukat OE	Max	Salute Bush (Fireworks)	Aurora	Mean
0 liter / 200 liter water	0.36	0.37	0.29	0.32	0.49	0.37
0.5 liter / 200 liter water	0.55	0.41	0.35	0.40	0.67	0.48
1 liter / 200 liter water	0.67	0.51	0.51	0.62	0.88	0.64
1.5 liter / 200 liter water	0.81	0.61	0.62	0.76	1.10	0.78
Mean	0.60	0.48	0.44	0.53	0.79	
LSD 0.05						
Algae concentrations	0.07					
Variety	0.05					
Algae concentrations x variety	0.11					

* Values are means of two seasons.

Table 8: Effect of foliar spray by different concentrations of blue-green algae extract, dill variety type and their interaction on essential oil yield per feddan (l) during the two successive seasons of 2012/2013 and 2013/2014.

Dill varieties / Algae extract concentrations	Local	Superdukat OE	Max	Salute Bush (Fireworks)	Aurora	Mean
0 liter / 200 liter water	13.44	13.81	10.83	11.95	18.29	13.66
0.5 liter / 200 liter water	20.53	15.31	13.07	14.93	25.01	17.77
1 liter / 200 liter water	25.01	19.04	19.04	23.15	32.85	23.82
1.5 liter / 200 liter water	30.24	22.77	23.15	28.37	41.07	29.12
Mean	22.31	17.73	16.52	19.60	29.31	
LSD 0.05						
Algae concentrations	2.57					
Variety	1.99					
Algae concentrations x variety	3.97					

* Values are means of two seasons.

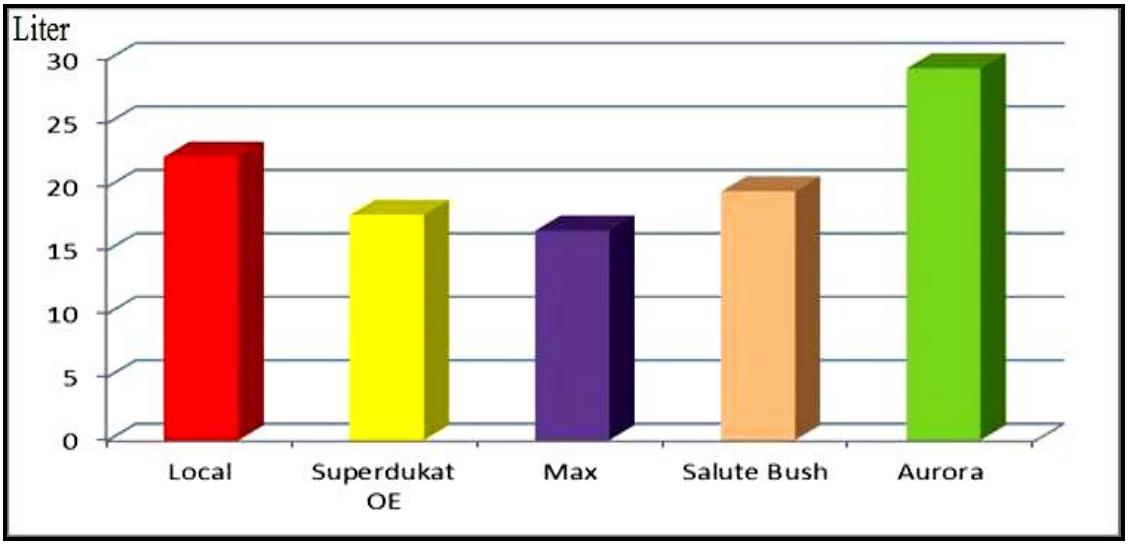

Fig 2: Effect of dill variety type on seed essential oil yield per feddan (l).

Table 9: Effect of the interaction between treatments on seed volatile oils chemical constituents (%).

NO	Compound	Local variety + without foliar spray of algae extract	Local variety + foliar spray of 1.5 liter algae extract	Superdukat OE variety + without foliar spray of algae extract	Superdukat OE variety + foliar spray of 1.5 liter algae extract	Max variety + without foliar spray of algae extract	Max variety + foliar spray of 1.5 liter algae extract	Salute Bush (Fireworks) variety + without foliar spray of algae extract	Salute Bush (Fireworks) variety + foliar spray of 1.5 liter algae extract	Aurora variety + without foliar spray of algae extract	Aurora variety + foliar spray of 1.5 liter algae extract
1	2-Pentanone, 3,4-epoxy-3,4-dimethyl-	-	-	0.05	-	-	0.03	-	-	-	-
2	3-Methylheptane	-	-	-	0.02	-	-	0.02	-	-	-
3	Ceanothene-c	-	0.04	-	-	-	-	-	-	-	-
4	α-Thujene	-	0.07	0.15	0.09	0.15	0.17	0.10	-	0.15	0.16
5	α-Pinene	-	0.63	0.79	0.56	0.89	1.16	0.61	1.78	0.96	1.13
6	Hexane	-	-	-	-	-	-	0.02	-	-	-
7	Camphene	-	0.05	-	-	0.03	-	-	0.06	-	-
8	Sabinene	-	0.20	0.13	0.08	0.05	0.13	0.04	0.12	0.09	0.08
9	2-α-pinene	-	-	-	-	-	-	0.05	-	0.06	0.06
10	α-Myrcene	-	0.07	0.14	0.13	0.11	0.12	0.07	0.15	0.16	0.10
11	Geraniol formate		0.20	0.03	-	-	-	-	-	-	-
12	3-Methylene-1,5,5-trimethylcyclohexene	-	0.09	-	-	-	-	-	-	-	-
13	α-Phellandrene	1.15	5.34	7.77	9.30	9.30	11.30	5.69	12.76	10.39	12.74
14	D-Limonene	12.89	31.60	34.66	43.96	46.54	48.59	33.75	38.29	43.68	44.23
15	Linalool	-	-	-		-	-	-	0.08	-	-
16	Carvone oxide, cis-	-	0.05	-	-	-	-	-	-	-	-
17	Nerol	-	-	0.06	0.05	0.04	0.07	-	-	-	-
18	1-Terpineol	-	-	-	-	-	-	0.06	-	-	0.07
19	exo-2,7,7-trimethylbicyclo[2.2.1]heptan-2-ol		-	-	-	-	-	-	-	-	-
20	Trans-D-Dihydrocarveol	-	-	-	-	-	-	-	0.07	-	-
21	Cis-Limonene oxide	-	0.04	0.03	0.03	0.04	0.03	0.02	0.10	-	0.03
22	p-Mentha-6,8-dien-2-ol,cis-	-	-	-	0.02	0.02	0.03	-	0.13	-	-
23	Carveol 2	-	-	-	-	-	-	0.03	-	-	-
24	4,6,6-Trimethylbicyclo [3.1.1]heptan-2-ol	-	-	-	-	-	-	-	-	-	0.03
25	Oxanamide	-	0.05	-	-	-	-	-	-	0.04	-
26	(+)-2-Bornanone	-	1.05	-	-	-	-	-	-	-	-
27	Perilla alcohol	-	-	-	-	-	-	-	0.08	-	-
28	Trans-2-Caren-4-ol	-	-	-	-	-	-	0.02	-	-	-
29	3-Pinanylamine	-	-	-	-	0.04	-	-	-	-	0.04
30	Trans-Z-α-Bisabolene epoxide	-	0.04	-	-	-	-	-	-	0.05	-
31	Capric acid methyl ester	0.97	-	-	-	-	-	-	-	-	-
32	Dill ether	-	0.39	0.43	0.59	0.17	0.26	0.20	0.48	0.30	0.48
33	(+)-4-Carene	-	-	-	0.02	-	-	-	-	-	-
34	Cis-dihydrocarvone	2.92	0.17	0.17	0.11	0.13	0.15	0.27	0.18	0.15	-
35	Dihydrocarvone	-	1.89	3.39	1.94	2.76	2.50	4.11	3.87	2.69	2.51
36	p-Menth-8-en-2-ol	-	0.06	0.04	-	0.11	0.03	-	0.18	0.05	0.20
37	Phellandral	-	-	-	-	-	-	-	-	0.03	-
38	Limonene oxide	-	0.04	-	0.03	-	-	-	0.06	-	-
39	Trans-(+)-carveol	-	-	-	0.04	0.06	0.03		-	-	0.09
40	9-Octadecenal	-	-	-	-	-	-	0.03	-	-	-
41	Methyl 8-oxooctanoate	4.53	-	-	-	-	0.03	-	-	-	-

42	Cis-D-dihydrocarveol	-	-	-	0.11	-	0.07	0.14	-	0.15	0.07
43	1,7,7-Trimethylbicyclo[2.2.1]heptane-2,5-diol	-	-	-	-	-	0.06	-	-	-	0.04
44	Dihydrocarveol	-	0.12	0.15	-	-	-	0.05	-	-	-
45	Carvone	49.43	44.73	51.86	42.66	39.06	34.98	54.47	40.31	40.86	37.70
46	1,7,7-Trimethylbicyclo [2.2.1]heptane-2,5diol	-	-	-	-	-	-	-	0.23	-	-
47	Piperitone	4.68	9.06	-	-	-	-	-	-	-	-
48	d-Carvone	-	0.04	0.15	0.03	0.31	0.16	0.06	0.19	0.14	0.24
49	Dihydrocarvyl acetate	-	-	-	-	0.08	0.10	0.16	0.43	-	-
50	3-Isopropenyl-1-cyclooctene	-	-	-	-	-	-	-	-	0.05	-
51	5,8,11-Heptadecatrien-1-ol	-	-	-	-	0.06	-	-	-	-	-
52	(2Z,6Z)-2, 6-Dimethyl2, 6octadiene-1, 8-diol	-	-	-	-	-	-	-	-	-	-
53	Limonen-6-ol,pivalate	-	-	-	-	0.05	-	0.03	-	-	-
54	Methyl undecanoate	0.83	-	-	-	-	-	-	-	-	-
55	Methyl 6-nonynoate	0.93	-	-	-	-	-	-	0.08	-	-
56	Non-1-yn-5-en-9-aldehyde, 4-ethoxycarbonyl-	-	-	-	-	-	-	-	0.37	-	-
57	Azelaaldehydic acid, methyl ester	4.97	-	-	-	-	-	-	-	-	-
58	α-Bergamotene	-	-	-	0.06	-	-	-	-	-	-
59	10-Oxo-decanoic acid methyl ester	5.70	-	-	-	-	-	-	-	-	-
60	Azelaic acid, dimethyl ester	0.84	-	-	-	-	-		-	-	-
61	α-copaene	-	-	-	0.02	-	-	-	-	-	-
62	ç-Muurolene	-	-	-	0.02	-	-	-	-	-	-
63	Methyl 10-oxodecanoate	0.95	-	-	-	-	-	-	-	-	-
64	Methyl (7E)-7-hexadecenoate	0.66	-	-	-	-	-	-	-	-	-
65	(9Z)8Methyl9tetradecenoic acid	0.78	-	-	-	-	-	-	-	-	-
66	Methyl-tridec-12-ynoate	0.98	-	-	-	-	-	-	-	-	-
67	8-epi-.gama.eudesmol	-	-	-	0.04	-	-	-	-	-	-
68	Methyl 13-tetradecynoate	0.88	-	-	-	-	-	-	-	-	-
69	Dill-Apiol	2.70	3.98	-	-	-	-	-	-	-	-
70	.tau. Cadinol	-	-	-	0.09	-	-	-	-	-	-
71	Methyl (9E)-11-oxo-9-undecenoate	3.21	-	-	-	-	-	-	-	-	-

Conclusion

From the foregoing results, we could conclude that under El-Magara region conditions, North Sinai Governorate, Aurora dill variety is recommended to be cultivated and plants should be foliar sprayed with *Spirulina platensis* extract at concentration of 1.5 liter extract / 200 liter water/feddan after 60 and 90 days of sowing date for producing the highest seed yield with the highest quality specifications.

References

1. Duke J. The Green Pharmacy, The Ultimate Compendium of Natural Remedies from the World's Foremost Authority on Healing and Herbs. Rodale Press, USA, 1997.
2. Osman YAH, Abd El-Wahab MA. Economic evaluations for harvesting management of parsley (*Petroselinium Sativum Crispum* (Mill.) Nym) and dill (*Anithum Graveolens* L.) plants under North Sinai conditions. Research Journal of Agriculture and Biological Sciences 2009; 5(3):218-222.
3. Peter KV. Handbook of Herbs and Spices. Woodhead Publishing Limited, UK, 2012.
4. Snedecor GW, Cochran WG. Statistical Methods, the Iowa State Univ., Press, Ames, Iowa, U.S.A, 1982.
5. British Pharmacopoeia. Determination of Volatile Oil in Drugs. The Pharmaceutical Press, London, 1963.
6. Aly, Esawy. Evaluation of *Spirulina platensis* as bio. Stimulator for organic farming systems. JGEB. 2008; 6(1):1-7.
7. Anitha L, Bramari GS, Kalpana P. Effect of Supplementation of *Spirulina platensis* to Enhance the Zinc Status in Plants of *Amaranthus gangeticus*, *Phaseolus aureus* and Tomato. Advances in Bioscience and Biotechnology. 2016; 7:289-299.
8. Khater RMR. Effect of sowing dates and foliar spray with algae extract on cluster bean (*Cyamopsis tetragonoloba* L.). International Journal of Pharm Tech Research 2016; 9(9):75-84.
9. Moghith WMA. Effect of organic and biofertilization on the growth, production and the chemical constituents of *Origanum vulgare* L. plants, M.Sc. Thesis, Fac. Agric., Tanta Univ., Egypt, 2016.
10. Kemka HO, Rebecca AA, Gideon OA. Influence of temperature and pH bioresource and protein biosynthesis in putative *Spirulina* sp. Bioresource Technology, 2007; 98:2207-2211.
11. Karklelienė R, Radzevičius A, Maročkienė N, Dambrauskienė E, Duchovskienė L. Dill (*Anethum graveolens* L.) productivity evaluation and varieties selection for organic growing. Sodininkystė ir Daržininkystė. 2012; 31(1/2):50-54.
12. Blank, Grosch W. Evaluation of potent odorants in dill seed and dill herb (*Anethum graveolens* L.) by aroma extract dlution analysis. Journal of Food Science. 1991; 56(1):63-67.
13. Jirovetz L, Buchbauer G, Stoyanova AS, Georgiev EV, Damianova ST. Composition, quality control, and antimicrobial activity of the essential oil of long-time stored dill (*Anethum graveolens* L.) seeds from Bulgaria. Journal of Agricultural and Food Chemistry. 2003; 51(13):3854-7.
14. Herrero M, Ibáñez E, Cifuentes A, Señoráns J. Pressurized liquid extracts from *Spirulina platensis* microalga. Determination of their antioxidant activity and preliminary analysis by micellar electrokinetic chromatography. Journal of Chromatography A 2004; 1047(2):195-203.
15. Wall DA, Friesen GH. The effect of herbicides and

weeds on the yields and composition of dill (*Anethum graveolens* L.) oil. Crop Prot. 1986; 5:137-142.
16. Guenther E. In The Essential Oils. Van Nostrland Comp. Inc. New York, 1972, IV.
17. Badoc A, Lamarti A. A chemotaxonomic evaluation of *Anethum graveolens* L. (Dill) of various origins. Journal of Essential Oil Research. 2003; 3:269-278.
18. Kaur GJ, Arora DS. Bioactive potential of *Anethum graveolens*, *Foeniculum vulgare* and *Trachyspermum ammi* belonging to the family Umbelliferae - Current status. Journal of Medicinal Plants Research. 2010; 4(2):087-094.
19. Sigh S. Organic Produce Supply Chains in India, Allied Publishers, India, 2009.