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Improvement of growth parameters and essential oil productivity of *Anthricus cerefolium* L. by planting distances and fertilization treatments

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Anthriscus cerefolium (L.) Hoffm .(Apiaceae) is a fragrant plant, commonly used as flavouring agent in culinary. Scientific studies have also proven its antioxidant and anti-inflammatory properties. Different agro-technique approaches have been utilized in order to improve its productivity of biologically active compounds in the climatic conditions of Egypt. Thus, previously it was established that the main constituents of essential oil of the plant cultivated in Egypt are strongly dependent on the application of nitrogen (N) and/or potassium (K) fertilizers. Therefore in order to broaden the possibility to enhance the productivity of the plant, in the present work the effect of planting distances (15cm - 30cm - 45cm), NPK feedings (0, 25%, 50%, 75% and 100%) and combination treatments between compost (10, 15 and 20 m^3/fed) and NPK were experimented. It was established that the increment of sowing distance from 15cm to 45cm increased gradually vegetative growth parameters. The highest mean values of oil percentage were resulted from sowing distance at 45cm followed by 30cm. Compost at 20ton/fed. gave the highest values of growth characters and essential oil (%). NPK fertilizer levels caused very noticeable effect on different growth parameters compared with untreated plants. Thus, 100% of NPK gave the maximum values of different traits parameters and essential oil (%). Concerning the effect of the combination treatments between NPK and compost had a great effect on growth traits and essential oil (%). The combination treatment between compost at 20ton/fed and NPK at 100% gave the greatest values of growth characters and essential oil%. Essential oil constituents were identified with GC-MS.The main constituents were methyleugenol and estragole.

Keywords: Chervil, *Anthricus cerefolium*, Compost, NPK, Essential oil and Sowing distance.

INTRODUCTION

Chervil (garden chervil, *Anthriscus cerefolium,* Apiaceae), is an essential oil bearing plant, related to parsley. It is commonly used to season mild-flavoured dishes and is a constituent of the French herb mixture fines herbs. It is native to the Caucasus and was spread by the Romans through most of Europe, where it is now naturalized (Vaughan et al., 1997)It is an excellent source of antioxidants that stabilize cell membranes and reduce inflammation associated with headache, sinusitis, peptic ulcer, and infections. The essential oil contains estragole (as does tarragon and basil), plus anethole. The leaves contain a fixed oil, high concentrations of potassium and calcium and apiin-a glycoside. The characteristic constituents of chervil (*Anthriscus cerefolium*) were investigated for free radical scavenging effects(Feijes et al., 2003).Flavonoids from the herb and lignans from the root showed strong free radical quenching activity, while the volatile oil obtained from the herb was less effective. The identification of the constituents of the extracts indicated that apiin is the main flavonoid, deoxypodophyllo toxin the major lignan, and methyl chavicol the predominant constituent of the essential oil (Feijes et al., 2003)

A comparative study of the essential oil from the different plant parts of the plant collected in the urban area of Vienna showed that the essential oils of were dominated by estragole (methyl chavicol) and 1-allyl-2,4-dimethoxybenzene, their content varying in the different samples. Thus, while the oils from young flowering plants contained more estragole than 1-allyl-2,4-dimethoxybenzene, the fruits from one of the studied locations reached 95% estragole in the essential oil. (Chizzola 2011) Another study has shown that the four main components of the wild growing plant in Turkey are methyl chavicol (83.10%), 1-allyl-2,4-dimethoxybenzene (15.15%), undecane (1.75%) and β-pinene (<0.01%) (Baser, et al., 2011)

Fertilization an important role for plants to get healthy and optimum production. Nitrogen (N), phosphor (P) and potassium (K) are the essential important nutrients which enhance the production, accelerate and accumulate metabolites. Many investigators studied the effect of these three elements on some medicinal and aromatic plants such as *Juniperus horizontalis* (Baser, et al., 2011) chamomile (Emongor et al., 1990)sweet basil(Chimura,et al., 1993)], *Agasta cherugosa (*Ohk et al., 2000).*Pimpinella anisum* L. (Azizi., 2000)*Thymus vulgaris* L. Baranauskienne.et al., (2003),Rue (*Ruta graveolens L*.) (Khalid et al., 2007)*Cuminum cyminun* (Azizi, and Kahrizi. 2008)*Mentha longifolia (*Alsafar, and Al-Hassan. 2009)

Mentha piperita(Mollafilabi et al., 2010)and *Ocimum basilicum* (Mohamed et al., 2016)

Pollution with chemical fertilizers causes damage to human health through excessive use of fertilizers. So, many studies were being carried out to solve these problems. In this respect, organic farming technique represents to become an alternative system of agriculture (Abd-Allah et al., 2001) In this respect, several investigators were studied the effect of organic fertilizers on some medicinal and aromatic plants i.e. (Edris et al., 2003) and(Fatma et al., 2008) on *Majorana hortensis*, (Adholeya and Prakash., 2004)on *Cymbopogon winterianus* and Hendawy, and Khalid (2011) on *Matricaria chamomilla* L.)

Different agro-technique approaches have proven to be effective to affect essential oil profile of different plant species. Thus, the combined application of different planting distance plots, farmyard manure and N/P/K fertilization affected the rhizome biomass formation and essential oil content in *Curcuma zedoaria.* (Joy et al., 2002)Different propagation methods showed to have a significant effect on the content of peppermint cultivars (Zheljaskov, et al., 1996)

Previous work has established that the main constituents of essential oil of the plant cultivated in Egypt (methyleugenol, estragole, 2-allyl-1,4-dimethoxybenzene) are strongly depended on the application of nitrogen (N) and/or potassium (K) fertilizers. The latter treatments also strongly affected developmental patterns and biomass yield(El Gendy., et al., 2015) In addition agro-technique experiments have shown that biomass formation and essential oils yield of the plant were also affected by soluble potassium silicate applied to chervil plant to reduce amount of irrigation water (Abd El-Razik et al., 2015).

In continuation of this, here the effect of KNP fertilization, as well as planting distance were experimented in order to study their effect on biomass formation and essential oil productivity of the plant under the cultivation conditions of Egypt.

MATERIALS AND METHODS

Experimental site

The study was carried out at Al-Adlya Farm, Al-Sharkia Governorate, Egypt during two successive seasons (2016/2017 and 2017/2018). Indicate when were the plant planted, because below you write “two cuts were obtained during every season”.

Agrotechnique experiments

This study was divided into two parts in order to evaluate the effect of different agro-technique approaches on growth, yield and essential oil constituents of Chervil plants.

The effect of planting distances plantlets were planted in the soil at the following three planting distances:

15cm- 30cm- 45cm. The effect of NPK fertilizer and compost.

The physical and chemical characteristics of the soils were determined as described in (Jackson 1973).The soil texture was sand (81.8% sand, 16.79% silt, 1.23% clay and 0.85% organic matter). Chemical analysis of soil was: pH= 7.56; E.C (dsm^{-1}) = 2.22; and total nitrogen =55mg/g; available phosphorus =8.6 mg/g and potassium= 18 mg / g. Chemical analysis of used compost is presented in Table (A).

Compost and superphosphate were added during soil preparation. Ammonium sulfate was divided into two equal portions; the first portion was added after 21 days from transferring seedlings and the second one after month later. Potassium sulfate was added after 21 days from transplanting.

Table A. Compost Analysis

Contents	Values
Moisture (g / Kg)	17.6
EC (dsm^{-1})	10.2
pH	7.8
OM (g / Kg)	35.9
Total N (g / Kg)	1.10
C/N ratio	18
NH_4-N (mg / Kg)	760
NO_3-N (mg / Kg)	415
Total P (g / Kg)	0.9
Available P (mg / Kg)	298
Total K (g / Kg)	1.65
Available K (mg / Kg)	415
Fe (mg / Kg)	816
Zn (mg / Kg)	251
Mn (mg / Kg)	298
Cu (mg / Kg)	123

(10 m^3 compost): 1- (zero NPK) 2-NPK (25%) 3-NPK (50%) 4-NPK (75%) 5-NPK (100%)
(15 m^3 compost): 1- (Zero NPK) 2-NPK (25%) 3- NPK (50%)4-NPK (75%) 5-NPK (100%)
(20 m^3 compost): 1- (Zero NPK) 2-NPK (25%)3-NPK (50%)4-NPK (75%) 5-NPK (100%)
NPK (100%) recommended dose for parsley (the same family).

Vegetative growth measurements

Two cuts were obtained during two seasons, the first cut was carried out after 3 months from transplanting and the 2nd one after 3 months later. The following growth parameters were studied: plant height (cm), fresh and dry weight (g / plant).

Oil extraction and GC/MS analysis.

Essential oil content (%) and yield (ml/plant) were recorded.100g of herb fresh weight from each treatment was used to extract essential oil. Hydro distillation by Clevenger apparatus was used (Guenther 1961).The obtained oils were dried over anhydrous sodium sulphate and stored in sealed vials at 4 °C before analysis.

The GC-MS analysis of the essential oil samples for the first cut was carried out in the second season using 16 gas chromatography-mass spectrometry instrument stands at the Department of Medicinal and Aromatic Plants Research. National Research Center 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 TG-WAX MS column (30 m x 0.25 mm I,d, 0.25 µm film thickness). Analyses were carried out using helium as carrier gas at a flow rate of 1,0 ml min^{-1} and a split ratio of 1:10 using the following temperature program: 40 °C for 1 ml; and 4.0 °C min^{-1} to 160 °C and held for 6 min; rising at 6 °C min^{-1} to 210 °C and held for 1min. The injector and detector were held at 210 °C. Diluted samples (1:10 hexane, v/v) of 0.2 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. Most of the compounds were identified using two different analytical methods: (a) KI, Kovats indices in reference to nalkanes (C9-C22) (National Institute of Standards and Technology, 2009); and (b) mass spectra (authentic chemicals, Wiley spectral library collection and NSIT library).

Statistical analysis

The obtained data were subjected to statistical analysis including L.S.D (least significant differences) at level of 5% as well as Duncan analysis (Snedecor, Cochran1990).The 1st experiment includes one factor (planting distance) while the S2nd experiment includes 2 factors, compost as the main factor and NPK as the submain.

The Correlation Coefficient between Sowing Distances and Different Traits:

Correlation and linear regression are the most commonly used techniques for investigating the relationship between two quantitative variables.

Correlation analysis is to see whether two measurement variables co vary, and to quantify the strength of the relationship between the variables, whereas regression expresses the relationship in the form of an equation.

The correlation coefficient can be used, such as the Pearson Product Moment Correlation Coefficient, to test if there is a linear relationship between the variables. To quantify the strength of the relationship, it can be calculated the correlation coefficient (r). Its numerical value ranges from +1.0 to -1.0. r> 0 indicates positive linear relationship, r < 0 indicates negative linear relationship while r = 0 indicates no linear relationship. The coefficient of determination R2, which represents the proportion of common variation in the two variables (i.e., the "strength" or "magnitude" of the relationship) In order to evaluate the correlation between variables, it is important to know this "magnitude" or "strength" as well as the significance of the correlation. It expresses the amount of common variation between the two variables.

RESULTS

First Experiment: Effect of Sowing Distance

Growth Characters:

Data presented in Table (1) indicated that the sowing distance 45cm gave the maximum mean values of plant height (45.53 and 32.79cm), herb fresh weight (214.05 and 158.13g / plant) and herb dry weight (58.48 and 43.20g / plant) during the 1st and 2nd cuts, respectively. The increment of plant growth characters due to increase in plant density was obtained as a result of increment of the inter-plant competition over light and the disruption of the growth regulators balance. So, the decrement of light penetration into canopy middle and lower layers decreases auxin decomposition and thus, plant growth parameters increase.

Essential oil yield (%) and (ml / plant):

Data of mean comparisons as shown in Table (2), revealed that, the highest mean values of oil percentage (0.12%) was obtained at 45cm sowing distance while the lowest one (0.080 and 0.10%) as a result of sowing distance at 15cm during both cuts , respectively.

The same results were observed for essential oil yield (ml/plant) where, sowing distance at 45cm resulted in the maximum mean values (0.257 and 0.190ml/plant) during 1st and 2nd cuts, respectively.

The Correlation Coefficient between Sowing Distances and Different Traits:

Significant positive correlation between the sowing distances and the different growth traits during both cuts were observed (Table 3).

Essential Oil Constituents

Samples of the essential oils obtained of the Chervil plants growing under the different sowing distances were subjected to GC/MS analysis. Comparison was made based on 33 compounds, representing from 86.90 to 96.87%. Oxygenated compounds ranged from 70.41 to 82.09 % against hydrocarbons compounds which representing from 14.78 to 22.12%. Methyl eugenol was identified as the major compound in different sowing distance treatments ranging from 32.93 to 47.60 %, Estragole, the second main component, ranged from 15.71 to 18.52%. The third one was 2-Allyl-1,4-dimethoxybenzene which ranged from 5.50 to 7.80 % followed by Zingiberene which ranged from 2.57 to 4.48 %. The maximum relative percentage of Methyleugenol (47.60%), Estragole (18.52 %) and 2-Allyl-1,4-dimethoxybenzene (7.80 %) were obtained at 15cm sowing distance.

Table 1. Effect of sowing distances on growth characters (Mean values of two successive seasons)

Planting distance	Plant height [cm]		Fresh weight [g/plant]		Dry weight [g/plant]	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
15cm	24.83c	21.98c	107.18c	89.97c	29.28c	24.58c
30 cm	32.01b	27.76b	168.35b	121.43b	46.00b	33.18b
45 cm	45.53a	32.79a	214.05a	158.13a	58.48a	43.20a
LSD at 5%	3.46	3.93	5.71	12.49	3.46	2.27

Means followed by similar letter(s) within the same column are not significantly different at P ≤ 0.05 according to Duncan's Multiple Range Test.

Table 2. Effect of sowing distances on essential oil percentage and yield (ml / plant) (Mean values of two successive seasons)

Planting distance	Essential oil yield [%]		Essential oil content(ml / plant)	
	1st cut	2nd cut	1st cut	2nd cut
15cm	0.08^{b}	0.10^{b}	0.086^{c}	0.090^{c}
30 cm	0.09^{b}	0.11^{ab}	0.152^{b}	0.134^{b}
45 cm	0.12^{a}	0.12^{a}	0.257^{a}	0.190^{a}
LSD at 5%	0.02	0.01	0.026	0.026

Means followed by similar letter(s) within the same column are not significantly different at P ≤ 0.05 according to Duncan's Multiple Range Test.

Second Experiment:

Effect of Fertilization on Chervil (*Anthricus cerefolium L.*) Plant.

Effect of Compost:

Growth parameters:

All compost treatments had a pronounced increment for growth parameters of chervil (Table 5). The highest mean values of plant height (33.77cm and 24.81cm), herb fresh 208.54 and 142.68 g / plant) and dry weight (56.98 and 38.98 g/plant) were obtained as a result of the application of the compost at 20m^3/fed during the 1st and 2nd cuts, respectively.

Essential oil content (%) and yield (ml / plant):

It is clear from the data presented in Table 6 that, compost treatments had a pronounced effect on both essential oil yield and content (ml/plant) during both cuts. Essential oil percentage and essential oil yield reached to their maximum mean values as a result of compost application at 20m^3/fed.

Effect of NPK:

Growth Characters:

Plant growth characters such as plant height [cm], herb fresh and dry weight [g/plant] were significantly affected by changes in the NPK fertilization (Table 7). Thus the various growth characters in general increased under the various NPK fertilization levels compared with unfertilized plants. Highest values of plant growth characters were obtained in the NPK (100%) treatment with the values of 29.82, 23.35cm (plant height), 213.74 , 159.11g/plant (herb fresh weight) and 58.40 , 43.47g/plant (herb dry weight) during the first and second cuts, respectively compared with control and other treatments (Table 7).

Essential oil yield (%) and content (ml / plant):

Concerning the effect of NPK treatments on essential oil percentage and yield, data presented in Table 8, reveal that NPK treatments had a significant effect on essential oil percentage and oil yield except for during the 2nd cut for essential oil yield. Essential oil percentage and essential oil yield increased gradually with increment of NPK levels. So, the highest mean values of essential oil percentage (0.107 and 0,100%) and essential oil yield (0.234 and 0.161ml/plant) were obtained from plants fertilized by NPK at (100%) during 1st and 2nd respectively.

Effect of the combination treatments between compost and NPK:

Growth Characters:

The interaction treatments had a pronounced effect on growth parameters (Table 9). The results presented in Table (9) show that, the combination treatments between NPK and compost gave the superior results comparing with plants fertilized by compost only. The highest mean values of plant height (35.83 and 26.99cm) , herb fresh weight (265.2 and 183.18g/plant) and herb dry weight (72.46 and 50.05 g / plant) were obtained from plants fertilized by compost at 20m^3 + NPK (100%) during 1st and 2nd cuts respectively followed by compost at 20m^3 + NPK (75%).

Essential oil content (%) and yield (ml / plant):

Different combinations of NPK and compost fertilizer resulted in a pronounced effect on oil percentage as well as yield during both cuts. The highest mean values of essential oil percentage were obtained by compost at 20m^3+ NPK at 75% and the combination between 20m^3+ NPK at 50% which recorded 0.130 during first and second cuts, respectively. Concerning, the combination treatments on essential oil yield, results found in Table (10), clear that the combination between compost at 20m^3+ NPK (75%) resulted in the highest mean values of essential oil yield (0.332 and 0.200ml/plant) during 1st and 2nd cuts respectively.

Essential oil constituents:

The effect of fertilizer on chemical composition of the essential oil of *Anthriscus cerefolium* L and retention indices are shown in Table (11). 31 components were identified in the essential oil of *Anthriscus cerefolium* L under different treatments that recorded 93.71 - 96.39%. It can be observed that, hydrocarbon compounds accounted for 10.03 to 12.84% against total oxygenated compounds which recorded 81.57 % to 85.63%.

Table;4 EffectofSowing distances on the relative percentage of the main constituents of the essential oil of chervil plants

NO.	RT	Compounds	KI*	15cm	30cm	45cm
1	3.90	α-Pinene	1109	0.10	0.20	0.65
2	5.28	(-)-β-Pinene	1190	1.25	0.32	0.65
3	7.38	D-Limonene	1278	1.70	0.72	1.30
4	7.71	Eucalyptol	1291	1.26	1.48	2.93
5	8.64	γ-Terpinene	1324	1.21	2.80	2.97
6	9.43	o-Cymene	1351	0.43	0.50	0.65
7	12.26	3-Nonanone	1444	0.40	0.32	0.26
8	14.74	1-Nonene	1524	2.73	2.10	2.91
9	15.39	Isomenthone	1544	0.33	0.38	2.51
10	15.81	Copaene	1558	0.24	0.24	0.25
11	16.06	Non-3-Enyl Acetate	1566	0.31	0.26	0.39
12	16.34	p-Menthan-3-one cis	1575	1.02	0.16	1.90
13	16.58	3-Nonanol	1582	0.30	0.32	0.32
14	17.03	Pentadecane	1597	0.63	0.60	1.32
15	17.90	1-Hexadecanol	1625	0.34	0.42	0.41
16	18.32	1-Nonen-3-ol	1639	0.60	0.55	0.60
17	19.03	Caryophyllene	1663	0.26	0.39	0.36
18	20.64	3-Octen-2-ol, (Z)-	1716	0.70	0.64	0.80
19	21.05	Pulegone	1731	0.36	0.78	1.24
20	21.82	Estragole	1757	18.52	15.71	17.30
21	22.39	GermacreneD	1777	1.05	1.02	1.82
22	22.86	(-)-Zingiberene	1793	2.84	2.57	4.48
23	23.00	β-Bisabolene	1798	0.39	0.81	0.87
24	23.83	α-Farnesene	1827	0.30	0.27	0.35
25	24.21	β-Sesquiphellandrene	1840	0.22	0.17	0.37
26	24.39	Curcumene	1847	0.41	0.26	0.53
27	28.14	Geranyl propionate	1983	0.42	0.29	0.56
28	28.75	Geranylisovalerate	2006	0.49	0.40	0.78
29	30.33	2-Allyl-1,4dimethoxybenzene	2068	7.80	5.50	5.90
30	30.87	Methyleugenol	2090	47.60	32.93	35.30
31	31.57	Trans-MethylIso-eugenol	2115	0.79	0.31	1.24
32	38.52	Carvacrol	2313	0.21	0.12	0.12
33	49.18	1-Octadecanol	----	1.66	0.79	0.49
	Oxygenated compounds			82.09	72.69	70.41
	Hydrocarbons compounds			14.78	14.21	22.12
	Total identified compounds			96.87	86.90	92.53

Table (5). Effect of Compost on Growth Characters of Chervil plants (Mean Values of two successive seasons)

Compost	Plant height		Fresh weight		Dry weight	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
10	19.42c	18.41b	142.95c	111.53c	39.06c	30.47c
15	24.85b	18.99b	174.16b	129.84b	47.59b	35.48b
20	33.77a	24.81a	208.54a	142.68a	56.98a	38.98a
LSD at 5%	0.71	0.81	2.45	2.07	0.79	0.88

Means followed by similar letter(s) within the same column are not significantly different at P ≤ 0.05 according to Duncan's Multiple Range Test.

Table (6). Effect of Compost on Essential Oil Percentage and Yield (ml / plant) (Mean Values of two successive seasons)

Compost	Essential oil %		Essential Oil Yield (ml/plant)	
	1st cut	2nd cut	1st cut	2nd cut
10	0.076c	0.084b	0.110c	0.093c
15	0.090b	0.087b	0.160b	0.118b
20	0.110c	0.110a	0.234a	0.159a
LSD at 5%	0.007	0.006	0.020	0.006

Means followed by similar letter(s) within the same column are not significantly different at P ≤ 0.05 according to Duncan's Multiple Range Test.

Table 7. Effect of NPK fertilizer on growth characters (Mean Values of two successive seasons)

NPK	Plant height		Fresh weight		Dry weight	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
0	23.39d	17.88e	117.68e	101.5d	32.15d	27.73e
25%	24.38d	19.47d	146.44d	103.53d	40.01d	28.29d
50%	25.49c	20.74c	177.66c	129.44c	48.54c	35.37c
75%	26.98b	22.36b	206.16b	145.52b	56.33b	39.76b
100%	29.82a	23.35a	213.74a	159.11a	58.40a	43.47a
LSD at 5%	1.01	0.69	2.45	3.39	1.05	0.56

Means followed by similar letter(s) within the same column are not significantly differentat P ≤ 0.05 according to Duncan's Multiple Range Test.

Table 8.Effect of NPK fertilizer on Essential Oil Percentage and Yield (ml/ plant) (Mean Values of two successive seasons)

NPK	Essential oil %		Essential Oil Yield (ml/plant)	
	1st cut	2nd cut	1st cut	2nd cut
0	0.080d	0.087a	0.096c	0.088e
25%	0.087c	0.090a	0.142b	0.094d
50%	0.090c	0.097a	0.162b	0.129c
75%	0.097b	0.096a	0.207a	0.144b
100%	0.107a	0.100a	0.234a	0.161a
LSD at 5%	0.005	NS	0.032	0.006

Means followed by similar letter(s) within the same column are not significantly different at P ≤ 0.05 according to Duncan's Multiple Range Test.

Table 9; Effect of the Combination Treatments between Compost and NPK on Growth Characters (Mean Values of two successive seasons)

compost	NPK	Plant height		Fresh Weight g/		Dry Weight g/pot	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
10 m³ compost	0 NPK	17.14g	15.06e	96.61k	99.50f	26.40j	27.19e
	25 % NPK	18.55g	17.20e	133.43i	102.20f	36.46h	27.22hi
	50 % NPK	20.20ef	19.96d	145.45h	104.50f	39.74g	28.55gh
	75 % NPK	20.43ef	19.83d	168.44g	120.50e	46.02f	32.92f
	100 % NPK	20.79ef	20.00d	170.84g	130.97d	46.68f	35.78e
15 m³ compost	0 NPK	20.43ef	16.50e	124.59j	100.93f	34.04i	27.58hi
	25 % NPK	22.20de	16.19e	167.86g	103.87f	45.86f	28.38ghi
	50 % NPK	23.65cd	17.20e	178.18f	132.13d	48.68e	36.10e
	75 % NPK	25.12c	22.03cd	195.02e	149.10c	53.28d	40.74d
	100 % NPK	32.83b	23.05bc	205.17d	163.18b	56.06c	44.58c
20 m³ compost	0 NPK	32.59b	22.08cd	131.83i	104.07f	36.02h	28.43ghi
	25 % NPK	32.40b	24.70ab	181.29f	107.47f	49.53e	29.36g
	50 % NPK	32.61b	25.06ab	209.35c	151.70c	57.20c	41.45d
	75 % NPK	35.40a	25.23ab	255.02b	166.96b	69.68b	45.62b
	100 % NPK	35.83a	26.99a	265.20a	183.18a	72.46a	50.05a
LSD at 5%		1.59	1.81	3.83	5.30	1.65	0.88

Means followed by similar letter(s) within the same column are not significantly different at P ≤ 0.05 according to Duncan's Multiple Range Test.

Table (10) Effect of the Combination Treatments Between Compost and NPK on Essential Oil Percentage and Yield (Mean Values of two successive seasons)

compost	NPK	Essential oil %		Essential Oil Yield (ml / plant)	
		1st Cut	2nd Cut	1st Cut	2nd Cut
10 m³	0 NPK	0.070e	0.100abcd	0.068f	0.100e
	25 % NPK	0.070e	0.080cd	0.093ef	0.082g
	50 % NPK	0.080de	0.080cd	0.116def	0.084fg
	75 % NPK	0.080de	0.080cd	0.135cdef	0.096e
	100 % NPK	0.080de	0.080cd	0.137cdef	0.105e
15 m³	0 NPK	0.070e	0.070d	0.087ef	0.071h
	25 % NPK	0.090cd	0.080cd	0.151cde	0.083fg
	50 % NPK	0.090cd	0.080cd	0.160cde	0.106e
	75 % NPK	0.080de	0.087cd	0.156cde	0.134c
	100 % NPK	0.120b	0.120ab	0.246b	0.196a
20 m³	0 NPK	0.100c	0.090bcd	0.132cdef	0.094ef
	25 % NPK	0.100c	0.110abc	0.181cd	0.118d
	50 % NPK	0.100c	0.130a	0.209bc	0.197a
	75 % NPK	0.130a	0.120ab	0.332a	0.200a
	100 % NPK	0.120b	0.100abcd	0.318a	0.183b
LSD at 5%		0.008	0.021	0.051	0.009

Means followed by similar letter(s) within the same column are not significantly different at P ≤ 0.05 according to Duncan's Multiple Range Test.

Table11: **Effect of Fertilizers on the relative percentage of the main constituents of the essential oil of chervil plants**

No	RT	Constituents	KI*	Compost 10			Compost 15			Compost 20		
				0	50	100	0	50	100	0	50	100
1	3.90	α-Pinene	1109	t	t	t	0.62	0.40	t	0.28	0.2	0.44
2	5.28	(-)-β-Pinene	1190	1.00	0.36	1.12	0.85	0.97	0.21	0.58	0.19	0.77
3	7.38	D-Limonene	1278	1.17	0.92	1.33	1.37	1.23	0.99	0.92	0.36	1.15
4	7.71	Eucalyptol	1291	0.26	t	0.5	2.31	0.97	t	1.14	0.39	1.45
5	8.64	γ-Terpinene	1324	0.21	1.1	0.33	2.24	0.76	t	0.97	0.26	1.25
6	9.43	o-Cymene	1351	t	0.31	t	0.7	0.28	t	0.33	t	0.44
7	12.26	3-Nonanone	1444	0.57	0.29	0.48	0.28	0.52	0.6	0.24	0.3	0.44
8	14.74	1-Nonene	1524	2.71	2.19	2.24	1.49	1.96	2.84	2.18	2.16	2.2
9	15.39	Isomenthone	1544	0.5	0.53	0.48	1.58	0.59	0.35	1.09	0.4	1.22
10	15.81	Copaene	1558	0.19	0.2	t	t	t	0.22	t	0.26	t
11	16.06	Non-3-Enyl Acetate	1566	0.53	0.36	0.35	0.21	0.29	0.54	0.34	0.38	0.42
12	16.34	p-Menthan-3-onecis	1575	0.15	t	0.21	0.90	0.29	t	0.59	t	0.6
13	16.58	3-Nonanol	1582	0.32	0.25	0.35	0.3	0.31	0.25	0.26	0.2	0.28
14	17.03	Pentadecane	1597	0,9	0,66	0,66	0,59	0,67	0,33	0,64	0,97	0,84
15	17.82	2-Nonenal, (E)-	1623	t	0.21	0.35	0.19	0.20	0.15	0.36	0.23	0.25
16	17.90	1-Hexadecanol	1625	0.54	0.42	0.41	0.26	0.46	0.23	0.34	0.62	0.48
17	18.32	1-Nonen-3-ol	1639	1.01	0.51	0.77	0.63	0.79	0.75	0.49	0.49	0.63
18	19.03	Caryophyllene	1663	0.17	0.18	t	t	t	0.24	t	0.24	0.19
19	20.64	3-Octen-2-ol, (Z)-	1716	1.24	0.73	0.69	0.52	0.72	0.32	0.61	0.76	0.67
20	21.05	Pulegone	1731	0.62	1.36	0.55	3.2	1.00	t	1.96	0.43	2.37
21	21.82	Estragole	1757	21.14	19.26	24.29	20.6	25.33	26.43	20.49	23	22.63
22	22.39	GermacreneD	1777	1.54	1.76	1.03	1.04	0.94	1.46	1.32	1.42	1.16
23	22.86	(-)-Zingiberene	1793	3.46	4.32	2.44	2.72	2.73	4.10	3.28	4.36	3.36
24	23.00	β-Bisabolene	1798	0.43	0.55	0.27	0.31	0.29	0.39	0.42	0.53	0.40
25	23.83	α-Farnesene	1827	0.5	0.54	0.34	0.33	0.46	0.17	0.4	0.6	0.47
26	24.21	β-Sesquiphellandrene	1840	0.33	0.34	t	0.21	0.21	0.28	0.27	0.36	0.26
27	24.39	Curcumene	1847	0.42	0.56	0.27	0.3	0.23	0.28	0.44	0.46	0.38
28	28.14	Geranyl propionate	1983	0.72	0.5	0.34	0.35	0.37	0.13	0.4	0.49	0.40
29	28.75	Geranylisovalerate	2006	0.97	0.61	0.44	0.5	0.5	0.26	0.62	0.73	0.59
30	30.33	2-Allyl-1,4-dimethoxybenzene	2068	8.71	7.99	8.43	7.25	7.83	9.48	8.33	8.41	8.34
31	30.87	Methyleugenol	2090	44.67	46.11	44.41	42.39	43.33	43.87	40.37	41.55	40.37
32	31.57	Trans-MethylIso-Eugenol	2115	1.45	0.93	0.96	0.99	0.96	1.35	0.93	1.27	1.11
33	49.18	1-Octadecanol		0.86	1.97	1.62	1.18	1.46	0.70	3.76	2.94	1.45
	Oxygenated compounds			83.55	81.57	84.97	83.05	85.25	85.63	82.32	82.85	83.70
	Hydrocarbons			12.84	13.79	10.03	12.77	11.13	10.96	11.39	11.14	12.47
	Total			96.39	95.36	95.00	95.82	96.38	96.59	93.71	93.99	96.17

DISCUSSION

Effect of sowing distance on biomass formation and essential oil yields

Growth and production of medicinal plants is influenced by many factors included genetic and agronomic factors. Choosing the most suitable sowing distance is one of the most important factors of success in agriculture. The establishment of the suitable density of healthy plants at the farm levels is the foundation of a successful system of agronomic. In this connection density less than optimum use of available environmental factors such as light, moisture and nutrients was not maximum; against at densities higher than optimal the existence of intense competition would reduce the growth and yield characters of plants (Sarmadnia, and Koocheki. 1990)

In respect of essential oil content, (Lawrence et al., 1983) reported that Chervil leaves contain 0.03% of essential oil. The oil contained pinene, phellandrene, methyl chavicol (75.1%) and 1-allyl-2,4-dimethoxybenzene (22.3%). Abd El-Razik et al., (2015) and El Gendy., et al., (2015)

found that methyl eugenol, estragole, 2-allyl-1, 4- dimethoxy benzene and (-)-zingiberene are the major components of chervil essential oil under Egyptian conditions. In this connection, chemical composition of essential oil of chervil herb is very variable depending on the habitat and climate.

Effect of compost application on biomass formation and essential oil yields

The positive effect of compost fertilizer on growth characters may be due to the role of compost in improving soil structure, encouraging root development and providing plant nutrients. Moreover, compost affects water absorption and retention by soil positively and this reduces erosion and run-off and thereby protects surface water from sedimentation and help to bind agriculture chemicals. The observed results were supported by those declared by Sarmadnia, and Koocheki. (1990) on *Ocimum basilicum* L., Edris et al., (2003)on *Origanum morjorana* L., Ferreir et al., (2004) on *Catharnthus roseus* and El-Sherbeny, et al., (2005) on *Sideritis montana* L., Badawy et al., (2009) on *Dracocephalum moldavica* L . and Abdullah et al., (2012) on *Rosmarinus officinalis*.

The results obtained on the effect of compost application on essential oils yields are in agreement with findings of Sarmadnia, and Koocheki. (1990)

on *Ocimum basilicum* L., Edris et al., (2003) on *Origanum morjorana* L., Ferreir et al., (2004) on *Catharnthus roseus*, Badawy et al., (2009) on *Dracocephalum moldavica* L .and Abdullah et al., (2012) on *Rosmarinus officinalis*.

Effect of NPK application on biomass formation and essential oil yields

Nutrition is one of the most important factors that increase plant production through encourage protein synthesis, photosynthesis, metabolic processes and enzymes activation. These results were supported by those obtained by Ardelan, et al., (2010) on *Thymus vulgaris*, Khalid et al., (2015).on *S. hortensis* and El Gendy., et al., (2015) on Chervil , Ardelan, et al., (2010) on *Nigella sativa*.

Nutrition plays an important role in the growth and development of all crop plants. In the case of medicinal and aromatic plants that synthesize essential oils, nutrients can effectively increase oil yield and quality 38 (Zheljazkov et al., 2010),Zheljazkov et al., (2011), Sharafzadeh et al., (2011) ,El Gendy., et al., (2015) and Khalid et al., (2015)

Effect of the combination treatments between compost and NPK on biomass formation and essential oil yields

The main constituents were methyleugenol, estragole, 2-Allyl-1, 4- dimethoxybenzene, (-)-zingiberene (2.44 – 4.36%) and 1-nonene. The main components as methyleugenol, 2- allyl-1,4-dimethoxybenzene, trans-methyl-isoeugenol and estragole are phenylpropanoid derivatives. Phenylpropanoid biosynthesis starts with the formation of the aromatic amino acid phenylalanine. Phenylalanine ammonia lyase (PAL) catalyzes the phenylalanine into cinnamic acid. Cinnamate 4-hydroxylase (C4L) and 4-coumarate-CoA ligase (4CL) then catalyze the conversion of cinnamic acid to p-coumaroyl-CoA, which is the precursor for many phenylpropanoid products. Methyl chavicol (estragole), showing carcinogenic effect Nurzyńska-Wierdak (2007a) which is found in smaller amounts in European basil varieties Nurzyńska-Wierdak (2007a)has a relaxant and anticonvulsive effect as well as fungi static and antifungal activity Młodnicki (2006)

CONCLUSION

Cultivation *Anthricus cerefolium* at 45cm sowing distance and fertilized by compost at 20ton/fed. and NPK at 100% gave the greatest values of growth characters and essential oil%

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed in collecting and analyzing data. All authors participated in writing every part of this study. All authors read and approved the final version

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