EFFECT OF ORGANIC AGRICULTURE ON PRODUCTIVITY OF SOME RUSSIAN PARSLEY VARIETIES UNDER NORTH SINAI CONDITIONS

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This field experiment was conducted during the two successive seasons of 2012/2013 and 2013/2014 in El-Maghara Research Station, Desert Research Center, North Sinai Governorate to evaluate the productivity and quality of some Russian parsley varieties by using organic farming practices. Compost manure was added to the soil at three rates of 10, 15 and 20 m^3/feddan. Seeds of different flat-leaf parsley varieties were sown (local, Leaf Breeze, Legendary Hero and Leaf Sandwich). The results showed that the increase in organic fertilization rates led to an increase in herb yield and its quality characters (chlorophyll pigment content in the leaves and essential oil yield). Despite the superiority of local variety in herb productivity, its quality parameters were low, while vegetative yield of foreign varieties was marked by high quality specifications (high chlorophyll content and essential oil yield). There were differences in constituents of essential oil between varieties. The response of plants to organic fertilization treatments was varied according to variety type. The best of the Russian varieties was Legendary Hero variety fertilized with 15 m^3 compost/feddan.

Keywords: parsley, varieties, herb, essential oil, chlorophyll content

Parsley (*Petroselinum crispum* Mill.) is one of the most important culinary herbs belongs to family Apiaceae. It imparts a wonderful savory and herbaceous flavour, making it a great culinary foundation. The plants are cultivated extensively for the purpose of sending its fresh leaves to markets. It is also available in dried and powdered form to be used as a culinary flavouring, especially in the winter months, when the fresh supply is very low. Chopped parsley fresh leaves are used in soups, stuffings, minces, rissoles and also as a garnish over vegetables and salads. Furthermore, its leaves are used widely in folk herbal medicine, pharmaceutical industries and cosmetics (Lopez et al., 1999; Khan and Abourashed, 2011; Peter, 2012 and Aburto-Gill, 2014).

In Egypt, the flat-leaf parsley type (ssp. *neapolitanum*, Danert) is the most common type and is cultivated in a commercial scale for local consumption and export. However, the cultivation of foreign parsley varieties based on their increasing global markets demand and higher quality in terms of color and aroma than the local variety, it is considered necessary today for increasing exports (Atta-Aly, 1999; EMAP, 2013 and Sabry et al., 2013). Hence, the aim of the present study was to evaluate the productivity and quality of some Russian flat-leaf parsley 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 the Agricultural Experimental Station of the Desert Research Center at El-Maghara region (30.71º N and 33.33º E), North Sinai Governorate.

Three foreign flat-leaf parsley varieties (Leaf Breeze, Legendary Hero and Leaf Sandwich) (Fig. 1) were introduced from Russia to be evaluated and compared to the local flat-leaf variety. Seeds of Russian varieties were obtained from both of Gavrish Group Company (www.seeds.gavrish.ru) and Agrofirma Search Company (www.semenasad.ru) at Moscow, while seeds of the local variety were obtained from the Egyptian Ministry of Agriculture and Land Reclamation.

Compost manure was added to the sandy soil before sowing at three different rates of 10, 15 and 20 m^3 per feddan. Sowing was done on October 1st for both seasons under drip irrigation system in rows, 60 cm apart and 30 cm between hills. A biofertilizer consisting of four strains of bacteria namely: *Azotobacter chroococcum*, *Azospirillum lipoferum*, *Bacillus megatherium* and *Pseudomonas fluorescence* ($1x10^8$ cfu/ml) was obtained from Soil Fertility and Microbiology Department, Desert Research Center and was used for plants inoculation. The biofertilizer was added as a soil drench after 45, 60 and 90 days of sowing date and repeated after the first cut for one time.

Parsley plants were harvested at the stage of marketable foliage size, by cutting at a height of 5 cm above soil surface. The plants were harvested two times per season, i.e. on 26 January and 26 March.

The experimental design was split plot design with compost manure rates as the main plot treatments and varieties as the sub-plot treatments. Three replicates were used for each treatment. L.S.D. test at 0.05 was used to compare the average means of treatments, according to Snedecor and Cochran (1982).

The following data were recorded:

1. Growth and Yield Characters

Plant height (cm), herb fresh weight/m^2 (g), herb fresh weight/feddan (ton), herb dry weight/m^2 (g) and herb dry weight/feddan (ton).

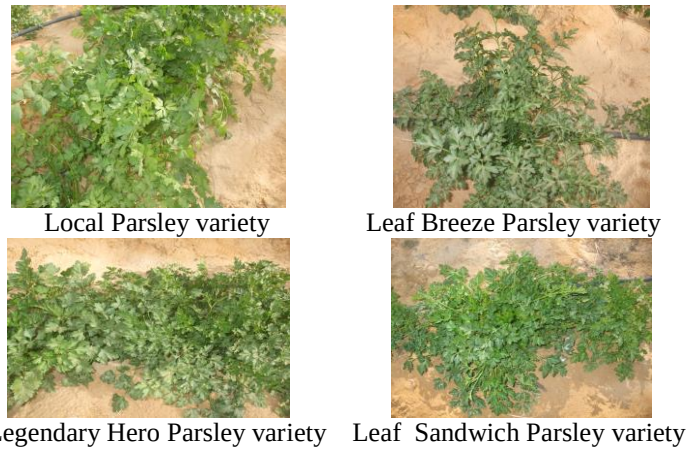

Fig. (1). Local and Russian flat-leaf parsley varieties.

2. Quality Characters

2.1. Chlorophyll content

Leaves were taken using a portable chlorophyll meter (SPAD-502, Minolta, Tokyo, Japan) and was expressed in arbitrary absorbance (or SPAD values).

2.2. Essential oil percentage

Essential oil percentage was determined in the air dried herb by hydrodistillation for 3 hours using a Clevenger type apparatus. The essential oil (%) was calculated as a relative percentage (v/w) (British Pharmacopoeia, 1963).

2.3. Essential oil yield/ m^2 (ml)

This was calculated as $\frac{\text{oil percentage} \times \text{herb dry weight/m}^2\text{ (g)}}{100}$

2.4. Essential oil yield per feddan (L)

This was calculated as essential oil yield/m^2 × 4200 m^2

2.5. Essential oil components

GC-MS analysis of essential oils was conducted in the second season for the second harvest using Gas Chromatography-Mass Spectrometry instrument stands 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 1 min. 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 and compost manure samples were analyzed at the laboratories of Desert Research Center and Soils, Water and Environment Research Institute, as shown in tables (1, 2, 3 and 4). The analyses were carried out as described by Jackson (1976) and AOAC (2002).

Table (1). 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 (2). The chemical analysis of the experimental soil area.

pH	E.C.	O.M.	Soluble anions (meq/l)				Soluble cations (meq/l)			
	(ds/m)	(%)	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 (3). 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 (4). 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

RESULTS AND DISCUSSION

1. Growth and Yield Characters

Data of the effect of organic fertilization, variety type and their interaction on growth and yield characters (plant height, herb fresh weight/m^2, herb fresh weight/feddan, herb dry weight/m^2 and herb dry weight/feddan) are shown in tables (5, 6, 7, 8 and 9).

Regarding the effect of organic fertilization treatments, in both seasons, raising the level of compost manure resulted in a steady increase in plant height, fresh and dry weights of herb per square meter or per feddan, but without significant differences between 15 m^3/feddan and 20 m^3/feddan. Similar trends were obtained by Peyvast et al. (2008) who found that the addition of vermicompost to the soil increased parsley plant height, numbers of leaves and total yields. Mylavarapu and Zinati (2009) showed that the addition of compost to sandy soil improved both physical and chemical properties of the soil as well as increased parsley yields.

With respect to the effect of variety type, in both seasons, the local variety recorded highest significant increments in plant height, fresh and dry weights of herb per square meter or per feddan as compared to other varieties followed by Legendary Hero variety, Leaf Breeze variety and then Leaf Sandwich variety. These results coincide with those reported by Osińska et al. (2012) and Sabry et al. (2013), who indicated that among the compared parsley cultivars, some yields were higher than others.

As for the effect of interaction between organic fertilization treatments and variety type, in both seasons, the response of plants to organic fertilization treatments was different according to variety type. The highest significant increases in fresh and dry weights of herb per square meter or per feddan were detected from the treatments of supplying local parsley variety with 20 m^3 compost/feddan, followed by Legendary Hero variety with 15 m^3 compost/feddan, Leaf Breeze variety with 10 m^3 compost/feddan and at last Leaf Sandwich variety with 20 m^3 compost/feddan in comparison to control treatment (fertilizing local variety with 10 m^3 compost/feddan).

These results were in harmony with those reported by Pasikowska et al. (2002) and Dris and Jain (2007), who stated that the differences in nutrients uptake and metabolism in plants is influenced by genetic variability between plant crops and even between cultivars within the same species. These genetic factors inevitably determine the productivity of the species or cultivar and thus together with fertilizer application determine crop yield. Also, it is noteworthy from the previous data that although the lower productivity of organic farming, organic farming is to be more healthy and friendly environmental than that of conventional farming. Moreover, there is a great potential for farmers of organic herbal spices to enjoy the premium

price in the international market (Peter, 2004; Ponti et al., 2012 and Post and Schahczenski, 2012).

Table (5). Effect of organic fertilization, variety type and their interaction on plant height (cm) during the two successive seasons of 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	20.00	15.00	17.00	10.40	15.60	35.13	23.25	24.00	19.36	25.44
Compost at 15 m^3/feddan	22.78	18.80	20.20	10.67	18.11	39.83	23.00	27.60	18.00	27.11
Compost at 20 m^3/feddan	23.20	19.27	17.50	12.57	18.14	40.38	27.00	23.17	24.86	28.85
Mean	21.99	17.69	18.23	11.21		38.45	24.42	24.92	20.74	
LSD 0.05										
Organic fertilization			2.095					2.861		
Variety			2.419					3.303		
Organic fertilization x Variety			4.190					5.722		

* Values are means of two seasons.

Table (6). Effect of organic fertilization, variety type and their interaction on herb fresh weight/m^2 (g) during the two successive seasons of 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	195.09	291.69	153.16	113.33	188.32	392.17	517.23	338.39	247.78	373.89
Compost at 15 m^3/feddan	352.49	188.83	433.24	142.69	279.32	445.60	376.87	507.93	337.24	416.91
Compost at 20 m^3/feddan	463.47	158.24	191.91	310.26	280.97	582.02	273.10	376.35	443.17	418.66
Mean	337.02	212.92	259.44	188.76		473.26	389.07	407.56	342.73	
LSD 0.05										
Organic fertilization			39.770					42.730		
Variety			47.470					55.510		
Organic fertilization x Variety			89.550					103.50		

* Values are means of two seasons.

Table (7). Effect of organic fertilization, variety type and their interaction on herb fresh weight/feddan (ton) during the two successive 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	0.82	1.23	0.64	0.48	0.79	1.65	2.17	1.42	1.04	1.57
Compost at 15 m^3/feddan	1.48	0.79	1.82	0.60	1.17	1.87	1.58	2.13	1.42	1.75
Compost at 20 m^3/feddan	1.95	0.67	0.81	1.30	1.18	2.44	1.15	1.58	1.86	1.76
Mean	1.42	0.90	1.09	0.79		1.99	1.63	1.71	1.44	
LSD 0.05										
Organic fertilization			0.113					0.138		
Variety			0.145					0.175		
Organic fertilization x Variety			0.325					0.376		

* Values are means of two seasons.

Table (8). Effect of organic fertilization, variety type and their interaction on herb dry weight/m^2 (g) during the two successive seasons of 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	37.85	52.04	24.58	21.86	34.08	100.07	125.76	84.57	50.12	90.13
Compost at 15 m^3/feddan	68.39	33.69	69.54	27.54	49.79	113.70	91.64	126.94	68.22	100.13
Compost at 20 m^3/feddan	82.00	28.23	30.80	59.87	50.23	146.43	66.41	94.05	89.64	99.13
Mean	62.75	37.99	41.64	36.42		120.07	94.60	101.85	69.32	
LSD 0.05										
Organic fertilization			5.184					8.690		
Variety			5.986					10.650		
Organic fertilization x Variety			10.370					21.370		

* Values are means of two seasons.

Table (9). Effect of organic fertilization, variety type and their interaction on herb dry weight/feddan (ton) during the two successive seasons of 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	0.16	0.22	0.10	0.09	0.14	0.42	0.53	0.36	0.21	0.38
Compost at 15 m^3/feddan	0.29	0.14	0.29	0.12	0.21	0.48	0.40	0.53	0.29	0.43
Compost at 20 m^3/feddan	0.34	0.12	0.13	0.25	0.21	0.62	0.28	0.40	0.38	0.42
Mean	0.26	0.16	0.17	0.15		0.51	0.40	0.43	0.29	
LSD 0.05										
Organic fertilization			0.027					0.054		
Variety			0.031					0.062		
Organic fertilization x Variety			0.054					0.107		

* Values are means of two seasons.

2. Quality Characters

Data of the effect of organic fertilization, variety type and their interaction on quality parameters of parsley (chlorophyll content, essential oil percentage, essential oil yield/m^2, essential oil yield/feddan and chemical constituents of the oil) are presented in tables (10, 11, 12 and 13).

2.1. Chlorophyll content

Among the most important traits in production of parsley are pigments of total chlorophylls, which determine the appearance of both raw material and its biological value (Piagentini et al., 2002). Data of chlorophyll measurements are given in table (10).

For the effect of organic fertilization treatments on chlorophyll content, in both seasons, data revealed that the addition of compost manure with high rates significantly increased the leaves chlorophyll contents. The highest significant values were detected for fertilization with 20 m^3 compost/feddan as compared to the lowest rate. These results seem to agree with the findings of Jahanshahi et al. (2014) on dill (*Anethum graveolens* L.), who found that the increase in chlorophyll content was on account of vermicompost application.

Concerning the effect of variety type on chlorophyll content, in both seasons, the Russian varieties (Leaf Breeze, Legendary Hero and Leaf Sandwich) had the highest significant values of chlorophyll contents as compared to local parsley variety, which recorded the lowest value. So, it could be noticed that the foreign varieties had a higher chlorophyll accumulation. These results seem to match with that reported by Novac (2011) and Osińska et al. (2012), who found that the content of chlorophyll in the leaves of parsley plants is depended on the variety.

Table (10). Effect of organic fertilization, variety type and their interaction on chlorophyll contents during the two successive seasons of 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	Chlorophyll SPAD-units									
	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	26.64	39.78	29.33	37.92	33.42	26.00	44.33	35.50	38.96	36.20
Compost at 15 m^3/feddan	25.30	34.73	38.98	43.5	35.63	33.10	38.63	45.33	43.30	40.09
Compost at 20 m^3/feddan	29.44	41.05	41.45	38.25	37.55	33.32	45.25	42.65	43.70	41.48
Mean	27.13	38.52	36.59	39.89		30.81	42.74	41.16	41.99	
LSD 0.05										
Organic fertilization			1.244					0.641		
Variety			1.436					0.740		
Organic fertilization x Variety			2.487					1.282		

* Values are means of two seasons.

Dealing with the effect of combination between organic fertilization treatments and variety type on chlorophyll content, in both seasons, the highest significant measurements were obtained from the treatments of fertilizing foreign varieties with the highest levels of compost manure.

These results revealed the healthy benefits of new introduced foreign varieties as a rich source of chlorophyll pigment. The therapeutic properties of chlorophyll can be summarized as stimulating immune system; benefit against sinusitis, fluid buildup and skin rashes; ability to help compact anemia; eliminating molds in the body; purifying the blood and the organism, cleaning of toxins; ability to help in preventing cancer and is being used in cancer therapy; cleaning the intestines; ability to help to rejuvenate and energize the body; detoxification of the liver; ability to normalize blood pressure, antimicrobial and compacting bad odors, bad breath as well as body odor due to the magnesium salts that it contains (Inanç, 2011 and Doddanna et al., 2013).

Also, the new foreign varieties had a good availability for export as mentioned by United States Department of Agriculture, who reported that the standard parsley grade should have a good green color, which is free from yellow or discolored leaves (United States Standards for Grades of Parsley, 2007).

2.2. Essential oil percentage and oil yield

Guenther (1972) reported that only parsley herb oil represents the true odor and flavor of the garnish, which is so widely employed in culinary preparations. The presented data herein deal with the effect of organic fertilization, variety type and their interaction on essential oil percentage, essential oil yield per square meter and per feddan (Tables 11, 12 and 13).

Data concerning the effect of organic fertilization, in the second

season showed that organic fertilization with compost manure at 20 m^3/ feddan significantly increased essential oil percentage and essential oil yield per square meter and per feddan, while the differences were non-significant in the first season.

With respect to the effect of variety type, all foreign parsley varieties superpassed significantly the local variety in terms of essential oil percentage and essential oil yield per square meter and per feddan in the two seasons.

Table (11). Effect of organic fertilization, variety type and their interaction on essential oil percentage during the two successive seasons of 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	0.04	0.04	0.18	0.16	0.11	0.06	0.13	0.18	0.21	0.15
Compost at 15 m^3/feddan	0.02	0.10	0.12	0.10	0.09	0.03	0.27	0.17	0.16	0.16
Compost at 20 m^3/feddan	0.02	0.07	0.09	0.09	0.07	0.12	0.18	0.18	0.23	0.18
Mean	0.03	0.07	0.13	0.12		0.07	0.19	0.18	0.20	
LSD 0.05										
Organic fertilization			0.001					0.027		
Variety			0.001					0.031		
Organic fertilization x Variety			0.002					0.054		

* Values are means of two seasons.

Table (12). Effect of organic fertilization, variety type and their interaction on essential oil yield/ m^2 (ml) during the two successive seasons of 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	0.02	0.01	0.04	0.04	0.03	0.06	0.16	0.15	0.11	0.14
Compost at 15 m^3/feddan	0.01	0.03	0.08	0.03	0.04	0.03	0.25	0.22	0.11	0.16
Compost at 20 m^3/feddan	0.02	0.02	0.03	0.05	0.03	0.18	0.12	0.17	0.21	0.18
Mean										
LSD 0.05										
Organic fertilization			0.001					0.027		
Variety			0.001					0.031		
Organic fertilization x Variety			0.002					0.054		

* Values are means of two seasons.

Table (13). Effect of organic fertilization, variety type and their interaction on essential oil yield/feddan (L.) during the two successive seasons of 2012/2013 and 2013/2014.

Parsley varieties / Organic fertilization	1st cut					2nd cut				
	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich	Mean
Compost at 10 m^3/feddan	0.08	0.04	0.17	0.17	0.12	0.25	0.67	0.63	0.46	0.50
Compost at 15 m^3/feddan	0.04	0.13	0.34	0.13	0.16	0.13	1.05	0.92	0.46	0.64
Compost at 20 m^3/feddan	0.08	0.08	0.13	0.21	0.13	0.76	0.50	0.71	0.88	0.71
Mean	0.07	0.08	0.21	0.17		0.38	0.74	0.75	0.60	
LSD 0.05										
Organic fertilization			0.060					0.093		
Variety			0.069					0.107		
Organic fertilization x Variety			0.120					0.186		

* Values are means of two seasons.

As for of the effect of interaction between organic fertilization treatments and variety type, in both seasons, the significantly highest increments in essential oil percentage and essential oil yield per square meter or per feddan were generally resulted from the combination between the highest organic fertilization rates and foreign parsley varieties.

These results are in line with those of Osińska et al. (2012), who found significant influence in the term cultivar in the content of essential oil in the fresh leaves of parsley, and Sabry et al. (2013), who observed variations in the essential oil yield among different parsley varieties.

2.3. Essential oil constituents

Data presented in table (13) pointed out that, the chemical composition of essential oil was different in response to the variety type as follows: In the oil of local variety the main constituents were myristicin (20.13%), β-pinene (18.75%), p-cymenene (18.19%), α-pinene (13.17%), d-limonene (9.25%), apiol (4.04%), 3-amino-6,8-dimethoxy-1,2,3,4-tetrahydroquinoline (2.41%), 4-terpineol (1.91%) and n-pentadecane (1.25%).

With regard to the oil of Leaf Breeze variety, the dominant components were myristicin (64.17%), iolongifolan-8-ol (3.00%), carotol (2.76%), (R)-(+)-6-chloro-2-methyl-2,3-dihydro-4H-1-benzopyran (2.60%), p-cymenene (2.49%), α-phellandrene (2.00%), dihydro-α-agarofuran (1.93%), methyl chrysanthemate (1.87%), 5-isopropyl-6-methyl-3-heptyne-2,5-diol (1.86%), crypton (1.72%), epiglobulol (1.44%), α-myrcene (1.36%), α-pinene (1.32%), 4-isopropyl-3-methoxymethylene-1,1-dimethyl-cyclohexane (1.16%) and endo-4-vinyl-1-methyl-3-oxabicyclo [3,1,0] hexane (1.06%).

Referring to the oil of Legendary Hero variety, its major constituents were p-cymenene (20.87%), apiol (15.16%), myristicin

(12.93%), α-phellandrene (9.04%), α-pinene (8.32%), α-myrcene (7.23%), β-pinene (3.32%), p-cymene-8-ol (3.30%), α-terpinolene (3.03%), carotol (2.50%), trans-caryophyllene (1.64%), (-)-caryophyllene oxide (1.13%), p-menthe-1,3,8-triene (1.12%) and 4-terpineol (1.08%).

Concerning the oil of Leaf Sandwich variety, its chief components were myristicin (32.13%), apiol (23.01%), p-cymenene (10.38%), α-phellandrene (5.40%), α-pinene (3.61%), methyl chrysanthemate (2.94%), α-myrcene (2.88%), carotol (2.56%), 3a,6,6-trimethyl-hexahydro-benzofuran-2-one (1.59%), β-pinene (1.66 %), p-cymen-8-ol (1.23%), isolongifolan-8-ol (1.17%), dihydro-α-agarofuran (1.15%) and α-terpinolene (1.03%).

These results could be confirmed by those of Bernath (1986), who found that the composition of essential oil in different plant crops, particularly parsley, is affected by genotype. Attokaran (2011) reported that the essential oil from the parsley herb contains apiol, myristicin, α-pinene, β-phellandrene, myrcene and some oxygenated compounds. Sabry et al. (2013) showed that parsley cultivars showed significant differences in their essential oil composition in response to the different species.

Also, it could be noticed that the essential oils of both of Leaf Breeze and Leaf Sandwich varieties were rich in myristicin than the local variety. Furthermore, essential oils of Legendary Hero and Sandwich varieties contained highest percentages of apiol, while the local variety recorded lower value. These analyses proved the importance of new introduced varieties for medical and food sectors as myristicin had an antioxidant and anticancer properties. Furthermore, apiol contributes significantly to the flavor of parsley; moreover, it had an antioxidant, anticancer and antimicrobial activities (Zhang et al. 2006; Attokaran 2011; Lien et al., 2011 and Jenecius and Mohan, 2014).

From the aforementioned results, although the local parsley variety was more adapted to environmental stresses in cultivation area and produced highest vegetative yield, its leaves had lowest quality parameters (lowest chlorophyll content and essential oil yield), which may be considered a lower grade in global markets.

Table (13). Chemical constituents (%) of essential oils of the parsley herb of different varieties.

RT	Compound	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich
5.43	α-pinene	13.17	1.32	8.32	3.61
6.70	β-pinene	18.75	0.51	3.32	1.66
7.04	α-myrcene	-	1.36	7.23	2.88
7.69	l-phellandrene	-	-		-
8.41	d-limonene	9.25	-	-	-
8.52	α-phellandrene	-	2.00	9.04	5.40
9.42	Oxanamide	0.33	-	-	-
10.41	3,5-dimethylbenzyl alcohol	0.49	-	-	-
10.49	α-terpinolene	-	-	3.03	1.03
10.81	p-cymenene	18.19	2.49	20.87	10.38
11.63	(-)-carvyl acetate	0.75	-	-	-
11.70	p-menthe-1,3,8-triene	-	-	1.12	0.83
12.85	2(10)-pinene-3-ol	0.24	-	-	-
13.03	Terpenene-1-ol	-	-	-	0.27
13.20	Camphor	0.34	-	-	-
14.54	4-terpineol	1.91	-	1.08	0.36
15.07	p-cymene-8-ol	-	-	3.30	1.23
15.11	Crypton	-	1.72	-	-
15.26	α-terpineol	0.83	-	-	-
15.86	m-cymene	-	-	0.45	0.22
16.13	4,7-dimethylbenzofuran	-	-	0.27	-
17.10	Durenol	0.64	-	0.38	0.62
17.51	(-)-carvone	-	0.70	-	0.34
17.91	n-pentadecane	1.25	-	-	-
18.20	Ethyl 2-methyl-3-oxohexanoate	-	0.47	-	0.23
18.56	1-(2,6,6-trimethyl-2-cyclohexen-1-yl)acetone	0.67	-	0.45	-
18.61	Methyl chrysanthemate	-	1.87	-	2.94
18.82	Bornyl acetate	0.32	-	0.57	-
18.91	5-isopropenyl-2-methyl-7-oxabicyclo[4.1.0]heptan-2-ol	-	0.41	-	0.41
19.99	dodecylcyclohexanol	-	0.34	-	-
20.37	2,6,11-trimethyldodecane	0.25	-	-	-
20.92	2-I-(2-oxopropylidene)-5-methyltetrahydrofuran	-	0.39	-	-
21.01	Methyl(4E)-3,3,6-trimethyl-4,6-heptadienoate	-	0.98	0.31	-
21.82	3a,6,6-trimethyl-hexahydro-benzofuran-2-one	-	-	0.34	1.59
22.15	(4'-methylthio)acetophenone	-	-	0.26	-
22.77	4-isopropyl-3-methoxymethylene-1,1-dimethyl-cyclohexane	-	1.16	-	0.22
23.63	2-methylisoborneol	-	-	0.72	-

Table (13). Continued

RT	Compound	Local	Leaf Breeze	Legendary Hero	Leaf Sandwich
23.75	5-isopropyl-6-methyl-3-heptyne-2,5-diol	-	1.86	-	0.60
23.86	2,3-dimethyl-1,4-dimethoxybenzene	-	-	0.81	-
24.13	7-ethyl-5-methoxybicyclo[4.2.0]octa-1,3,5-trien-7-ol	-	0.67	-	-
24.35	Trans-caryophyllene	-	-	1.64	0.51
24.74	ç-elmene	0.24	-	0.38	-
24.87	Endo-4-vinyl-1-methyl-3-oxabicyclo[3,1,0]hexane	-	1.06	-	0.56
25.45	I-(+)-6-chloro-2-methyl-2,3-dihydro-4H-1-benzopyran	-	2.60	-	0.87
26.00	Bicyclo[2.2.1]heptane-7-propanoic acid,α-methyl-,methyl ester	-	-	0.25	-
26.78	n-octadecane	0.50	-	-	-
26.80	4,4-dimethoxy-6-pentyl-2-cyclohexene-1-one	-	0.50	-	-
26.93	Germacrene-D	-	-	0.57	-
27.23	Dihydro-α-agarofuran	0.54	1.93	0.99	1.15
28.64	Heneicosane	0.49	-	-	-
28.87	Epiglobulol	0.45	1.44	0.84	0.86
29.06	Myristicin	20.13	64.17	12.93	32.13
30.01	Elemicin	-	-	0.96	-
30.05	3-amino-6,8-dimethoxy-1,2,3,4-tetrahydroquinoline	2.41	0.54	-	0.72
30.26	Isolongifolan-8-ol	-	3.00	-	1.17
30.41	Isoshyobunone	0.70	0.57	0.45	-
30.52	Diepicedrene-1-oxide	-	-	-	0.26
31.02	(-)-caryophyllene oxide	0.70	0.58	1.13	0.77
31.51	Hexadecamethyl-cyclooctasioxane	0.26	-	-	-
31.87	Carotol	0.86	2.76	2.50	2.56
32.35	10-epi- ç-eudesmol	-	0.37	-	-
33.52	α-cadinol	0.48	0.64	0.33	0.35
34.12	Cis-z-α-bisabolene epoxide	-	0.42	-	-
34.22	7-tetracyclo[(6.2.1.0(3.8)0(3.9)]undecanol,4,4,11,11-tetramethyl-	-	-	-	0.26
34.53	Elemol	-	0.38	-	-
34.90	Apiol	4.04	0.37	15.16	23.01
36.07	Isospathulenol	0.23	-	-	-
36.47	Icosane	0.34	-	-	-
36.62	Longipinocarveol, trans-	-	0.42	-	-
38.24	7-methyl-4-(1-methlethylidene)bicycle [5.3.1]undec-1-en-8-ol	0.25	-	-	-

Finally, the treatment of fertilization of Legendary Hero variety with 15 m^3 compost/ feddan recorded the highest vegetative yield productivity with good quality parameters (high chlorophyll content and essential oil yield) among Russian varieties in the two seasons, so it can be used in Egypt as a substituent for the local variety.

CONCLUSION

According to the present study, the cultivation the Russian parsley variety (Ligendro Hero) under El-Maghara region, North Sinai Governorate, is recommended, and the plants should be fertilized with compost manure, before sowing throughout soil preparation at the rate of 15 m^3/feddan for producing highest herb yield with the highest quality specifications.

REFERENCES

Aburto-Gill, S. (2014). In "Herbs to Help You Heal". Volume II, iUniverse, 378 pp.

Atta-Aly, M.A. (1999). Effect of nickel addition on the yield and quality of parsley leaves. Scientia Horticulturae, 82: 9-24.

AOAC (2002). Association of Official Analytical Chemists. In "Official Methods of Analysis". Published by AOAC International 17th ed. Washington, D.C.

Attokaran, M. (2011). In "Natural Food Flavors and Colorants". Wiley-Blackwell Publishing, Ltd., 464 pp.

Bernath, J. (1986). Production Ecology of Secondary Plant Products. (Craker, LE. and J. E. Simon Eds.). In "Herbs, Spices and Medicinal Plants: Recent Advances in Botany, Horticulture and Pharmacolog". Oryx Press, 1: 185-234.

British Pharmacopoeia (1963). In "Determination of Volatile Oil in Drugs". The Pharmaceutical Press, London.

Doddanna, S.J., S. Patel, M.A. Sundarrao and R.S. Veerabhadrappa (2013). Antimicrobial activity of plant extracts on *Candida albicans*: An *in vitro* study. Indian Journal of Dental Research, 24 (4): 401-405.

Dris, R. and S.M. Jain (2007). In "Production Practices and Quality Assessment of Food Crops: Plant Mineral Nutrition and Pesticide Management". Volume 2, Springer Science and Business Media, 278 pp.

EMAP (2013). Upgrading the medicinal and aromatic plants value chain access to export markets. News for the Medicinal and Aromatic Plants sector in Egypt. Available online: http://www.emap-eg.org/emap/wp-content/themes/emap/js/files/2013 10%20EMAP%20October%20Newsletter_Revision%20LK.pdf

Guenther, E. (1972). In "The Essential Oils". Vol. IV. Van Nostrland Comp.

Inc., New York.
Inanç. A.L. (2011). Chlorophyll: structural properties, health benefits and its occurrence in virgin olive oils. Akademik Gida, 9 (2): 26-32.
Jackson, M.L. (1976). In "Soil Chemical Analysis". Constable. Co. Lt., London.
Jahanshahi, S., A. Pazoki and H. Zahedi (2014). Effect of planting date and vermicompost on growth and chlorophyll content of dill (*Anethum graveolens* L.). Res. Crops, 15 (1): 232-236.
Jenecius, A. and V.R. Mohan (2014). GC-MS analysis of bioactive components on the stem extract of *Bacolepsis nervosa* Decne. ex. Moq. (Periplocaceae). World Journal of Pharmacy and Pharmaceutical Sciences, 3 (4): 1044-1059.
Khan, I.A. and E.A. Abourashed (2011). In "Leung's Encyclopedia of Common Natural Ingredients: Used in Food, Drugs and Cosmetics". Third edition, John Wiley and Sons, Inc., 810 pp.
Lien, H.M., P.T. Kuo, C.L. Hung, J.Y. Kao, H. Lin, D.Y. Yang and Y.Y. Lai (2011). Study of the anti-proliferative activity of 5-substituted 4,7-dimethoxy-1,3-benzodioxole derivatives of SY-1 from *Antrodia camphorata* on human COLO 205 colon cancer cells. Evidence-Based Complementary and Alternative Medicine, volume 2011, Article ID 450529, 8 pp.
Lopez, M.G., I.R. Sanchez-Mendoza and N. Ochoa-Alejo (1999). Comparative study of volatile components and fatty acids of plant and *in vitro* cultures of parsley *Petroselinum crispum* (Mill) Nym Ex W Hill. J. Agr. Food Chem., 47: 3292-3296.
Mylavarapu, R.S. and G.M. Zinati (2009). Improvement of soil properties using compost for optimum parsley production in sandy soils. Scientia Horticulturae, 120: 426-430.
Novac, T. (2011). Content of nitrates and pigments in leaves of some parsley cultivars grown in greenhouse. Bulletin UASVM Horticulture, 68 (1): 261-264.
Osińska, E., W. Roslon and M. Drzewiecka (2012). The evaluation of quality of selected cultivars of parsley *(Petroselinum sativum* L. ssp. *crispum*). Acta Sci. Pol., Hortorum Cultus, 11 (4): 47-57.
Pasikowska, R., B. Dabrowska and E. Capecka (2002). The effect of nitrogen fertilization rate on the yield and quality of two cultivars of parsley (*Petroselinum sativum* L. ssp. *crispum*) grown on different soil types. Folia Horticulturae, 14 (1): 177.
Peter, K.V. (2004). In "Handbook of Herbs and Spices". Published by Woodhead Publishing, England, Volume 2, 336 pp.
Peter, K.V. (2012). In "Handbook of Herbs and Spices". Published by Woodhead Publishing Limited, Second edition, Volume 1, 640 pp.

Peyvast, G.H., J.A. Olfati, S. Madeni, A. Forghani and H. Samizadeh (2008). Vermicompost as a soil supplement to improve growth and yield of parsley. International Journal of Vegetable Science, 14 (1): 82-92.

Piagentini, A.M., D.R. Guemes and M.E. Pirovani (2002). Sensory characteristics of fresh cut spinach preserved by combined factors methodology. J. Food Sci., 64 (4): 1544-1549.

Ponti, T.d., B. Rijk and M.K.V. Ittersum (2012). The crop yield gap between organic and conventional agriculture. Agricultural Systems, 108: 1-9.

Post, E. and J. Schahczenski (2012). Understanding organic pricing and costs of production. National sustainable Agriculture Information Service. Available online: http://www.attra.ncat.org

Sabry, R.M., M.A.M. Kandil and S.S. Ahmed (2013). Comparative study of some parsley cultivars grown in Egypt for some potent compounds. Journal of Applied Sciences Research, 9 (10): 6419-6424.

Snedecor, G.W. and W.G. Cochran (1982). In "Statistical Methods". The Iowa State Univ. Press, Ames, Iowa, USA, 507 pp.

United States Standards for Grades of Parsley (2007). Available online: https://www.ams.usda.gov/sites/default/files/media/Parsley_Standard%5B1%5D.pdf

Zhang, H., F. Chen, X. Wang and H.Y. Yao (2006). Evaluation of antioxidant activity of parsley (*Petroselinum crispum*) essential oil and identification of its antioxidant constituents. Food Research International, 39: 833-839.

تأثير الزراعة العضوية على إنتاجية بعض أصناف البقدونس الروسي تحت ظروف شمال سيناء

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أجريت هذه التجربة الحقلية خلال موسمين متتاليين ٢٠١٢/٢٠١٣ و٢٠١٣/٢٠١٤ بمحطة بحوث المغارة، مركز بحوث الصحراء، محافظة شمال سيناء، لتقييم إنتاجية وجودة بعض أصناف البقدونس الروسي باستخدام ممارسات الزراعة العضوية. تم إضافة ثلاث معدلات من سماد الكمبوست للتربة قبل الزراعة وهي ١٠، ١٥ و٢٠ م^3 / فدان. تم زراعة بذور أصناف مختلفة من البقدونس مسطحة الأوراق (المحلي، Leaf Breeze، Legendary Hero، Leaf Sandwitch). أظهرت النتائج أن زيادة معدلات التسميد العضوي أدت إلى زيادة في محصول العشب وصفات الجودة (محتوى الأوراق من صبغة الكلوروفيل ومحصول الزيت الطيار). بالرغم من تفوق صنف البقدونس المحلي فى إنتاجية العشب إلا أن صفات جودته كانت منخفضة في حين تميز المحصول الخضري لأصناف البقدونس الأجنبية بإرتفاع مواصفات الجودة (إرتفاع المحتوى من الكلوروفيل ومحصول الزيت الطيار). وكانت هناك إختلافات في مكونات الزيت الطيار بين الأصناف. وقد أختلفت إستجابة النباتات لمعاملات التسميد العضوي وفقًا لنوع الصنف. وكان أفضل الأصناف الروسية هو زراعة الصنف Legendary Hero والتسميد بمعدل ١٥م^3 كمبوست/ فدان.