J. Plant Production, Mansoura Univ., Vol. 5 (7): 1345-1373, 2014

RESPONSE OF *Pelargonium graveolens* L. PLANTS TO TREATMENTS OF IRRIGATION, CHEMICAL, ORGANIC AND BIO-FERTILIZATION UNDER SANDY SOIL CONDITIONS.

Abd El-Kafee, Omaima M.*; El-Mogy E. E. A. M. and Nahlaa A. M. A. Ashour ****

*** Hort. Dept., Fac. Agric., Mansoura Univ. Egypt**

**** Horticulture Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt**

ABSTRACT

The field work was carried out at the Experimental Farm of Horticultural Research Station in El-Quassassin, Ismailia Governorate, Egypt, during the two successive seasons of 2009-2011 and 2010-2012, to investigate the effect of drip irrigation treatments (1, 2 and 3 times/week, 2 hours every time) and fertilization treatments (ammonium sulphate (20.5 N %) at 300 kg/fed., calcium superphosphate (15.5 P_2O_5 %) at 300 kg/fed. and potassium sulphate (48 K_2O %) at 100 kg/fed., humic acid at 280 g/fed., effective microorganisms (EM_1) at 5 liters/fed. and active dry yeast at 6 g/L.) and their interactions on the vegetative growth parameters (plant height, number of branches and fresh weight of herb/plant), yield of herb (fresh herb yield/fed./cut and fresh herb yield/fed./year), essential oil contents (essential oil percentage, content(ml.)/plant, oil yield (L.)/fed./cut and oil yield (L.)/fed./year) and the chemical compositions (N, P, K and carbohydrates %) of Pelargonium graveolens L. plant.

The results showed that, the treatment of irrigation 3 times every week gave the highest values of all vegetative growth parameters, essential oil contents and chemical composition (N, P and carbohydrates %) followed by 2 times/week, during 4 cuts in the two seasons. Fertilizing with recommended NPK gave the highest results of all vegetative growth parameters, yield of herb, essential oil contents and chemical composition (N, P and K %), followed by humic acid, throughout the four cuts in both seasons. The combined treatment of irrigation 3 times/week + NPK resulted in the highest values of vegetative growth parameters, yield of herb, essential oil contents and chemical composition (N, P and carbohydrates %) followed by the interaction treatment of irrigation 3 times/week + humic acid fertilizer, during 4 cuts in the two seasons. From the results of this study, we observed that, the highest values of vegetative growth parameters, herb yield, essential oil contents obtained in the third cut followed by the fourth cut in the second year of season, while the least results found in the first and second cuts, in the first year of season, these findings repeated in the two seasons.

Keywords : Geranium - Pelargonium graveolens - humic acid - Effective microorganisms (EM_1) - Active Dry Yeast - Irrigation - fertilization

INTRODUCTION

Pelargonium graveolens, L.Herit (Rose-scented geranium) belonging to Family Geraniaceae. There are over 700 varieties of cultivated geranium, however, most are grown for ornamental purposes. The plants of geranium are native to South Africa (Shawi *et al.,* 2006).

Pelargonium graveolins L'Herit is cultivated in Egypt on a large scale as a source of geranium essential oil. The essential oil is obtained by steam

distillation of the green material either directly after harvesting, or after 24 h in order to reduce the volume and to release the oil from the glycosidal form. Maximal content of up to 0.4 % may be obtained from herbage harvested just before and during flowering (Fleisher and Fleisher, 1985).

Concerning the effect of irrigation, Sidky *et al* (1998) mentioned that long irrigation intervals (5 or 7 days) appeared to be more beneficial for the growth and productivity of roselle plants, while (3 days) gave the highest leaf chemical contents. Hassan (2007) recorded that the increasing of water irrigation amount for 560 to 2240 m^3/fed. resulted in significant increase in plant height, number of branches and fresh and dry weights in roselle plant. The tallest plant results from using 1680 m^3/fed. treatment in the three seasons, respectively.

A microbial culture named "Effective Microorganisms" (EM) selected species of microorganisms including predominant population of lactic acid bacteria and yeast, and smaller of photosynthetic bacteria, actinomycetes and other types of organisms. All of these are mutually compatible with one another and can coexist in liquid culture (Higa and Parr, 1994). Okorski and Majchrzak (2007) showed that, there was an influence of EM_1 on the composition and number of fungi isolated from soil was found in the experiment. A total of 18111 fungal cultures were isolated from the roots of pea at flowering stage.

Shahwani *et al* (2005) treated canola plants (*Brassica napus* L.) with EM 55 days after sowing and reported that, EM supported mycorrhizal association, which resulted in a parallel increase in number and biomass of leaves as well as stem length. Muthaura *et al* (2010) stated that, there were significant differences ($p \leq 0.05$) in shoot height growth, stem diameter, leaf numbers per plant, leaf area, leaf fresh and dry weights and root fresh and dry weights among inoculation of effective microorganism to Pigweed (*Amaranthus dubians*) plants. Okorski *et al* (2010) showed that, the best method of EM_1 application was soil treatment combined with chemical control, which increased all yield - related morphometric parameters of pea. Hu and Qi (2013) stated that, the application of EM in combination with compost significantly increased wheat straw biomass, grain yields, straw and grain nutrition compared with traditional compost and control treatment.

Ali (2001) studied the effect of yeast on vegetative growth and flowering of pot marigold, *Calendula officinalis* plants. The plants were treated with active dry yeast at the rates of 0.0, 1.5, 3.0 and 4.5 g/L. as foliar spray. The high rate (4.5 g/L.) increased plant height, number of branches and dry weight of herb. Ahmed and Ali (2004) on *Ambrosia maritime* plants indicated that application of yeast at (0, 1 and 2 g/L.) significantly increased the vegetative growth by increasing the concentration used. Heikal (2005) found that, the highest values of essential oil production of thyme (*Thymus vulgaris* L.) plants were recorded when plants sprayed with 4 g/L. active dry yeast. Ali (2009) on fennel plants found that active dry yeast application at 2 and 4 g/L. significantly increased plant height and number of main branches as well as leaves fresh weight of plant and oil percentage in the two seasons. While 4 g/L. produced the highest carbohydrates content.

humic acid is one of the major components of humic substances which are dark brown and major constituents of soil organic matter humus that contributes to soil chemical and physical quality. humic substances consist of heterogeneous mixtures of transformed biomolecules exhibiting a supramolecular structure that can be separated in their small molecular components by sequential chemical fractionation (Piccolo, 2002). Since the end of the 18th century, humic substances have been designated as either humic acid, fulvic acid or humin. These fractions are defined strictly on their solubility in either acid or alkali (Fiorentino *et al*., 2006).

Norman *et al* (2002) reported that, substitution of humates ranging from 250 – 1000 mg kg^{-1} MM 360, increased root growth of marigold and pepper. In the same trend, it significantly increased root growth and number of fruits of strawberries. Mohammad (2009) showed that, plant height, number of branches, leaf fresh and dry weights and nitrogen, phosphorus and potassium percentages and contents of *Catharanthus roseus* were generally increased with gradual increase in humic acid levels up to 200 ppm in the two seasons.

Rao *et al* (1990) demonstrated that, the highest results of essential oil content and yield on *Pelargonium graveolens* plants obtained with 100 kg N/ha. El-Ghadban (1998) on *Mentha viridis* and *Origanum majorana* found significant increases in N, P and K percentages and essential oil percentage in fresh herb by the different NPK fertilization treatments as compared to unfertilized plants. Ali (2009) revealed that, NPK fertilizers at 200:200:100 kg/fed., respectively, significantly increased leaves fresh weight, oil yield/plant and total carbohydrates content in leaves in *Foeneculum vulgare* plants. El-Naggar (2013) fertilized cantaloupe plants (*Cucumis melo var. cantaloupensis*) with NPK at three levels, and showed that, the second level (100, 50 and 100 kg/fed.) recorded the highest shoot fresh weight at 45 days from transplant during 1st season. While, after 60 and 90 days the third level (50, 25 and 50 kg/fed.) resulted the maximum shoot fresh weight. On the other hand, the first level (150, 100 and 150 kg/fed.) significantly increased number of branches/plant at 60 days from transplanting compared with other treatments which had no significant differences among them.

The aim of this study, investigate the effect of different irrigation intervals, chemical (recommended NPK) and bio fertilization (EM, active dry yeast and humic acid) and their interactions on vegetative growth parameters, herb yield, essential oil contents and chemical composition of Rose-scented geranium plants (*Pelargonium graveolens,* L.Herit.) arriving to the best treatment to achieve the highest fresh herb and essential oil yields throughout four cuts in two years/season.

MATERIALS AND METHODS

The field work was carried out at the Experimental Farm of Horticultural Research Station in El-Quassassin, Ismailia Governorate, Egypt, during the two successive seasons of 2009-2011 and 2010-2012 (every season consists of two years).

The cuttings of geranium (*Pelargonium graveolens* L.) plants were planting in the experimental units on November 20th in the two seasons of 2009 and 2010. The experimental unit area was 12.6 m^2. Every unit contained three rows with 6 m length. The distances between rows were 70 cm and 25 cm between hills. Every experimental unit contained 72 plants (about 24000 plants per feddan).

The dry compost was added to the experimental area during preparing soil before planting in the two seasons as a rate of 2 tons/fed. The same volume of compost was added to the plants after second cut during both seasons. The chemical composition of the dry compost is shown in Table (A).

Table (A): Compost analysis.

Fresh weight (m^3)	750 – 850 kg	**Macro elements**	
Dry weight (m^3)	550 – 650 kg	N %	0.8 – 1.2
Moisture %	25 – 30 %	P %	0.4 – 0.6
pH	7.5 – 8.5	K %	0.8 – 1.4
EC ds/m	3.5 – 6.5	Micro elements (ppm)	
Saturation %	150 – 200	Fe	1000 – 1800
Organic matter %	25 – 30	Mn	80 – 120
Organic carbon %	14.5 – 17.5	Cu	100 – 160
C/N ratio	1:14.5 or 1:18	Zn	30 – 50

The treatments were arranged in a split plot design with three replicates. The three water amounts of irrigation treatments were arranged in the main plots, while four kinds of fertilization treatments were in sub plots. So, this experiment contains twelve treatments.

Irrigation treatments (main plots):

Drip irrigation system was used in this experiment with the drippers of 2 liters/hour discharge for each at 0.5 bar. The experimental unit contained the three drip irrigation lines spaced 70 cm apart. The distances between drippers were 50 cm on the irrigation lines.

During and after planting all cuttings were irrigated 2 hours every day at the first 10 days. Then, the plants were watered one time/day (starting 09.00 Am) for duration of 1 hour/day in each treatment only in the first year during the three winter months (December 2009, January and February 2010). While in eight months later (March to October), all treatments irrigated 2 hours/day each time.

In the same trend, the plants in second year watered 1 hour/day during 4 months (November, December 2010, January and February 2011). While in seven months later (March to September 2011) the plants in all treatments irrigated 2 hours/day. This way repeated in the second season (2010 – 2012).

The amounts of applied water irrigation m^3/fed. for every irrigation treatment were determined during the growth period are shown in Table (B).

Table (B): Irrigation treatments and water amount added per feddan in the two years during the plant growth season.

Number of irrigation/ week	First year						
	December – February			March - October			Water quantity (m^3)/year
	Water rate (L.) /dripper /time	Water quantity (m^3)/week /fed	Water quantity (m^3)/ 3 winter months	Water rate (L.) /dripper /time	Water quantity (m^3)/week /fed.	Water quantity (m^3)/ 8 summer months	
1	2	24	307	4	48	1680	2467*
2	4	48	614	8	96	3360	4454*
3	6	72	921	12	144	5040	6441*
Number of irrigation/ week	Second year						
	November – February			March – September			Water quantity/ year
	Water rate/ dripper (L.)	Water quantity/ week/ fed.(m^3)	Water quantity/4 winter months	Water rate/ dripper (L.)	Water quantity/ week/ fed.(m^3)	Water quantity/7 months	
1	2	24	410	4	48	1469	1879
2	4	48	821	8	96	2938	3759
3	6	72	1231	12	144	4406	5637

* **In addition to 480 m^3/fed. were added for all treatments during the first 10 days after cuttings planting.**

Fertilization treatments (sub plots):

Chemical fertilizers treatment NPK (control)

The geranium plants were fertilized with ammonium sulphate (20.5 N %) at 300 kg/fed., calcium superphosphate (15.5 P_2O_5 %) at 300 kg/fed. and potassium sulphate (48 K_2O %) at 100 kg/fed. The nitrogen and potassium fertilizers were applied as soil dressing beside drippers. The amount of nitrogen and potassium fertilizers were divided into three equal doses, the first dose was added after one month from planting, whereas the other two doses were applied one month between them and between the first one. While calcium superphosphate fertilizer was added during soil preparation.

These treatments were conducted in the second year as mentioned in the first year, but the first dose of nitrogen and potassium fertilizers and calcium superphosphate fertilizer were added after the second cut in October. The second and third doses had the same manner in the first year.

Organic fertilizer treatment (humic acid)

Vegetarian humic acid fertilizer contains 86 % humic acid (Abo-Zaabal Company for Fertilizers Manufacturing).

The vegetarian humic acid fertilizer was added to the experimental units as a rate of 280 g/fed. which contains 241.5 g humic acid, one month from planting and repeated one month later in the first year. The same doses conducted in the second year starting on month after the second cut. The same application was done in the second season.

Bio-Fertilizers treatments

Effective microorganisms (EM_1) :

EM_1 used was applied as the concentration of 5 liters/fed. and added to the experimental units four times. The first time was one month after the date of planting, while, the second time was one month after the first adding. The

third time was after second cut, while the fourth time after one month from the third time. These treatments were conducted in the second season. The content of Effective Microorganisms (EM_1) was observed in Table (C) according to described by (Daly and Stewart, 1999 and Higa, 2002).

Table (C): The content of Effective Microorganisms (EM_1).

Photosynthetic bacteria :	*Rhodopseudomonas palustrus*
	Rhodobacter spaeroides
Lactic acid bacteria :	*Lactobacillus plantarum*
	Lactobacillus casei
	Streptococcus lactis
Yeasts :	*Saccharomyces cerevisiae*
	Candida utilis
Actinomycetes :	*Streptomyces albus*
	Streptomyces griseus
Fungi :	*Aspergillus oryzae*
	Mucor hiemalis

Active dry yeast :

The application of active dry yeast (*Saccharomyces cerevisiae*) was used as foliar spray with the concentration of 6 g/L. The plants were sprayed by aqueous solution of dry yeast three times; the first was on December 20th, while the second and third ones were at 21 days intervals after the first one during the first year. The same treatment was done in the second year starting from November 1st as conducted in the first year.

Recorded data :

Vegetative growth:

The different growth characters were recorded at four cuts (15th May and 1st October, in the first year, and the same dates in the second year) during both seasons.

Plants in the middle dripper lines were randomly chosen by cutting the aerial parts of each plant 5 cm above the soil surface.

The following measurements were recorded:

1- Plant height (cm).
2- Number of branches/plant.
3- Fresh weight of herb (g)/plant

The Essential Oil :

In the same times as in the vegetative growth, the essential oil characters were recorded:

1- Essential oil percentage (%).
2- Essential oil yield (ml.)/plant was calculated from multiplying the values of essential oil (%) × fresh weight of herb (g)/plant.

Chemical Analysis :

Chemical analysis of samples (at the third cut) of the first and second seasons of the geranium plant leaves dried at 70 ^{o}c was carried out at the beginning bloom stage. The following determinations were carried out:

1. Total nitrogen percentage was determined according to the methods described by Mazumder and Majumder (2003).

2. Total phosphorus percentage was determined according to the method described by Jackson (1967).
3. Total potassium percentage determination was done photometrically according to the method described by Mazumder and Majumder (2003).
4. Total carbohydrate percentage was carried out according to Herbert *et al* (1971).

Statistical Analysis :

The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980), using New L.S.D. at 5% and 1% levels for comparison between means of different treatments.

RESULTS AND DISCUSSION

Effect of irrigation intervals, chemical, organic and bio-fertilization and their interactions on vegetative growth of *Pelargonium graveolens* L. plants.

Plant height :

Data presented in Table (1) show the effect of irrigation intervals on plant height of geranium plants. The differences between irrigation treatments were highly significant. The tallest plants were obtained when irrigated three times every week followed by two times every week, during four cuts, in both seasons. These results were in great harmony with those obtained by Talha *et al* (1980) on *Pelargonium graveolens* and Ebrahim (2005) in roselle plants.

As for the main effect of fertilization, the results in Table (1) clear that, there were highly significant increases between treatments in plant height. Moreover, the superior treatment in this respect was recommended NPK, followed by humic acid treatments, while the shortest plants observed with spraying active dry yeast treatment, during four cuts in the two seasons. Obtained results in this study were in harmony with those reported by Sakr (2001) on *Mentha piperita*.

The effect of the interaction treatments between irrigation intervals and fertilization kinds on plant height of geranium plants was recorded in Table (1). The results stated that, there were effects due to the interaction treatments and the differences between them were significant. The treatment of irrigation three times every week + chemical fertilization (NPK) gave the tallest plants followed by the treatment of irrigated plants three times/week plus fertilization with humic acid. The differences between both treatments were highly significant during the second and fourth cuts in the two seasons. While, it was non-significant in the first cut during the first season and in the third cut during the second season. The shortest plants obtained from plants irrigated one time/week and sprayed with active dry yeast in the four cuts during the two seasons.

Table (1): Effect of irrigation intervals, fertilization treatments and the interaction between them on plant height of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

Treatments		Plant height							
		First season				Second season			
		1st cut	2nd cut	3rd cut	4th cut	1st cut	2nd cut	3rd cut	4th cut
		Irrigation intervals treatments							
3* every week		53.2	53.2	80.6	125.3	60.8	40.8	79.3	128.5
2* every week		49.4	45.3	75.2	114.1	53.7	38.3	74.7	118.3
1* every week		46.4	40.4	66.3	105.8	48.6	33.8	63.8	105.0
New L.S.D at 5%		0.20	0.10	0.62	0.49	0.65	0.32	0.55	0.41
New L.S.D at 1%		0.30	0.14	0.91	0.73	0.96	0.47	0.82	0.60
		Fertilization treatments							
EM		49.0	45.1	75.4	111.1	54.2	36.0	73.1	110.8
Active dry yeast		46.0	33.4	56.2	93.3	40.1	30.2	54.6	105.8
humic acid		50.3	50.4	80.6	122.3	60.0	39.6	80.1	122.4
NPK		53.3	56.2	83.8	133.4	63.1	44.8	82.7	130.0
New L.S.D at 5%		0.24	0.58	0.65	0.59	0.32	0.40	0.81	0.45
New L.S.D at 1%		0.32	0.77	0.86	0.79	0.43	0.53	1.08	0.60
Irrigation intervals	Fertilization treatments	Interaction treatments							
3* every week	EM	53.7	55.0	86.3	118.0	58.7	40.7	82.7	122.3
	Active dry yeast	50.3	38.3	54.0	101.0	50.0	31.0	53.0	115.7
	humic acid	54.0	57.7	89.7	133.3	65.3	44.7	89.7	134.3
	NPK	54.7	61.7	92.3	149.0	69.3	47.0	92.0	141.7
2* every week	EM	47.0	43.0	74.7	110.3	54.7	37.0	75.7	112.3
	Active dry yeast	46.0	32.8	61.0	93.0	37.7	31.3	59.3	105.7
	humic acid	50.7	48.7	81.3	122.0	59.0	39.0	80.7	123.0
	NPK	54.0	56.7	83.7	131.0	63.3	45.7	83.0	132.0
1* every week	EM	46.3	37.3	65.3	105.0	49.3	30.3	61.0	97.7
	Active dry yeast	41.7	29.0	53.7	86.0	32.7	28.3	51.3	96.0
	humic acid	46.3	45.0	70.7	111.7	55.7	35.0	70.0	110.0
	NPK	51.3	50.3	75.3	120.3	56.7	41.7	73.0	116.3
New L.S.D at 5%		0.77	2.17	2.07	1.89	1.03	1.33	2.59	1.68
New L.S.D at 1%		1.00	3.11	2.68	2.45	1.33	1.82	3.50	2.40

*** Number of irrigation times every week.**

Number of branches :

The data presented in Table (2) clearly show that, drip irrigation treatments had highly significant effect on number of branches. The highest values were obtained when irrigated plants 3 times every week, while the least one obtained from plants irrigated one time every week, during four cuts in the two seasons. These results are in agreement with those reported by Ebrahim (2005) who indicated that roselle irrigation treatment every 3 days increased number of branches.

Table (2): Effect of irrigation intervals, fertilization treatments and the interaction between them on number of branches/plant of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

Treatments		Number of branches/plant							
		First season				Second season			
		1st cut	2nd cut	3rd cut	4th cut	1st cut	2nd cut	3rd cut	4th cut
		Irrigation intervals treatments							
3* every week		22.7	34.7	79.0	63.6	26.8	21.3	63.8	36.2
2* every week		18.8	29.7	66.2	45.3	16.9	16.9	49.5	31.7
1* every week		13.8	14.2	61.3	30.8	8.4	14.4	53.6	27.0
New L.S.D at 5%		0.56	1.01	1.22	0.88	1.41	0.15	1.12	0.43
New L.S.D at 1%		0.83	1.49	1.81	1.30	2.08	0.22	1.65	0.64
		Fertilization treatments							
EM		17.6	21.9	60.8	41.8	10.9	16.1	46.1	30.1
Active dry yeast		11.4	13.1	35.6	19.8	4.8	11.1	31.0	22.9
humic acid		20.3	28.6	82.6	56.6	20.0	19.8	62.6	32.6
NPK		24.2	41.1	96.4	68.1	33.9	23.2	82.9	40.9
New L.S.D at 5%		0.43	0.79	0.86	1.23	1.14	0.11	1.16	0.22
New L.S.D at 1%		0.57	1.06	1.15	1.65	1.53	0.15	1.55	0.29
Irrigation	Fertilization	Interaction treatments							
3* every week	EM	21.0	25.3	65.0	56.0	18.0	20.0	48.0	32.7
	Active dry yeast	15.0	18.0	43.3	26.7	7.0	13.0	31.0	25.0
	humic acid	26.0	41.3	98.7	78.7	30.0	24.0	71.7	36.3
	NPK	28.7	54.0	109.0	93.0	52.3	28.3	104.7	50.7
2* every week	EM	17.7	31.7	61.0	37.3	10.0	15.3	39.0	30.3
	Active dry yeast	12.3	16.3	34.7	20.0	4.3	11.7	24.3	21.3
	humic acid	20.0	26.0	77.7	55.3	23.3	18.7	64.3	32.3
	NPK	25.0	44.7	91.3	68.7	30.0	22.0	70.3	42.7
1* every week	EM	14.0	8.7	56.3	32.0	4.7	13.0	51.3	27.3
	Active dry yeast	7.0	5.0	28.7	12.7	3.0	8.7	37.7	22.3
	humic acid	15.0	18.3	71.3	35.7	6.7	16.7	51.7	29.0
	NPK	19.0	24.7	89.0	42.7	19.3	19.3	73.7	29.3
New L.S.D at 5%		1.89	2.53	2.87	3.95	3.65	0.33	3.56	0.65
New L.S.D at 1%		---	3.29	3.93	5.13	4.75	0.44	4.78	0.87

*** Number of irrigation times every week.**

It is obvious from data tabulated in Table (2) that, all tested treatments of fertilizers resulted increments in the number of branches. The best result was recorded by using the recommended doses of NPK fertilizers, followed by humic acid, EM and yeast. The differences between all treatments were highly significant during four cuts in both seasons. These results agree with those reported by Ahmed (1988) on geranium plants, Mohammad (2009) on *Catharanthus roseus* and Khalil (2006) on *Plantago afra* L.

Regarding the effect of the interaction treatments between irrigation intervals and fertilization kinds (NPK, humic acid, EM and active dry yeast) on number of branches of geranium plants, the data illustrated in Table (2) reveal that, there were effects with highly significant differences between treatments. The highest values recorded with the interaction treatment of

plants irrigated 3 times/week and fertilized with NPK, followed by irrigation 3 time every week + humic acid treatment. The lightest results showed in plants irrigated 1 time/week and sprayed with active dry yeast.

Table (3): Effect of irrigation intervals, fertilization treatments and the interaction between them on fresh weight of herb (g)/plant of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

Treatments		Fresh weight of herb (g)/plant							
		First season				Second season			
		1st cut	2nd cut	3rd cut	4th cut	1st cut	2nd cut	3rd cut	4th cut
		Irrigation intervals treatments							
3* every week		470.2	422.6	1962.4	876.9	320.3	416.8	1598.8	665.0
2* every week		334.8	293.1	1025.8	658.8	222.6	333.8	910.3	532.5
1* every week		325.3	183.5	762.5	528.6	147.3	254.2	761.3	417.8
New L.S.D at 5%		5.9	0.8	65.3	7.8	3.2	1.2	42.6	5.05
New L.S.D at 1%		8.8	1.2	96.7	11.5	4.7	1.8	63.0	7.47
		Fertilization treatments							
EM		323.2	282.7	1130.5	527.6	212.9	298.6	1034.3	437.0
Active dry yeast		196.2	148.7	536.5	344.3	110.3	245.3	621.1	362.2
humic acid		434.3	360.2	1404.0	731.6	287.1	362.8	1203.7	558.5
NPK		553.3	407.3	1930.0	1149.0	309.9	433.1	1501.2	796.0
New L.S.D at 5%		4.4	2.0	60.0	4.8	3.4	1.6	41.2	4.44
New L.S.D at 1%		5.9	2.6	80.1	6.4	4.5	2.2	55.1	5.93
Irrigation intervals	Fertilization treatments	Interaction treatments							
3* every week	EM	323.5	429.3	1676.1	614.7	288.0	380.7	1479.7	549.6
	Active dry yeast	244.6	204.1	772.5	447.3	153.0	310.0	821.0	482.1
	humic acid	527.8	465.7	2161.6	902.0	402.7	457.7	1852.3	725.1
	NPK	784.8	591.2	3239.5	1543.7	437.3	519.0	2242.0	903.4
2* every week	EM	289.7	257.0	883.5	509.3	216.7	312.7	834.0	459.5
	Active dry yeast	186.3	159.9	501.8	316.7	97.3	259.7	539.7	322.3
	humic acid	402.1	346.7	1235.5	698.3	293.7	333.7	1075.3	591.2
	NPK	461.1	409.0	1482.4	1111.0	282.7	429.3	1192.0	757.0
1* every week	EM	356.3	161.9	831.8	458.7	134.0	202.3	789.3	302.1
	Active dry yeast	157.8	82.1	335.1	269.0	80.7	166.3	502.7	282.2
	humic acid	373.1	268.3	815.0	594.3	165.0	297.0	683.3	359.3
	NPK	413.9	221.8	1068.2	792.3	209.7	351.0	1069.7	727.7
New L.S.D at 5%		13.2	5.9	191.8	14.4	10.2	4.8	138.0	13.33
New L.S.D at 1%		17.6	7.9	249.2	19.2	13.6	6.5	189.0	17.80

*** Number of irrigation times every week.**

Fresh weight of herb (g)/plant :

The results on fresh weight of herb/plant as affected by irrigation intervals presented in Table (3) and Fig. (1) show that, increasing irrigation times every week treatments up to 3 times/week increased fresh weight of herb/plant. Moreover, the differences between treatments were highly significant. The best treatment in increasing fresh weight of herb/plant was that of 3 times every week compared to the other ones under study during 4 cuts, in the two seasons. The plants irrigated 3 times/week resulted 470.2, 422.6, 1962.4 and 876.9 g fresh weight of herb/plant in the first season, and 320.3, 416.8, 1598.8 and 665.0 g fresh weight of herb/plant in the second season during 1st, 2nd, 3rd and 4th cuts, respectively. A similar trend was

resulted by Singh *et al* (1996) on *Pelargonium graveolens* recorded that, the irrigation every 5 days interval gave the highest herb yield.

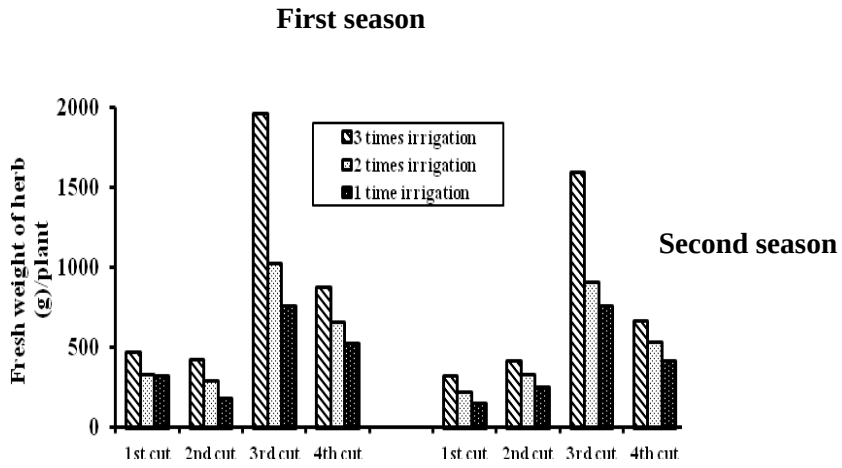

Fig. (1): Effect of Irrigation intervals on fresh weight of herb (g)/plant of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

It is obvious from data in Table (3) and illustrated in Fig. (2) that, all examined treatments of chemical, organic and bio fertilization resulted in highly significant increments in the fresh weight of herb/plant. However, the heaviest fresh weight of herb/plant was recorded by using the treatment of NPK followed by humic acid, EM and yeast. Using the recommended doses of NPK fertilizer gave 553.3, 407.3, 1930.0 and 1149.0 g fresh weight of herb/plant in the first season, while it gave 309.9, 433.1, 1501.2 and 796.0 g fresh weight of herb/plant in the second season, for first, second, third and fourth cuts, respectively. from the same trend, the humic acid treatment resulted 434.3, 360.2, 1404.0 and 731.6 g fresh weight of herb/plant in the first season, and gave 287.1, 362.8, 1203.7 and 558.5 g fresh weight of herb/plant in the second season, during 1^{st}, 2^{nd}, 3^{rd} and 4^{th} cuts, respectively. Similarly, the effect of chemical, organic and bio fertilization on fresh weight of herb/plant was studied by Hunter and Anders (2004) revealed that, humic acid has a stimulatory effect in turfgrass fresh and dry weights and Khalil (2006) demonstrated that, application of effective microorganism (EM) on *Plantago afra* L. pronouncedly improved herb fresh and dry weights.

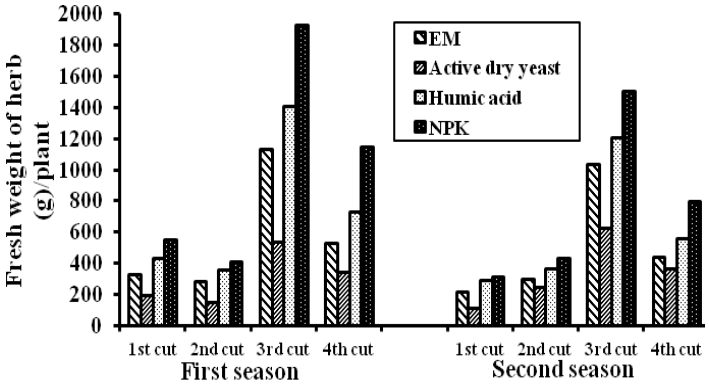

Fig. (2): Effect of fertilization treatments on fresh weight of herb (g)/plant of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

According to data tabulated in Table (3) in fresh weight of herb/plant as affected by the combined treatments between irrigation intervals and different kinds of fertilization on *Pelargonium graveolens,* it could be concluded that, the highest effects were observed with the interaction treatment of irrigation three times/week and NPK fertilization, followed by irrigation 3 times every week + humic acid. The differences between both treatments were highly significant. These findings noticed during the four cuts in the two seasons. The plants irrigated three times every week and fertilized with NPK gave 784.8, 591.2, 3239.5 and 1543.7 g fresh weight of herb/plant in the first season, while it recorded 437.3, 519.0, 2242.0 and 903.4 g fresh weight of herb/plant in the second one, during first, second, third and fourth cuts, respectively.

From the data studied in Table (3), it could be noticed that, the biggest values of fresh weight of herb/plant found in the 3rd cut, followed by 4th, 1st and 2nd cuts, in the first season, and followed by 4th, 2nd and 1st cuts in the second one. This finding may be due to the volume of roots in the third cut bigger than the roots in the first and second cuts, which enhance the fresh weight of herb/plant. In the same time, the plants in 3rd cut remained in soil about 7 months, while the plants in 4th cut remained in the soil about 4 months.

Effect of irrigation intervals, chemical, organic and bio-fertilization and their interactions on essential oil contents of *Pelargonium graveolens* L. plants.

Essential oil percentage :

Data presented in Table (4) and illustrated in Fig. (3) show the effect of irrigation intervals on essential oil (%) of geranium plants. The differences between irrigation treatments were highly significant. The highest percentage was found in plants irrigated three times every week followed by two times

every week, during four cuts, in both seasons. These results are similar with those obtained by Toima (1992) who stated that, the short period of irrigation interval (5 days) significantly increased the volatile oil percentage in coriander plants.

Table (4): Effect of irrigation intervals, fertilization treatments and the interaction between them on essential oil percentage of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

Treatments		Essential oil percentage							
		First season				Second season			
		1st cut	2nd cut	3rd cut	4th cut	1st cut	2nd cut	3rd cut	4th cut
		Irrigation intervals treatments							
3* every week		0.165	0.153	0.159	0.169	0.151	0.167	0.156	0.160
2* every week		0.162	0.150	0.158	0.163	0.150	0.161	0.151	0.159
1* every week		0.142	0.142	0.152	0.151	0.147	0.148	0.136	0.140
New L.S.D at 5%		0.0010	0.0013	0.0019	0.0023	0.0020	0.0020	0.0010	0.0027
New L.S.D at 1%		0.0020	0.0021	0.0028	0.0034	-----	0.0030	0.0020	0.0039
		Fertilization treatments							
EM		0.157	0.144	0.153	0.163	0.144	0.155	0.140	0.153
Active dry yeast		0.137	0.137	0.137	0.153	0.135	0.141	0.127	0.143
humic acid		0.167	0.160	0.170	0.165	0.159	0.170	0.159	0.157
NPK		0.163	0.151	0.165	0.164	0.158	0.168	0.165	0.159
New L.S.D at 5%		0.002	0.0007	0.0003	0.0023	0.0012	0.002	0.002	0.0007
New L.S.D at 1%		0.003	0.0009	0.0004	0.0034	0.0016	0.003	0.003	0.0009
Irrigation intervals	Fertilization treatments	Interaction treatments							
3* every week	EM	0.161	0.150	0.162	0.160	0.146	0.165	0.150	0.161
	Active dry yeast	0.158	0.143	0.138	0.150	0.140	0.148	0.138	0.143
	humic acid	0.172	0.163	0.173	0.181	0.165	0.181	0.166	0.172
	NPK	0.169	0.155	0.163	0.185	0.150	0.174	0.169	0.163
2* every week	EM	0.163	0.144	0.152	0.179	0.143	0.156	0.144	0.151
	Active dry yeast	0.150	0.141	0.143	0.163	0.136	0.143	0.136	0.150
	humic acid	0.169	0.160	0.169	0.156	0.157	0.173	0.162	0.169
	NPK	0.166	0.153	0.166	0.155	0.164	0.170	0.163	0.167
1* every week	EM	0.148	0.138	0.144	0.148	0.143	0.145	0.125	0.146
	Active dry yeast	0.103	0.127	0.130	0.145	0.129	0.132	0.108	0.135
	humic acid	0.161	0.157	0.168	0.157	0.154	0.155	0.150	0.131
	NPK	0.155	0.146	0.166	0.153	0.160	0.160	0.159	0.148
New L.S.D at 5%		0.007	0.0023	0.001	0.002	0.0039	0.009	0.008	0.0021
New L.S.D at 1%		0.009	0.0031	0.0014	0.0027	0.0054	-----	0.012	0.0028

*** Number of irrigation times every week.**

As for the main effect of fertilization, the results in Table (4) and showed in Fig. (4) clear that, there were highly significant increases between treatments in essential oil (%). Moreover, the superior treatment in this respect was humic acid, followed by recommended NPK treatments in all cuts during first season and for 1st and 2nd cuts in the second season, while NPK gave the highest percentage in the 3rd and 4th cuts followed by humic acid in the second season. The least percentage observed with spraying active dry yeast treatment, during four cuts in the first season and in 1st and 2nd cuts in the second one. A similar trend was resulted by Kassem (1997) on

Rosmarinus officinalis plants, El-Ghadban (1998) on *Mentha viridis* and Jacoub (1999) in *Ocimum basilicum* and *Thymus vulgaris* plants stated that, NPK fertilization increased the essential oil percentage in fresh herb. Zaghloul *et al* (2009) recorded that, foliar spray of potassium humate increased essential oil percentage of *Thuja orintalis* L. plants.

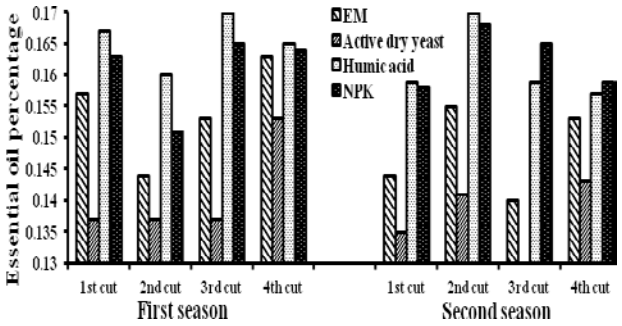

Fig. (3): Effect of Irrigation intervals on essential oil percentage of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

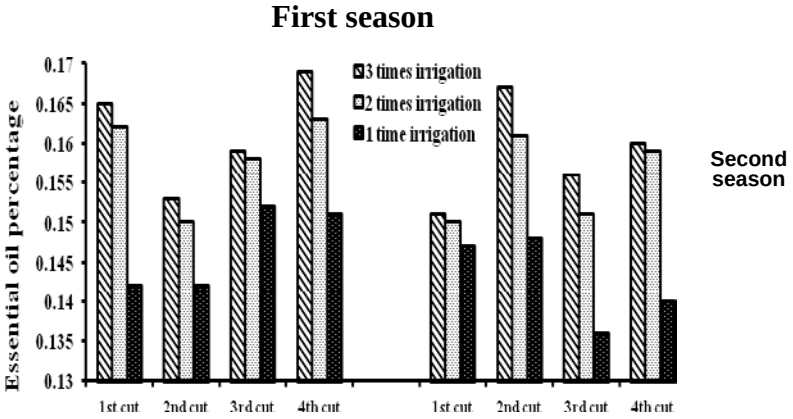

Fig. (4): Effect of fertilization treatments on essential oil percentage of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

The effect of the interaction treatments between irrigation intervals and fertilization kinds on essential oil percentage of geranium plants was recorded in Table (4). The results stated that, there were effects due to the interaction

treatments and the differences between them were significant. The treatment of irrigation three times every week + humic acid gave the highest oil percentage in the 1st, 2nd and 3rd cuts in the first season, and in 1st, 2nd and 4th cuts in the second season while the treatment of irrigated plants three times/week plus fertilization with chemical fertilization (NPK) gave the highest oil percentage in the fourth cut in 1st season and in third cut in 2nd season. The differences between both treatments were significant during the two seasons. The minimum oil percentage obtained from plants irrigated one time/week and sprayed with active dry yeast in the four cuts during the two seasons.

Essential oil yield (ml.)/plant :

Data of the effect of irrigation intervals on essential oil yield (ml.)/plant during four cuts in the two seasons presented in Table (5). The irrigation treatments had the observed effects, and the differences between treatments were highly significant. The highest result obtained from plants irrigated three times every week. These finding replicated through four cuts in both seasons. This treatment gave 0.787, 0.645, 3.202 and 1.513 ml. essential oil content/plant in the first season, and gave 0.438, 0.711, 2.623 and 0.543 ml. essential oil content/plant in the second season, during first, second, third and fourth cuts, respectively. On the other hand, the plants irrigated one time every week resulted minimum values in this respect during all cuts in both seasons. Similar findings were obtained by Khater *et al* (2005) revealed that, using irrigation intervals every one week produced the highest volatile oil yield/plant of *Mentha piperita* L. compared with other irrigation intervals (every 2, 3 or 4 weeks).

As for fertilization treatments, data tabulated in Table (5) showed that, the different kinds of fertilization had highly significant effects of essential oil content (ml.)/plant. The best result obtained from the recommended doses of NPK fertilizers treatment, followed by humic acid treatment. The differences between both treatments were highly significant. NPK treatment gave 0.912, 0.656, 3.208 and 1.940 ml. essential oil content/plant in the first season, and gave 0.542, 0.731, 2.597 and 0.525 ml. essential oil content/plant in the second season, from 1st, 2nd, 3rd and 4th cuts, respectively. The minimum values observed in plants treated with active dry yeast during 4 cuts in the two seasons. The same trend was also observed by many researchers such as Ughreja and Chundawat (1992) on *Coriandrum sativum* plants, Hammam (1996) on *Pimpinella anisum* plants, Zheljazkov *et al* (1996) on *Mentha arvensis* plants, and Ali (2009) on *Foeniculum vulgare* recorded that, essential oil content/plant was increased with increasing rates of NPK fertilizers. Zaghloul *et al* (2009) studying the effect of foliar spray with potassium humate on *Thuja orintalis* L. at different concentrations, they reached to the conclution that, K-humates recommended for possessed the best oil percentage.

According to data presented in Table (5) on essential oil content (ml.)/plant as affected by the interaction treatments between irrigation intervals and fertilization kinds, it could be concluded that, the differences between all treatments were significant. The largest essential oil content

(ml.)/plant recorded with the interaction treatment of irrigation 3 times every week + NPK fertilizers during all cuts in both seasons, followed by irrigation 3 times/week plus humic acid fertilizer treatment during first, second and third cuts in the first season, and in the all cuts in the second one. The least essential oil content (ml.)/plant observed with plants irrigated one time/week + spraying with active dry yeast, through 4 cuts in both seasons.

Table (5): Effect of irrigation intervals, fertilization treatments and the interaction between them on essential oil content (ml)/plant of *Pelargonium graveolens* plants in the four cuts during the two seasons of (2009-2011) and (2010-2012).

Treatments		Essential oil content (ml)/plant							
		First season				Second season			
		1st cut	2nd cut	3rd cut	4th cut	1st cut	2nd cut	3rd cut	4th cut
		Irrigation intervals treatments							
3* every week		0.787	0.645	3.202	1.513	0.438	0.711	2.623	0.543
2* every week		0.549	0.457	1.693	1.074	0.227	0.542	1.463	0.428
1* every week		0.485	0.283	1.170	0.807	0.177	0.400	1.143	0.329
New L.S.D at 5%		0.012	0.006	0.110	0.018	0.040	0.006	0.010	0.007
New L.S.D at 1%		0.018	0.009	0.170	0.027	0.060	0.009	0.015	0.011
		Fertilization treatments							
EM		0.508	0.402	1.719	0.858	0.102	0.470	1.506	0.409
Active dry yeast		0.277	0.208	0.747	0.512	0.109	0.367	0.855	0.316
humic acid		0.730	0.581	2.411	1.216	0.369	0.637	2.014	0.484
NPK		0.912	0.656	3.208	1.940	0.542	0.731	2.597	0.525
New L.S.D at 5%		0.011	0.006	0.100	0.019	0.030	0.016	0.019	0.007
New L.S.D at 1%		0.015	0.008	0.140	0.026	0.040	0.021	0.026	0.009
Irrigation	Fertilization	Interaction treatments							
3* every week	EM	0.521	0.614	2.711	0.985	0.140	0.628	2.221	0.495
	Active dry yeast	0.387	0.291	1.105	0.581	0.269	0.462	1.171	0.380
	humic acid	0.908	0.756	3.708	1.626	0.602	0.853	3.159	0.635
	NPK	1.331	0.920	5.283	2.860	0.741	0.903	3.941	0.664
2* every week	EM	0.473	0.372	1.364	0.912	0.118	0.488	1.256	0.361
	Active dry yeast	0.280	0.230	0.703	0.564	0.036	0.373	0.797	0.301
	humic acid	0.679	0.572	2.088	1.089	0.295	0.576	1.800	0.513
	NPK	0.764	0.653	2.616	1.733	0.460	0.730	1.998	0.535
1* every week	EM	0.532	0.219	1.083	0.676	0.049	0.294	1.041	0.370
	Active dry yeast	0.165	0.104	0.434	0.391	0.022	0.265	0.597	0.265
	humic acid	0.603	0.415	1.437	0.931	0.211	0.480	1.082	0.304
	NPK	0.642	0.394	1.726	1.228	0.426	0.561	1.851	0.377
New L.S.D at 5%		0.033	0.033	0.018	0.330	0.058	0.110	0.050	0.058
New L.S.D at 1%		0.044	0.044	0.024	0.440	0.078	-----	0.065	0.078

*** Number of irrigation times every week.**

From the superior treatment in Table (5), it is noticed that, the highest essential oil content (ml.)/plant showed in the third cut in the two seasons, followed by fourth, first and second cuts in the first season, and followed by second, first and fourth cuts, in the second season, respectively.

Effect of irrigation intervals, chemical, organic and bio-fertilization and their interactions on chemical compositions of *Pelargonium graveolens* L. plants.

Nitrogen percentage:

Data presented in Table (6) record the effect of irrigation intervals on nitrogen percentage of geranium leaves. The percentage was gradually decreased with decreasing irrigation intervals. The highest value obtained when plants irrigated three times followed by two times every week, in both seasons. These results are in agreement with those recorded by **Ebrahim** (2005) on roselle.

As for the main effect of fertilization, the results in Table (6) clear that, there was effect of treatments in nitrogen percentage. Moreover, the superior treatment in this respect was humic acid, followed by recommended NPK treatments, in the first season, and vice versa in the second one. While the lightest result observed with spraying active dry yeast treatment, in both seasons. The results go parallel with those obtained with Mohammad (2009) on *Catharanthus roseus*, Habib, (1992) on *Pelargonium peltatum* and Sakr (2001) on *Mentha piperit.*

Table (6): Effect of Irrigation intervals, chemical and bio-fertilization and their interactions on nitrogen percentage of *Pelargonium graveolens* plants during the two seasons of (2009-2011) and (2010-2012).

Fertilization treatments / Irrigation intervals	EM	Active dry yeast	humic acid	NPK	Mean of Irrigation
	First season				
3* every week	1.94	1.90	2.67	2.58	2.27
2* every week	2.29	1.63	2.29	2.50	2.18
1* every week	1.73	2.09	2.38	2.09	2.07
Main of Fertilization	1.99	1.87	2.45	2.39	
	Second season				
3* every week	2.26	1.69	2.29	2.67	2.23
2* every week	1.69	1.51	1.94	1.93	1.77
1* every week	1.69	2.10	2.14	2.13	2.02
Main of Fertilization	1.88	1.77	2.12	2.24	

*** Number of irrigation times every week.**

The effect of the interaction treatments between irrigation intervals and fertilization kinds on nitrogen percentage of geranium leaves was recorded in Table (6). The results stated that, there were observed effects due to the interaction treatments. The treatment of irrigation three times every week + humic acid gave the highest percentage of nitrogen followed by the treatment of irrigated plants three times/week plus chemical fertilization (NPK) fertilization in the second season. While, in the second one, the treatment of

irrigation three times every week + chemical fertilization (NPK) gave the best result, followed by the interaction treatment of irrigation three times every week + humic acid. The least results obtained from plants irrigated two times/week and sprayed with active dry yeast in the two seasons.

Phosphorus percentage :

The data presented in Table (7) clearly show that, drip irrigation treatments had observed effect on phosphorus percentage in leaves. The highest value was obtained when irrigated plants 3 times every week, while the least one obtained from plants irrigated one time every week, during the two seasons.

It is obvious from data tabulated in Table (7) that, all tested treatments of fertilizers resulted increments in the phosphorus percentage in leaves. The best results were recorded by using humic acid and the recommended doses of NPK fertilizers, followed by EM and yeast in both seasons.

Regarding the effect of the interaction treatments between irrigation intervals and fertilization kinds (NPK, humic acid, EM and active dry yeast) on phosphorus percentage of geranium leaves, the data illustrated in Table (7) reveal that, there were observed effects in this regard. The highest values recorded with the interaction treatments of plants irrigated 3 times/week with both treatments of recommended NPK and humic acid in both seasons. The minimum values showed in plants irrigated 2 times/week and sprayed with active dry yeast in the first season and from the treatment of irrigation one time/week + NPK in the second one.

Table (7): Effect of irrigation intervals, chemical and bio-fertilization and their interactions on phosphorus percentage of *Pelargonium graveolens* plants during the two seasons of (2009-2011) and (2010-2012).

Fertilization treatments / Irrigation intervals	EM	Active dry yeast	humic acid	NPK	Mean of Irrigation
	First season				
3* every week	0.517	0.500	0.590	0.597	0.550
2* every week	0.513	0.440	0.532	0.557	0.510
1* every week	0.503	0.445	0.510	0.503	0.490
Main of Fertilization	0.510	0.460	0.540	0.550	
	Second season				
3* every week	0.477	0.462	0.510	0.500	0.490
2* every week	0.432	0.412	0.445	0.440	0.430
1* every week	0.390	0.380	0.412	0.410	0.400
Main of Fertilization	0.430	0.420	0.460	0.450	

*** Number of irrigation times every week.**

Potassium percentage :

The data obtained for potassium percentage in geranium leaf as affected by some irrigation treatments were presented in Table (8). There were gradually increase in K% with decreasing the number of irrigation/week, so, the highest value was resulted from the treatment of irrigation 1 time/week followed by 2 and 3 times every week in the first season. While, the highest value in the second one was obtained from plants irrigated 1 followed by 3

and 2 times/week. These results are in accordance with these of El-Araby and Feleafel (2003) on *Lycopersicum esculentum,* and Ebrahim (2005) on guar and roselle plants, respectively.

Regardless, the effect of fertilization treatments on potassium percentage in geranium leaves, and recorded in Table (8), it could be concluded that, there were observed effects due to NPK, humic acid, EM and active dry yeast treatments. Moreover, the superior treatment in this respect was NPK which gave highly increase in K%, followed by humic acid, active dry yeast and EM during the two seasons. These results are in harmony with those recorded by Habib (1992) on *Pelargonium peltatum*, Sakr (2001) on *Mentha piperita* and El-Naggar (2013) on cantaloupe plants.

As for the interaction treatments between irrigation intervals and different kinds of fertilization on potassium percentage of *Pelargonium graveolens* L. leaves, the data showed in Table (8) state that, the interaction treatment of irrigation 1 time/week plus fertilization with NPK resulted in the highest value followed by irrigation 1 time/week + active dry yeast and humic acid in the first season. On the other side, the treatment of irrigation 3 times every week + humic acid fertilizer gave the highest K% followed by irrigation 2 times/week + NPK during the second season.

Table (8): Effect of irrigation intervals, chemical and bio-fertilization and their interactions on potassium percentage of *Pelargonium graveolens* plants during the two seasons of (2009-2011) and (2010-2012).

Fertilization treatments / Irrigation intervals	EM	Active dry yeast	humic acid	NPK	Mean of Irrigation
	First season				
3* every week	2.60	1.66	1.98	1.81	2.01
2* every week	2.17	1.99	2.26	2.50	2.23
1* every week	1.54	2.72	2.55	2.91	2.43
Main of Fertilization	2.10	2.12	2.26	2.41	
	Second season				
3* every week	1.69	1.95	2.60	2.12	2.09
2* every week	2.25	1.96	1.55	2.42	2.05
1* every week	1.81	2.21	2.14	2.22	2.10
Main of Fertilization	1.92	2.04	2.10	2.25	

*** Number of irrigation times every week.**

Total carbohydrates percentage :

The results on carbohydrates percentage in geranium leaves as affected by irrigation intervals presented in Table (9) show that, increasing irrigation times every week treatments up to that of 3 times/week increased carbohydrates percentage in leaves followed by 2 and 1 times/week in the two seasons. In accordance with those results, those found by Sakr (2001) on *Mentha piperita* and Ali (2009) on fennel plants.

It is obvious from data in Table (9) that, all examined treatments of chemical, organic and bio fertilization resulted in increments in carbohydrates percentage in geranium leaves. However, the highest value was recorded by using the treatment of humic acid, followed by NPK in both seasons.

According to data tabulated in Table (9) in carbohydrates percentage in geranium leaves as affected by the combined treatments between irrigation intervals and different kinds of fertilization on *Pelargonium graveolens,* it could be concluded that, the highest effects were observed with the interaction treatment of irrigation three times/week and humic acid, followed by irrigation 3 times every week + NPK fertilization in the first season, and vice versa in the second one.

Table (9): Effect of irrigation intervals, chemical and bio-fertilization and their interactions on total carbohydrates percentage of *Pelargonium graveolens* plants during the two seasons of (2009-2011) and (2010-2012).

Treatments		Essentialoil yield (L)/fed./year			
		First season		Second season	
		1st year	2nd year	1st year	2nd year
		Irrigation intervals treatments			
3* every week		34.116	113.152	26.347	75.981
2* every week		24.386	66.352	18.456	45.368
1* every week		18.440	47.444	13.854	35.330
New L.S.D at 5%		0.430	3.100	0.318	0.380
New L.S.D at 1%		0.640	4.580	0.470	0.570
		Fertilization treatments			
EM		21.835	61.851	13.741	45.949
Active dry yeast		11.653	30.229	9.767	28.085
Humic acid		31.136	87.037	24.136	59.947
NPK		37.965	123.480	30.565	74.925
New L.S.D at 5%		0.340	2.850	0.402	0.500
New L.S.D at 1%		0.450	3.810	0.537	0.670
Irrigation	Fertilization	Interaction treatments			
3* every week	EM	27.242	88.696	18.440	65.168
	Active dry yeast	16.272	40.472	12.580	37.200
	Humic acid	38.928	128.024	34.928	91.048
	NPK	54.024	195.416	39.440	110.510
2* every week	EM	20.255	54.632	14.536	38.808
	Active dry yeast	12.240	30.400	9.824	26.360
	Humic acid	30.040	76.240	20.904	55.528
	NPK	35.008	104.136	28.558	60.776
1* every week	EM	18.008	42.224	8.248	33.872
	Active dry yeast	6.448	19.816	6.896	20.696
	Humic acid	24.440	56.848	16.576	33.264
	NPK	24.864	70.888	23.696	53.488
New L.S.D at 5%		1.010	9.120	1.286	1.510
New L.S.D at 1%		1.350	12.320	1.670	2.010

Effect of irrigation intervals, chemical and bio-fertilization and their interactions treatments on chemical compositions of *Pelargonium graveolens*L. plants.

Nitrogen percentage :

Data presented in Table (10) record the effect of irrigation intervals on nitrogen percentage of geranium leaves. The percentage was gradually decreased with decreasing irrigation intervals. The highest value obtained when plants irrigated three times followed by two times every week, in both seasons.These results are in agreement with those recorded by Ebrahim (2005) on roselle.

As for the main effect of fertilization, the results in Table (10) clear that, there was effect of treatments in nitrogen percentage. Moreover, the superior treatment in this respect was Humic acid, followed by recommended NPK treatments, in the first season, and vice versa in the second one. While the lightest result observed with spraying active dry yeast treatment, in both seasons.The results go parallel with those obtained with Mohammad (2009) on *Catharanthusroseus*, Habib, (1992) on *Pelargonium peltatum* and Sakr(2001) on *Menthapiperit.*

The effect of the interaction treatments between irrigation intervals and fertilization kinds on nitrogen percentage of geranium leaves was recorded in Table (10). The results stated that, there were observed effects due to the interaction treatments. The treatment of irrigation three times every week + Humic acid gave the highest percentage of nitrogen followed by the treatment of irrigated plants three times/week plus chemical fertilization (NPK) fertilization in the second season. While, in the second one, the treatment of irrigation three times every week + chemical fertilization (NPK) gave the best result, followed by the interaction treatment of irrigation three times every week + Humic acid. The least results obtained from plants irrigated two times/week and sprayed with active dry yeast in the two seasons.

Table (10): Effect of Irrigation intervals, chemical and bio-fertilization and their interactions on nitrogen percentage of *Pelargonium graveolens* plants during the two seasons of (2009-2011) and (2010-2012).

Fertilizationtreatments / Irrigationintervals	EM	Active dry yeast	Humic acid	NPK	Mean of Irrigation
	First season				
3* every week	1.94	1.90	2.67	2.58	2.27
2* every week	2.29	1.63	2.29	2.50	2.18
1* every week	1.73	2.09	2.38	2.09	2.07
Main of Fertilization	1.99	1.87	2.45	2.39	
	Second season				
3* every week	2.26	1.69	2.29	2.67	2.23
2* every week	1.69	1.51	1.94	1.93	1.77
1* every week	1.69	2.10	2.14	2.13	2.02
Main of Fertilization	1.88	1.77	2.12	2.24	

*** Number of irrigation times every week.**

Phosphorus percentage :

The data presented in Table (11) clearly show that, drip irrigation treatments had observed effect on phosphorus percentage in leaves. The highest value was obtained when irrigated plants 3 times every week, while the least one obtained from plants irrigated one time every week, during the two seasons.

It is obvious from data tabulated in Table (11) that, all tested treatments of fertilizers resulted increments in the phosphorus percentage in leaves. The best results were recorded by using Humic acid and the recommended doses of NPK fertilizers, followed by EM and yeast in both seasons.

Regarding the effect of the interaction treatments between irrigation intervals and fertilization kinds (NPK, Humic acid, EM and active dry yeast) on phosphorus percentage of geranium leaves, the data illustrated in Table (11) reveal that, there were observed effects in this regard. The highest values recorded with the interaction treatments of plants irrigated 3 times/week with both treatments of recommended NPK and Humic acid in both seasons. The minimum values showed in plants irrigated 2 times/week and sprayed with active dry yeast in the first season and from the treatment of irrigation one time/week + NPK in the second one.

Table (11): Effect of irrigation intervals, chemical and bio-fertilization and their interactions on phosphorus percentage of *Pelargonium graveolens* plants during the two seasons of (2009-2011) and (2010-2012).

Fertilizationtreatments / Irrigationintervals	EM	Active dry yeast	Humic acid	NPK	Mean of Irrigation
	First season				
3* every week	0.517	0.500	0.590	0.597	0.550
2* every week	0.513	0.440	0.532	0.557	0.510
1* every week	0.503	0.445	0.510	0.503	0.490
Main of Fertilization	0.510	0.460	0.540	0.550	
	Second season				
3* every week	0.477	0.462	0.510	0.500	0.490
2* every week	0.432	0.412	0.445	0.440	0.430
1* every week	0.390	0.380	0.412	0.410	0.400
Main of Fertilization	0.430	0.420	0.460	0.450	

*** Number of irrigation times every week.**

Potassium percentage :

The data obtained for potassium percentage in geranium leaf as affected by some irrigation treatments were presented in Table (12). There were gradually increase in K% with decreasing the number of irrigation/week, so, the highest value was resulted from the treatment of irrigation 1 time/week followed by 2 and 3 times every week in the first season. While, the highest value in the second one was obtained from plants irrigated 1 followed by 3 and 2 times/week. These results are in accordance with these of El-Araby and Feleafel (2003) on *Lycopersicumesculentum,*Attia (2003) and Ebrahim (2005) on guar and roselle plants, respectively.

Regardless, the effect of fertilization treatments on potassium percentage in geranium leaves, and recorded in Table (12), it could be concluded that, there were observed effects due to NPK, Humic acid, EM and active dry yeast treatments. Moreover, the superior treatment in this respect was NPK which gave highly increase in K%, followed by Humic acid, active dry yeast and EM during the two seasons.These results are in harmony with those recorded byHabib (1992) on *Pelargonium peltatum*, Sakr (2001) on *Menthapiperita* and El-Naggar (2013) on cantaloupe plants.

As for the interaction treatments between irrigation intervals and different kinds of fertilization on potassium percentage of *Pelargonium graveolens*L. leaves, the data showed in Table (12) state that, the interaction treatment of irrigation 1 time/week plus fertilization with NPK resulted in the highest value followed by irrigation 1 time/week + active dry yeast and Humic acid in the first season. On the other side, the treatment of irrigation 3 times every week + Humic acid fertilizer gave the highest K% followed by irrigation 2 times/week + NPK during the second season.

Table (12): Effect of irrigation intervals, chemical and bio-fertilization and their interactions on potassium percentage of *Pelargonium graveolens* plants during the two seasons of (2009-2011) and (2010-2012).

Fertilizationtreatments / **Irrigationintervals**	**EM**	**Active dry yeast**	**Humic acid**	**NPK**	**Mean of Irrigation**
	First season				
3* every week	2.60	1.66	1.98	1.81	2.01
2* every week	2.17	1.99	2.26	2.50	2.23
1* every week	1.54	2.72	2.55	2.91	2.43
Main of Fertilization	2.10	2.12	2.26	2.41	
	Second season				
3* every week	1.69	1.95	2.60	2.12	2.09
2* every week	2.25	1.96	1.55	2.42	2.05
1* every week	1.81	2.21	2.14	2.22	2.10
Main of Fertilization	1.92	2.04	2.10	2.25	

*** Number of irrigation times every week.**

Total carbohydrates percentage :

The results on carbohydrates percentage in geranium leaves as affected by irrigation intervals presented in Table (13) show that, increasing irrigation times every week treatments up to that of 3 times/week increased carbohydrates percentage in leaves followed by 2 and 1 times/week in the two seasons.In accordance with those results, those found by Sakr (2001) on *Menthapiperita* and Ali (2009) on fennel plants.

Table (13): Effect of irrigation intervals, chemical and bio-fertilization and their interactions on total carbohydrates percentage of *Pelargonium graveolens* plants during the two seasons of (2009-2011) and (2010-2012).

Fertilizationtreatments / Irrigationintervals	EM	Active dry yeast	Humic acid	NPK	Mean of Irrigation
	First season				
3* every week	17.50	23.00	42.90	32.50	28.98
2* every week	16.25	13.60	24.05	22.10	19.00
1* every week	13.00	10.40	21.45	18.20	15.76
Main of Fertilization	15.58	15.67	29.47	24.27	
	Second season				
3* every week	25.35	14.95	26.65	31.20	24.54
2* every week	21.45	10.40	27.95	26.00	21.45
1* every week	11.70	8.45	25.35	21.45	16.74
Main of Fertilization	19.50	11.27	26.65	26.22	

*** Number of irrigation times every week.**

It is obvious from data in Table (13) that, all examined treatments of chemical, organic and bio fertilization resulted in increments in carbohydrates percentage in geranium leaves. However, the highest value was recorded by using the treatment of Humic acid, followed by NPK in both seasons.

According to data tabulated in Table (13) in carbohydrates percentage in geranium leaves as affected by the combined treatments between irrigation intervals and different kinds of fertilization on *Pelargonium graveolens,* it could be concluded that, the highest effects were observed with the interaction treatment of irrigation three times/week and Humic acid, followed by irrigation 3 times every week + NPK fertilization in the first season, and vice versa in the second one.

Recommendation

We can recommend to obtain good herb and oil yield that:

Irrigate geranium plants with drip irrigation 3 times every week (every time gave 4 liters/2 hours) in sandy soils.

The humic acid as organic fertilizer alone gave promising results in all parameters in this study when adding the compost during preparing the soil before transplanting.

May be using the humic acid, EM_1 and yeast as organic and bio-fertilizers but need to incorporated with different values of recommended doses from NPK fertilizers. This recommendation needs more research to achieve decreasing the amount of chemical fertilizers.

General Discussion

Irrigation intervals treatments gave the pest results in the vegetative growth characters, essential oil contents and chemical composition in the four cuts, during the two seasons. These results may be due to increasing of water quantity around the plant roots zone leads to increase in nutrient elements uptake in plants.

There were effects of EM on the vegetative growth characters, essential oil contents and chemical compositions in geranium plants under irrigation intervals. This effect may be due to EM selected species of microorganisms

including predominant population of lactic acid bacteria and yeast, and smaller of photosynthetic bacteria, actinomycetes and other types of organisms. All of these are mutually compatible with one another and can coexist in liquid culture (Higa and Parr, 1994), but EM had the third effect after NPK and humic acid in this study.

The treatment of active dry yeast applied as foliar on the herb of geranium plants and gave the minimum effect of all parameters of geranium plant under this study. However, it contains many useful minerals, vitamins, protein, carbohydrates, nucleic acids and lipids put the root application was the better than foliar application.

humic acid had the observed effects (after NPK effect) on vegetative growth characters, essential oil content/plant and chemical composition. On the other hand, it gave the highest values in essential oil and carbohydrates percentages over all fertilization treatments. These results may be due to, humic acid is an effective soil enhancer, a plant growth bio-stimulant, a chelating agent and a disease suppressant, in order to it have high in auxins, minerals, vitamins, etc. In soil it can; increases microbial and mycorrizal activity, promote nutrient uptake, increase crop yields and aid in reducing frost damage (Angin *et al*. 2008).

We found that, using the recommended doses of NPK resulted in the highest results in vegetative growth characters, essential oil content/plant and chemical composition. These findings may be due to, N, P and K elements play an important role in composition of many metabolic compounds such as proteins, sugars, carbohydrates, lipids and DNA, which consequently may increase these characters.

REFERENCES

Ahmed, Sh. K. (1988): Physiological studies on geranium. Ph. D. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Ahmed, S. R. and A. F. Ali (2004): Effect of salinity treatments and active dry yeast ingredients of *Ambrosia maritima* L. The Fifth Arabian Hort. Conf., Ismailia, Egypt, March, 24 – 28, pp. 212 – 225.

Ali, A. F. (2001): Response of pot marigold (*Calendula officinalis* L.) plants to some rock phosphate sources and yeast. The Fifth Arabian Hort. Conf., Ismailia, Egypt, March, 24 – 26, pp. 30 – 42.

Ali, Hanan, M. H. (2009): Effect of bio-fertilization on growth, yield and constituents of fennel plant. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Angin, I. ; M. Turan ; Q. M. Ketterings and A. Cakici (2008): humic acid addition enhances B and Pb phytoextraction by Vetiver grass (*Vetiveria zizanioides* L.Nash.). Water, Air & Soil Pollution, Vol. 188 (1 - 4): 335 – 343.

Daly, M. J. and D. P. C. Stewart (1999): Influence of "effective microorganisms" (EM) on vegetable production and carbon mineralization – a preliminary investigation. *Journal of Sustainable Agriculture,* 14: 15 – 25.

Ebrahim, M. M. H. (2005): Effect of some agriculture treatments on roselle plant in the new cultivated soils. M. Sc. Thesis, Fac. Agric., Zagazig Univ., Egypt.

El-Araby, S. M. and M. N. Feleafel (2003): Effect of irrigation regime, organic manure and phosphorus fertilizer on tomato plants vegetative growth, flowering and mineral contents. Alexandria Journal of Agricultural Research, 2003; 48 (3): 115 – 125.

El-Ghadban, E. A. E. (1998): Effect of some organic and inorganic fertilizers on growth, oil yield and chemical composition of spearmint and marjoram plants. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.

El-Naggar, Soaad, A. M. (2013): Effect of mineral and biofertilizer on productivity of cantaloupe in new reclaimed soil. Ph. D. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Fiorentino, G. ; R. Spaccini and A. Piccolo (2006): Separation of molecular constituents from a humic acid by solid-phase extraction following transesterification reaction. Talanta, Vol. 68: 1135 – 1142. (c.f. http//en.wikipedia.org/wiki/humic_acid).

Fleisher, A. and Z. Fleisher (1985): Yield and quality of essential oil from *Pelargonium graveolens* cultivated in Israel. J. Sci. Food Agric., 36:1047-1050.

Habib, A. (1992): Effect of planting media and chemical fertilization on growth and composition of geranium. M. Sc. Thesis, Fac. Agric., Cairo Univ., Egypt.

Hammam, K. A. (1996): Effect of nitrogenous fertilization and irrigation on growth, yield and active constituents of anise plants (*Pimpinella anisum* L.). M. Sc. Thesis, Fac. Agric., Cairo Univ., Egypt.

Hassan, Hayat, A. (2007): Physiological studies on roselle (*Hibiscus sabdariffa* L.) plant. Ph. D. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Heikal, A. A. M. (2005): Effect of organic and bio-fertilization on the growth, production and composition of thyme (*Thymus vulgaris* L.) plants. M. Sc. Thesis, Hort. Dept., Fac. Agric., Cairo Univ.

Herbert, D. ; P. T. Philip and R. E. Strange (1971): Determination of total carbohydrate. Methods in Microbiology, S (B): 290-341.

Higa, T. (2002): *Eine Revolution zur Rettung der Erde: mit Effektiven Mikroorganismen (EM) die Probleme unserer Welt Lösen.* 3. Aufl.- OLV Organischer Landbau – Verlag: Xanten, Germany.

Higa, T. and J. F. Parr (1994): Beneficial and Effective Microorganisms for a sustainable agriculture and environment. International Nature Farming Research Center, Atami, Japan.

Hu, C. and Y. Qi (2013): Long-term effective microorganisms application promote growth and increase yields and nutrition of wheat in China. European J. of Agronomy, Vol. 46, pp. 63–67.

Hunter, A. and A. Anders (2004): The influence of humic acid on turf grass growth and development of creeping bentgrass. Acta Hort. (ISHS), Vol. 661: 257 – 264.

Jackson, M. L. (1967): Soil Chemical Analysis. Prentice Hall of India, Private Limited; New Delhi, P. 115.

Jacoub, R. W. (1999): Effect of some organic and non-organic fertilizers on growth, oil yield and chemical composition of *Ocimum bacilicum* L. and *Thymus vulgaris* L. plants. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Kassem, Abeer, H. M. (1997): Effect of chemical fertilization on *Rosmarinus officinalis* L. plants. M. Sc. Thesis, Fac. Agric., Cairo Univ., Egypt.

Khalil, M. Y. (2006): How-far would *Plantago afra* L. respond to bio and organic manures amendments. Research Journal of Agriculture and Biological Sciences, 2 (1): 12-21.

Khater, M. R. ; A. M. El-Zahawy and F. A. Ali (2005): Effect of irrigation intervals on growth, volatile oil percentage, yield and composition of *Mentha piperita* L. plants. The 6th Arabian Conference For Horticulture, Ismailia, Egypt, P. 221 – 233, 2005.

Mazumder, B. C. and K. Majumder (2003): *Methods of Physiological Analysis of Fruits.* Daya Published House, Delhi, India.

Mohammad, K. E. A. (2009): Application of some hydroponic systems in production of periwinkle. M. Sc. Thesis, Fac. Agric., Suez Canal Univ., Egypt.

Muthaura, C.; D. M. Musyimi; J. A. Ogur and S. V. Okello (2010): Effective microorganisms and their influence on growth and yield of pigweed (*Amaranthus dubians*). ARPN Journal of Agricultural and Biological Science, Vol. 5, NO. 1, pp. 17-22.

Norman, Q. Arancon ; Stephen Lee ; Clive A. Edward and Rola Atiyeh (2002): The Soil Ecology Laboratory. The Ohio State University, 1735 Neil Avenue, Columbus, OH 43210, USA.

Okorski, A. ; J. Olszewski ; K. Głowacka ; S. Okorska ; A. Pszczółkowska (2010): The effect of the application of the biological control agent EM_1 on gas exchange parameters and productivity of *pisum sativum* L. infected with *fusarium oxysporum* schlecht. Acta Agrobotanica, Vol. 63 (2): 105–115.

Okorski, A. and B. Majchrzak (2007): Fungi isolated from soil before the seedling and after harvest of pea (*Pisum sativum* L.) after application of bio-control product EM_1. Acta Agrobotanica, Vol. 60 (1): 113-121.

Piccolo, A. (2002): The supramolecular structure of humic substances. A noval understanding of humus chemistry and implication in soil science. Advances in Agronomy, Vol. 75: 57 – 134.

Rao, BRR. ; Kailash-Singh ; AK. Bhattacharya and K. Singh (1990): Effect of nitrogen and method of harvesting on herbage and essential oil yields of geranium (*Pelargonium graveolens L.*). Indian Journal of Agronomy, 1990, 35: 3, 312 – 313; 1 ref.

Sakr, Weaam, R. A. (2001): Effect of some organic and inorganic fertilizers on *Mentha piperita* L. M. Sc. Thesis, Fac. Agric., Cairo Univ., Egypt.

Shahwani, N. ; A. U. Salarrazai ; K. M. Kakar ; A. K. Jaffar and R. G. Kakar (2005): Effect of ERM on VAM development and subsequent crop growth in canola (*Brassica napus* L.). J. App. Em. Sci., 1 (2): 1 – 3, July, 2005.

Shawi, A. S. ; T. Kumar ; N. Chist and S. Shabir (2006): Cultivation of Rose Scented Geranium (*Pelargonium*) as a Cash Crop in Kashmir Valley. Asian J. of Plant Science, 5 (41): 673 – 675.

Sidky, Mahasen, M. A. ; I. M. A. Harridi and I. A. I. Mousa (1998): Using chemical and organic fertilizers of the nutrition of roselle (*Hibiscus sabdariffa* L.) plants irrigated at different intervals. Egyptian Journal of Applied Science, 12 (9): 123 – 135.

Singh, M. ; G. Chandrashekhara and Rao-Evsp (1996): Effect of irrigation frequency and nitrogen on herb and oil yields of geranium (*Pelargonium graveolens*) during summer season. Journal of Medicinal and Aromatic Plant Sciences, 18: 3, 495; 4 ref. (Center Institute of Medicinal and Aromatic Plants, Field Station, Bangalore 560065, Karnataka, India).

Snedecor, G. W. and W. G. Cochran (1980): Statistical methods, 7th edition. The Iowa State Univ. Press, Ames, Iowa, U.S.A.

Talha, M. A. ; A. S. Radwan and S. Negm (1980): The combined effect of irrigation frequencies on geranium. Egypt. J. Soil Sci., 20 (2):111-120.

Toima, A. L. (1992): Effect of different irrigation intervals on *Coriandrun sativum* L. plants. M. Sc. Thesis, Fac. Agric., Cairo Univ.

Ughreja, P. P. and B. S. Chundawat (1992): Nutritional studies in coriander (*Coriandrum sativum* L.). II. Effect on growth and production. Guiarat Agric. Univ. Res. J., 17 (2): 87 – 93.

Zaghloul, S. M. ; E. M. Quesni and A. A. M. Mazhar (2009): Influence of potassium humate on growth and chemical constituents of *Thuja orientalis* L. seedlings. Ozean J. of App. Sci., Vol. 2(1): 73 – 78.

Zheljazkov, V. ; A. Margina ; L. E. Graker ; L. Nolan and K. Shetty (1996): Effect of nitrogen doses of fertilizer application on quantitative and qualitative characters of mint. Acta Hort., 426: 579 – 292.

إستجابة نباتات العتر لمعاملات الرى والتسميد الكيماوى والعضوى والحيوى تحت ظروف الأراضى الرملية .

أميمة محمد عبد الكافى* عصام الدين أحمد محمد الموجى و**
نهلة أبو سبع محمد أحمد عاشور**
*** قسم البساتين، كلية الزراعة، جامعة المنصورة ، مصر**
**** قسم بحوث النباتات الطبية والعطرية، معهد بحوث البساتين، مركز البحوث الزراعية ، مصر**

تم إجراء هذا العمل بالمزرعة البحثية لمحطة بحوث البساتين بالقصاصين ، محافظة الإسماعيلية ، مصر ، خلال موسمى الزراعة 2009-2011 و 2010-2012 (يستمر الموسم الواحد لمدة عامين متتاليين)، لدراسة تأثير معاملات الرى بالتنقيط (1 ، 2 و 3 مرات فى الإسبوع لمدة ساعتين فى كل مرة) ومعاملات التسميد { 300 كجم/فدان سلفات النشادر (20,5 % ن) ؛ 300 كجم/فدان سوبر فوسفات الكالسيوم (15,5 % فو$_2$أ$_5$) ؛ 100 كجم/فدان سلفات البوتاسيوم (48 % بو $_2$أ) ؛ حمض الهيوميك بمعدل 280 جم/فدان ؛ EM بمعدل 5 لتر/فدان و الخميرة الجافة النشطة بتركيز 6 جم/لتر} والتفاعل بينهما على نبات العتر.

وقد أظهرت النتائج أن الرى ثلاث مرات إسبوعياً أعطى أفضل النتائج فى كل صفات النمو الخضرى ومحتوى النبات من الزيت الطيار ومحتواه الكيماوى (نسبة ن ، فو ، الكربوهيدرات) تليها الرى مرتين إسبوعياً وذلك خلال الأربع حشات فى الموسمين. التسميد بالأسمدة الكيماوية الموصى بها أعطى أعلى القيم فى صفات النمو الخضرى ومحصول العرش ومحتوى النبات من الزيت العطرى ومن المحتوى الكيماوى (نسبة ن ، فو ، بو) وتليه معاملة حمض الهيوميك وذلك خلال الحشات الأربع فى كلا الموسمين. معاملة التفاعل ما بين الرى 3 مرات/إسبوع + (ن ، فو ، بو) أعطت أعلى القيم فى صفات النمو الخضرى ومحصول العرش ومحتوى النبات من الزيت الطيار ومحتواه من الكيماويات (نسبة ن ، فو والكاربوهيدرات) ، تليها معاملة التفاعل الرى 3 مرات/إسبوع + حمض الهيوميك ، وذلك فى الأربع حشات خلال الموسمين .

ومن خلال نتائج هذا البحث يمكن أن نلاحظ ما يلى : أعلى قيم النمو الخضرى ومحصول العرش ومحتوى النبات من الزيت الطيار ومحصول الزيت الطيار فى النبات وفى الفدان كانت فى الحشة الثالثة تليها الحشة الرابعة (فى السنة الثانية من الموسم) بينما أقل النتائج كانت فى الحشتين الأولى والثانية (فى السنة الأولى من الموسم) ، وهذه النتائج تكررت فى الموسمين .