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EFFECT OF TRICKLE IRRIGATION AND SALICYLIC ACID APPLICATIONS ON QUALITY AND PRODUCTIVITY OF *Pelargonium graveolens* PLANT

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ABSTRACT

The field work was carried out at El Qantara Research Station, Desert Research Center, North Sinai Governorate through the two successive seasons , 2016-2017 and 2017-2018. A split-plot design with three replicates as statistical design was used. on geranium (*Pelargonium graveolens*) to investigate the effect of three irrigation levels (10, 15 and 20 m^3/fed)throw trickle irrigation system and spraying with salicylic acid in four concentrations; (0 , 25 , 50 and 75 mg/l);and their interactions on actual evapotranspiration , WUE, herb fresh weight/plant (g), herb fresh weight /fed (kg), essential oil percentage in the fresh herb, essential oil yield ml/plant, essential oil yield l/fed.-l and essential oil chemical analyses for two successive seasons. Results showed that, the significantly highest for all parameters were obtained when irrigation by 20 m^3/fed, combined with foliar spray with salicylic acid at 75 mg/l followed by15 m^3/fed, combined with foliar sprays with salicylic acid at 75 mg/l . Meanwhile, the significantly lowest values for all parameters were detected by the treatment of irrigation by 10 m^3/fed, without foliar spray with salicylic acid; (The control treatment). Chemical composition of volatile oils showed that both of geraniol and citronellol were the principal components of the oil.

INTRODUCTION

Pelargonium graveolens (Geraniaceae family) is a perennial herbaceous plant, commonly known as rose geranium is one of more than 250 species within the Pelargonium genus (grows in South Africa) up to 1 meter high introduced and cultivated widely (Algeria, Morocco, Madagascar, Réunion, Russia, China, Egypt and Guinea) with hairy shrub leaves, toothed at the edges and small tinged purple, flowers **(Shawi *et al.*, 2006)**. Geranium is one of the important medicinal and aromatic plants produces the main commercial oil of geranium in the world with a rose fragrance **Pitman , 2004 and Groom, 2012** Geranium oil is obtained by water distillation of the leaves , is like rose oil in its odour and has positive benefits such as antibacterial , antifungal and antioxidant activities and is used as anti-inflammatory ,antidepressant, anti-hoemorrhagic, anticancer, insomnia, heart disease, antiseptic, astringent, asthma, nausea

cicatrisantdeodant, vomiting, diuretic, haemostatic, fever, stimulant (adrenal cortex), tuberculosis, tonic vermifuge, vulnerary, mosquito repellent, anti-inflammatory, , antiseptic, calmative and balancing for theendocrine system. Oil is also included in the industries pilot or dough in the treatment of some skin diseases to resist bacteria or fungi when used externally, as it is useful in gastric colic , expulsion of gases and bloating as it is a nerve agent, It is also used as a fragrant component in all kinds of cosmetics **(Aggarwal *et al*, 2000; Saraswathi *et al*, 2011, Galea and Hancu, 2014)** Geranium oil has many uses in fragrances and flavorings This is due to the strong odor in the production of liquid and concentrated essence for many food products such as yogurt, jelly and sweets **(Saraswathi *et al*, 2011).**The distilled water produced by the distillation process may be used in household sweets called the essence of sour. Presently, the oil enters the volatile oil produced from the green grass, It is used in industries of producing many perfumes, odors and various cosmetics, whether liquid or dry in the form of powders or creams. It also enters as a pink odor in the manufacture of soap and toilet paper. The percentage of essential oils(0.05-0.08%) contains the volatile oil of geranium plant as a chemical constituents Such as. geraniol (26.51-31.39%), citronellol (14.62-21.95%), geranyl butyrate(9.99-1.60%), linalol (6.17-5.67%),10-epic-eudesmol (8.91--%), geranyl formate (3.30-6.13%), dodecanol (2.72-5.79%), cis-linalool oxide (2.26-4.65%) according to **Cavar, and Maksimovi, (2012).** Nowadays, It is cultivated in large areas in BeniSuef Governorate and Bahariya Oases.

Irrigation water requirements and sensitivity to water deficits when growing geranium plants is a great interest for horticultural producers whewever planning irrigation strategies. The effect of different deficit irrigation strategies on physiological and morphological parameters must be studied to evaluate how such strategies can be safely used. Concerning the effect of irrigation, **Abd El-Kafee *et al* (2014)** 0n pelargonium graveolens mentioned that irrigation three times every week gave the highest values of all vegetative growth parameters, essential oil contents and chemical composition (N, P and carbohydrates %) followed by two times/week, during four cuts of two seasons. **Hassan (2007)** recorded that increasing of water irrigation amount from 560 to 2240 m^3 /fed/season resulted in significant increase in plant height, number of branches and fresh and dry weights in roselle plant. The tallest plant resulted from using 1680 m^3 /fed. treatment for three seasons, respectively. These results coincided with those obtained by **Bhan *et al*., 2006; Juliani *et al*., 2006; Nozipho *et al*., 2006 and Dyubeni *et al*., 2012** who reported that, quantity and chemical composition of geranium oil is largely affected by trickle irrigation and salicylic acid Applications which organizes many physiological processes, including induction of syphilis, regulation of ion absorption, hormonal balance, stomatal motion and photosynthesis. In addition, salicylic acid

plays an important role in regulating plant response to heat stress conditions, by increasing the efficiency of the enzymatic and non-enzyme defense systems and increasing the synthesis of some thermal shock proteins, amino acids and other positive effects under heat stress conditions. Due to climate changes and environmental stresses on the plant leading to crop shortage **(El-Hakem, 2008),** it was necessary to look for natural materials as synthetic one such as salicylic acid and study the effects that reduceenvironmental stresses beside studying the optimum and economical irrigation rates to obtain the highest yield conforming to quality specifications. The aim of this study was to investigate the effect of Trickle Irrigation and salicylic acid applications on the vegetative growth and oil production of *Pelargonium graveolens* L`Her. under Sinai conditions.

MATERIALS AND METHODS

The present study was conducted at El Qantara Research Station (latitude 31o 3\ N and longitude 32o 36\ E), Desert Research Center, North Sinai Governorate through the two successive seasons of 2017-2018 and 2018-2019. *Pelargonium graveolens* transplants were cultivated in the field on the October 20th in rows 75 cm apart with distances of 50 cm between hills. The drip irrigation system was applied in the whole experiment.Soil physical and chemical properties of the studied area are shown in Table (A) according to **(Chapman and Pratt, 1971).** The chemical analysis of irrigation water is shown in Table (B).

Table (A). Some physical and chemical properties of the experimental soil.

Particle size distribution (%)			Texture class	EC ds/m	pH soil paste	O.M%	$CaCO_3$ %	Soluble ions (mmol/l)								Available nutrients (mg/kg)		
								Cations				Anions						
Sand	Silt	Clay						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	SO_4^{--}	Cl^{-}	N	P	K
86.2	5.7	8.1	Sand	3.82	8.02	56	8.82	8.2	12.4	16.85	0.75	-	5.4	19.9	12.9	36.4	3.65	144

Table (B). Chemical analysis of irrigation water.

Samples	pH	E.C. (ds/m)	SAR	Soluble cations (mmol/l)				Soluble anions (mmol/l)			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	$SO_4^{=}$	Cl^{-}
1 st season	8.26	1.76	5.2	3.4	3.7	9.8	0.7	0.2	6.4	2.4	8.6
2nd. season	8.3	1.8	4.48	3.53	3.35	10.67	0.45	0.5	4.3	4.1	9.1

pH: Acidity, E.C.: Electrical conductivity, dSm^{-1}: decSiemen per meter, S.A.R: Sodium adsorption ratio, me/l: mille equivalent per liter

A split-plot design with three replicates as statistical design was used. The main plot werecontained three irrigation quantities (i) 10 (ii) 15 and (iii) 20 m^3/fed. The subplots consisted of spraying with salicylic acid with three concentrations (ii) 25 (iii) 50 (iv) 75 mg/l in addition to the control treatment 0 mg/l. The leafy branches of geranium were cut on 20^{th} of June and numerous parameters were measured as follows:

1- Herb fresh weight/plant (g).
2- Essential oil percentage was estimated in the fresh herb according to **British Pharmacopeia (1963).**
3- Essential oil yield/plant (ml) = oil% x herb fresh weight /100
4- Essential oil yield/fed. (l) = oil yield per plant × plant number / fedd.
5- Essential oil chemical analyses: The essential oil samples of the second season were analyzed by using the Gas-Liquid Chromatography, (GLC)Apparatus.
6- Water consumptive use was calculated using the following equation

$$CU=((M2-M1)\times dp\times D)\div 100$$

Where:

CU = Consumptive use (mm). Such CU is an estimate of actual evapotranspiration of the crop i.e. actual ET crop.
D = Depth (in mm) of the irrigated soil under consideration.
dp = Bulk density (g/cm3) of the soil in the relevant soil depth.
M2 = Percentage of moisture in soil (w/w) following maximum irrigation within the relevant soil depth.
M1 = Percentage of soil moisture (w/w) before next irrigation (within the relevant depth).

soil moisture content was gravimetrically determined for 3 depths; 0-20, 20-40 and 40-60 cm, immediately before and after 1 day of irrigation. The actual evapotranspiration (ETa) for each stage as well as for the total season were determined, according to **(Israelson and Hansen, 1962)**.

7- Crop Water Use Efficiency (WUE), kg/mm was calculated by dividing the crop yield by the amount of seasonal evapotranspiration (**Giriappa, 1983**).

Data were analyzed means were compared by L.S.D according to **(Snedecor, and Cochran (1990).**

RESULTS AND DISCUSSIONS

Data of the effect of irrigation amounts, foliarspray with salicylic acid and their interaction on yield are represented in Table (1).

Concerning the effect of irrigation amounts, data showed that, increasing irrigation amounts significantly increased herb fresh weight per plant, herb fresh weight per fed essential oil percentage, essential oil yield per plant and essential oil yield per fed. The maximum values were obtained by irrigation at 20 m^3/fed followed by 15 m^3/fed. On the opposite, the lowest values were obtained by irrigation at 10^3m/fed.

These results were achived in accidence by **Abd El-Wahab (2002) and Abd El-Kafee*et al*., (2014)** who found that herb fresh weight and volatile oil yield of *Pelargonium graveolens* were gradually increased with increasing of water supply.

As for the effect of foliar spray with salicylic acid, data revealed that increasing concentration of salicylic acid significantly increased herb fresh weight per plant, essential oil percentage, essential oil yield per plant as well as essential oil yield per fed.The best parameters were obtained by using the highest concentration of 75 mg/l. Salt stress and dehydration degrade plant health and salt tolerance of plants is a complex phenomenon that involves morphological and developmental as well as physiological and biochemical processes . Plant stress can be decreased by application of salicylic acid, which acts as an endogenous signal molecular responsible for inducing a biotic stress tolerance in plants. They emphasized that exogenous application of salicylic acid increased plant growth **(Bastam *et al*.,2013)** The stimulatry effect of salicylic acid on the productivity of plants may be due to its role in affecting leaf and chloroplast structure, stomata closure, chlorophyll and carotenoids contents and activity of enzymes. Salicylic acid has an essential function in regulating plant developmental processes that affect nutrient uptake and their status. Also, it improves photosynthesis, growth and various other physiological and biochemical characteristics in stressed plants .Also salicylic acid alienates the oxidative damaging effect of metal toxicity directly by acting as an antioxidant to rake the reactive oxygen species and by activating the antioxidant systems of plants and indirectly by reducing uptake of metals from their medium of growth. **(Hayat *et al*., 2013 and Wani *et al*., 2017).** These results were in agreement with those reported by **Hesami *et al*., (2012)** on *Coriandrum sativum*; **Abdul Qados (2015)** on *Capsicum annuum* and **Shekofteh *et al*., (2015)** on *Plantago ovat*a

With respect to the effect of the interaction between treatments, the significantly highest parameters were obtained by irrigation amount of 20 m^3/fed. combined with foliar spray with salicylic acid at the highest concentration (75 mg/l), which recorded the percentages of increases (14.06%) fresh weight per plant, (14.06%) herb fresh weight per fed (14.29%) essential oil percentage, (29.91%) essential oil yield per plant (29.92%) and essential oil yield per fed lower than control .On the other side, the lowest parameters were detected by the treatment of irrigation at 10 m^3/fed. without foliar spray with salicylic acid as a control treatment.Chemical composition of volatile oils showed that both of citronellol and geraniol were the principal components of the oil (Table 2). These results were in harmony with **(Abd El-Wahab, (2002); Kazemi and Shirzadeh, 2012 and Khalil *et al*., (2018).**

From the preceding data, it was clear that applying salicylic acid could be effective an increasing the growth and oil yield of geranium under the existing climate change environments which degrade plant yield.

Table 1: Effect of irrigation levels, salicylic acid concentrations and their interaction on yield attributesof *Pelargonium graveolens* during both successive seasons of 2017-2018 and 2018-2019.

Irrigation Levels	Salicylic acid Concentrations	Herb fresh weight/plant (g)	Herb fresh weight/fed (ton)	Essential oil (%)	Essential oil yield/plant (ml)	Essential oil yield/fed. (l)
10 m^3/fed.	0 mg/l	1294.20	14.50	0.05	0.65	7.28
	25 mg/l	1313.11	14.71	0.05	0.66	7.39
	50 mg/l	1346. 30	15.08	0.06	0.81	9.07
	75 mg/l	1394.01	15.61	0.07	0.98	10.98
Mean		1333.77	14.94	0.06	0.78	8.68
15 m^3/fed.	0 mg/l	1328.40	14.88	0.06	0.80	8.96
	25 mg/l	1492.13	16.71	0.07	1.05	11.76
	50 mg/l	1607.21	18.00	0.07	1.13	12.66
	75 mg/l	1653.05	18.51	0.08	1.32	14.78
Mean		1520.20	17.03	0.07	1.08	12.04
20 m^3/fed.	0 mg/l	1664.14	18.64	0.07	1.17	13.10
	25 mg/l	1818.21	20.36	0.07	1.27	14.22
	50 mg/l	1846.21	20.68	0.07	1.29	14.45
	75 mg/l	1898.13	21.26	0.08	1.52	17.02
Mean		1806.67	20.23	0.07	1.31	14.70
Over all means of salicylic acid concentration	0 mg/l	1428.91	16.00	0.06	0.87	9.78
	25 mg/l	1541.15	17.26	0.06	0.99	11.12
	50 mg/l	1599.91	17.92	0.07	1.08	12.06
	75 mg/l	1648.40	18.46	0.08	1.27	14.26
LSD at 0.05	Irrigation amounts Salicylic acid concentrations Interaction	10.08 11.64 20.17	1.1 1.25	0.01 0.01 0.01	0.11 0.12 0.17	1.23 1.36 2.46

Data of the influence of the interaction between treatments on chemical constituents of *Pelargonium graveolens* volatile oil are presented in Table (2). The primary identified compounds of the produced geranium oil under Baloza region, North Sinai were as follows: - geraniol (31.39-26.51%), citronellol (21.95-14.62%), geranyl butyrate (9.99-1.60%), 10-epic-eudesmol (8.91-0%), linalool (6.17-5.67%), geranylformate (6.13-3.30%), dodecanol (5.79-2.72%), cis-linalool oxide (4.65-2.26%), phenyl tiglate (1.70-0%), geranyltiglate (1.37-0%), geranyl acetate (1.19-0.26%), and ethyl decanoate (1.45-1.18%). These observed compounds were in a general trend with oil analyses results of **Abd El-Wahab (2002) and Abd El-Wahab *et al*., (2016)** who successfully cultivated rose geranium plants at El-Maghra as well as El-QantaraSharq regions, North Siani Governorate.

Citronellol and geraniol mixture (rhodinol) is very important and is responsible for the rose aroma of geranium oil; it is used in perfumes, flavors, pharmaceutical and other essential industries. The same table showed that the agriculture treatments positively influenced on volatile oil active constituents as the treatment of the highest irrigation level of 20 m^3/fed. combined with foliar spray with the highest salicylic acid concentration at 75 mg/l gave the superior citronellol and geraniol concentrations over control treatment (lowest irrigation level of 10 m^3/fed.without foliar spray with salicylic acid). The promotive effects of increasing both irrigation and salicylic acid levels may be attributed to their role of improving photosynthesis and consequently increasing of the secondary metabolites production **(Wani *et al*., 2017).**

Table (2): Effect of the interaction between treatments on chemical composition (%) of volatile oil

	Compound	Irrigation of 10 m^3/fed. without foliar spray with salicylic acid	Irrigation of 15 m^3/fed. without foliar spray with salicylic acid	Irrigation of 20 m^3/fed. + foliar spray with salicylic acid at concentration of 75 mg/l
1-	α-Pinene	0.22	o.21	0.18
2-	Camphene	0.25	0.31	0.34
3-	β-pinene	0.31	o.33	0.31
4-	p-Cymene	0.39	0.29	0.24
5-	cis-Linalool oxide	2.26	4.41	4.65
6-	trans-Linalool oxide	0.60	0.55	0.54
7-	Linalool	6.17	5.92	5.87
8-	Nerol	0.44	0.53	0.51
9-	Citronellol	15.62	18.26	21.95
10-	Geraniol	26.51	28.18	31.39
11-	Geranylformate	3.35	4.78	6.13
12-	Citronelly acetate	1.44	1.55	1.56
13-	Geranyl acetate	1.19	0.63	0.26
15-	Ethyl decanoate	1.18	1.22	1.45
16	β-Caryophyllene	0.37	0.35	0.33
17-	Dodecanol	3.72	4.26	5.79
18-	Geranyl butyrate	9.99	5.80	4.60
19-	Phenyl tiglate	1.74	1.67	1.62
20-	10-epic-eudesmol	8.91	8.73	8.55
21	Geranyltiglate	1.37	1.36	1.39
Total identified compounds		84.84	89.28	97.57

Effect of irrigation amounts, salicylic acid concentrations and their interaction on actual evapotranspiration.

Examining the results of the observation in table (3) found that there was an increase in actual water quantity consumed by planting in the age. The applied water quantities were significantly influencing the actual water consumption, the added water led to increasing the water consumption by 16.1 and 45.6% respectively. However , spraying the salicylic acid had an effective impact on water consumption , where it

reduced the water consumed by the plant. Spraying with a concentration 75 mg/l reduced water

consumption by 3.39,1.83 and 0.7% comparing to controlof25 and50 mg/l respectively. By studying the combined effect of both water quantities and salicylic acid spray , it was found that spraying with salicylic with a lack of water quantities reduced water consumption .The lowest treatment of consumed water was that was irrigated with$10m^3$and spraying by concentration of 75 mg/l of salicylic acid , while the highest treatment was of 20m3 without salicylic acid as this results agree with **Behnam Arzandi (2014),** who found that salicylic acid improved the traits and reduced the negative effect of drought stress.

Table (3): Effect of irrigation amounts, salicylic acid concentrations and their interaction on The average actualwater consumption of the plant during different growth stages.

Salicylic acid concentration mg/L	Q1 ($10m^3$/fed.)				Q2 ($15m^3$/fed.)				Q3 ($20m^3$/fed.)			
	Initial stage mm	Development stage mm	mid stage mm	Late stage mm	Initial stage mm	Development stage mm	mid stage mm	Late stage mm	Initial stage mm	Development stage mm	mid stage mm	Late stage mm
0 mg/l	72.1	108.0	121.0	109.01	86.95	123.06	136.11	124.08	93.52	157.3	170.31	140.5
25mg/l	67.3	105.9	117.8	109.4	85.01	121.42	134.02	123.14	192.86	154.9	168.11	139.26
50mg/l	64.9	104.0	116.7	107.52	82.97	119.85	133.05	122.89	92.07	152.13	167.8	139.01
75mg/l	62.8	103.5	115.8	106.02	82.46	118.09	131.97	454.5	91.16	152.07	167.52	138.72

Q_1=$10m^3$/fed. , Q_2=$15m^3$/fed. andQ_3=$20m^3$/fed. Q_1=$10m^3$/fed. , Q_2=$15m^3$/fed. andQ_3=$20m^3$/fed.

Effect of irrigation levels, salicylic acid concentrations and their interaction on water use efficiency.

The results breaented in table (4) showed that the water consumptive use efficiency was decreased by increasing the applied water quantity, while the opposite occurred with salicylic acid concentration. The examination of the joint impact of each of salicylic acid and water quantities revealed less treatment of the least water use efficiency was Q3T2 ($20m^3$ and 25mg/l salicylic acid) for the fresh weight, while the less efficient water consumption for the oil was Q1T1($10m^3$ and zero salicylic acid) . The highest treatments in the water consumption efficiency was Q2T4 for both fresh weight and oil. Because of the Q2T4 is the best treatment in term of water efficiency ,it saved about 25% of water when used in the cultivation of new land, it is permissibility in production by 16.1% . The application of the treatment

(Q2T4) is recommended when the planting ***Pelargonium graveolens*** under Qantara condition

Table (4): Effect of irrigation levels, salicylic acid concentrations and their interaction on water use efficiency.

Treatment	Total Eta(mm)	Total Eta(m^3)	WUE Fresh weight	WUE Oil
Q1T1	411.08	1726.5	8.3983	0.0042
Q1T2	401.76	1687.4	8.7176	0.0044
Q1T3	393.99	1654.8	9.1131	0.0055
Q1T4	389.29	1635.0	9.6043	0.0067
Q2T1	470.2	1974.8	7.5348	0.0045
Q2T2	463.59	1947.1	8.5821	0.0060
Q2T3	454.5	1908.9	9.4295	0.0066
Q2T4	461.77	1939.4	9.5440	0.0076
Q3T1	565.15	2373.6	7.8599	0.0055
Q3T2	658.72	2766.6	7.3592	0.0051
Q3T3	554.08	2327.1	8.8818	0.0062
Q3T4	551.29	2315.4	9.1819	0.0074

Q1=25m^3/fed., Q2=15m^3/fed. ,Q3=20m^3/fed.,T1=0 mg/l,T2=25mg/l,T3=50mg/l and T4=75mg/l

CONCLUSION

The highest herb fresh weight and volatile oil yield of *Pelargonium graveolens* were gradually increased with increasing of water supply. The significantly highest parameters were obtained by irrigation at 20 m^3/fed followed by irrigation at 15 m^3/fed, combined with foliar spray with salicylic acid at the highest concentration of 75 mg/l. When studding both the productivity, water consumption and water use efficiency , the treatment of Q2T4(15m^3 and 75mg/l salicylic acid) was the best while it would save 25% of the water when it is used to grow other land that would lead to 16.1% increase in productivity compared with Q3T4(20m3 and 75mg/l salicylic acid)

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تاثير معدلات الرى بالتنقيط والرش بحامض السليسليك على انتاجية وجودة نبات العتر (*Pelargonium graveolens*)

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1- قسم كمياء وطبيعة الراضى – مركز بحوث الصحراء

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تم تنفيذ التجربة في محطة بحوث القنطرة بمركز بحوث الصحراء بمحافظة شمال سيناء خلال الموسمين المتتالين (2016-2017 و 2017-2018). على نبات العتر (*Pelargonium graveolens*) بهدف دراسة تأثير ثلاثة مستويات للري (10 ، 15 و 20 م 3 / فدان) والرش بحمض الساليسيليك في أربعة تراكيز ؛ (0 ، 25 ، 50 و 75 ملجم / لتر) ؛ والتفاعل بين المعاملات على معدل البخر نتح الفعلى,WUE ,، الوزن الطازج للعشب / نبات (g)، الوزن الطازج للأعشاب / للفدان(كجم) ، النسبة المئوية للزيت الطيار في العشب الطازج ، ومحصول الزيت العطري / النبات ، ومحصول الزيت العطري / للفدان (l) والتحليل الكيميائي للزيوت الطياره في المواسم المتعاقبة ، .l. plant-1 **أظهرت نتائج التفاعل إنه قد تم الحصول على أعلى زيادات معنوية فى جميع القياسات** عند الري بمقدار 20 م 3 / للفدان ، مع الرش الورقي بحمض الساليسيليك بتركيز 75 ملجم / لتر وأن هذه المعاملة أعطت أعلى قيمه من الجيرانيول والسترونيللول واللذان كانا المكونين الرئيسيين للزيت يليه 15 م 3 / للفدان ، مع رش الأوراق بحمض الساليسيليك بتركيز75 ملجم / لتر . بينما أقل قيمه معنويه تم الحصول عليها لجميع القياسات من خلال رى النباتات بمقدار 10 م 3 / للفدان ، بدون رش النباتات بحمض الساليسيليك ؛ (كنترول).

الكلمات الدالة: *Pelargonium graveolens* العتر – نظام الري بالتنقيط – كميات المياه – حمض الساليسيليك –WUE .