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EFFECT OF NITROGEN SOURCES AND ASCORBIC ACID ON GROWTH AND ESSENTIAL OIL PRODUCTION OF GERANIUM (*PELARGONIUM GRAVEOLENS*, L.) PLANTS

M.A.H. Abdou*; E.E.T. Ahmed* and T.I.E. Ibrahim**

* Hort. Dept., Fac. Agric., Minia Univ., Egypt.
** Ministry of Agriculture, Egypt.

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Prof. Dr. E.S. Nofal,
Kafr El-Sheikh Univ.

Prof. Dr. M.S. Hanafy,
Cairo Univ.

ABSTRACT: The experiment was conducted during two successive seasons (2012/2013 and 2013/2014) in the nursery of ornamental plants and the Laboratory of Floriculture, Fac. of Agric., Minia Univ. The aim of this work is to study the effect of bio-mineral nitrogen and ascorbic acid (50, 100 and 150 ppm) on growth and essential oil production of geranium plants. Results showed that non-significant differences between mineral N (100%) and mineral N (75%) + Minia Azotein (*Azotobacter* strain) on growth and essential oil production of plants. The effect of high concentration (150 ppm) of ascorbic acid was superior to that other two concentrations (medium and low) on increasing plant growth and essential oil productivity.

The plants fertilized with mineral N (75%) plus Minia Azotein (*Azotobacter* strain) and spraying with 150 ppm ascorbic were equal (growth and essential oil production) with plants received 100% N plus 150 ppm ascorbic acid.

Key words: *Pelargonium graveolens*, bio-mineral nitrogen, ascorbic acid, vegetative growth, essential oil.

INTRODUCTION

Pelargonium graveolens, L. belongs to family Geraniaceae. It is not to be confused with the household variety of geranium, which is a completely different species. There are over 700 varieties of cultivated geranium, however, most are grown for ornamental purposes. The plants of *Pelargonium* are native to South Africa (Shawi *et al*., 2006). In warmer climates like that of Egypt, the plants are growing as a perennial, lasting on the average from four to six years (Kaul *et al.,* 1996).

Geranium oil can range from very sweet and rosy to musty, minty and green (Rejeshwara Rao, 2002). Its action include analgestic, antidepressant, antiseptic, astringent, cicatrisant, cytophylactic, deodorant, styptic, tonic, vulnerary (Qinghua, 1993).

Chemical nutrients especially nitrogen is very important for plants, because N partake in structure of several components of the whole plant. Application of mineral fertilization have been reported to enhance plant growth and to increase the active ingredient content in several medicinal plants such as geranium (Ram *et al.,* 2003), *Ocimum basilicum* (Golcz *et al.,* 2006), lemon Balm (Aziz and El-Ashry, 2009) and peppermint (Zheljazkov and Cerven, 2009).

Biofertilizers are considered to be low cost, eco-friendly and renewable sources of plant nutrients supplementing chemical fertilizers in sustainable agricultural system. This refer to microorganism, which increase crop growth through different mechanisms, i.e. biological nitrogen fixation, growth promoting or hormonal substances, increasing availability of soil nutrients (Galal and Aly, 2004). Application Minia Azotein as biofertilizer increased plant growth and essential oil production in several plants such as anise (Hemdan, 2008), black cumin (Helmy, 2008), borage plant (Abdou *et al.*, 2009) and sweet basil (Abdou *et al.*, 2014).

Ascorbic acid (vit. C) had many stimulating effects on growth and some physiological activities of different plant (Dewick, 2000; Ismail, 2008 and Abdou *et al.*, 2009).

This object of this study is to investigate the response of geranium plants to different levels of mineral nitrogen with biofertilizer (Minia Azotein) and ascorbic acid, as well as, their interaction on vegetative growth and essential oil yield in order to figure out the possibility of decreasing the amount of mineral nitrogen by the substitution with biofertilizers.

MATERIALS AND METHODS

A field experiment was conducted during the two successive growing seasons of 2012/2013 and 2013/2014 at the nursery of ornamental plants and the Laboratory of Floriculture, Fac. of Agric., Minia Univ. to investigate the effect of different concentrations of mineral nitrogen with Minia Azotein (*Azotobacter* strain) and ascorbic acid, as well as, their interaction treatments on vegetative growth traits and essential oil productivity of *Pelargonium graveolens*, L.

The uniform terminal cuttings of geranium were taken yearly from the mother plants in uniform size and length (18 cm) long. The cuttings were immediately planted in polyethylene bags in a mixture of clay: sand (1:1 v/v) on November 24th, 2012 and 2013, respectively. The seedlings were transplanted in the Experimental filed on February 20th for each season.

The experiment was arranged in a split-plot design with three replicates. The main plots included three levels of mineral N plus Minia Azotein (A), while, four treatments of ascorbic acid (B) occupied the sub plots. Therefore, the interaction treatments (A×B) were 16 treatments. The experimental unit (plot) was 3×3 m and containing 4 rows, 60 cm apart and seedlings were cultivated in hills, 32 plants. The physical and chemical analysis of the soil are shown in Table (a):

Treatments:

1- Main plots were mineral N 25% + Minia Azotein (M.A.), mineral N 50% + Minia Azotein, mineral N 75% + Minia Azotein and mineral N 100% (recommended dose). Mineral (full dose) was added at the rate of 400 kg/fed/year of ammonium nitrate (33.5% N). So the mineral N at 25, 50 and 75% were 100, 200 and 300 kg/fed/year.

All plants received mineral PK as calcium superphosphate (15.5% P_2O_5) at 300 kg/fed/year and potassium sulphate (48% K_2O) at 100 kg/fed/year, respectively.

All P amounts were added during preparing the soil to cultivation, while the mineral NK fertilizers were divided into four batches, two batches (the first and second

Table a. Physical and chemical analysis of the experimental soil.

Soil Characters	Values	Soil Characters		Values
Sand %	28.20	**Available P %**		15.12
Silt %	30.70	**Exch. K^+ (mg/100 g)**		2.11
Clay %	41.10	**Exch. Ca^{++} (mg/100 g)**		31.74
Soil type	Clayey loam	**Exch. Na^+ (mg/100 g)**		2.40
Organic matter %	1.62	**DTPA Ext. ppm**	**Fe**	8.54
$CaCO_3$ %	2.09		**Cu**	2.06
E.C. (mmhos/cm)	1.04		**Zn**	2.75
pH (1:2.5)	7.82		**Mn**	8.26
Total N %	0.08			

doses) were added at three weeks interval, starting from March 21st (for first cutting), and the other two batches (the third and fourth doses) were added at three weeks interval, starting from June 2nd (after 7 days of the first cutting time).

Minia Azotein (*Azotobacter* strain) as a biofertilizer was added (50 cm^3/plant) four times around the plants after one week from each addition of mineral N and K. All other agricultural practices were carried out as usual in the region in the two experimental seasons.

2- Sub plots were control (spraying with a distilled water) and ascorbic acid at 50, 100 and 150 ppm as a foliar spray four times for each season at the same schedule of mineral NK.

During each experimental season the plants were cut twice, the first cut was done on 25th May, while, the second cut was done on 25th September in the two growth seasons.

Data recorded:

Plant height (cm), number of main branches/plant, herb fresh weight/plant (g/cut and kg/season) and herb fresh weight/fed (ton/fed).

Essential oil determination:

Determination of essential oil % in random samples obtained from the fresh herb of each treatment (after 48 hours from each cut) was carried out in each cut during the two seasons according to the method described by British Pharmacopoeia (1963).

The essential oil percentage = Essential oil in the graduated tube in ml / Weight of sample (g) × 100.

Essential oil yield/plant was calculated by multiplying oil percentage by herb yield/plant and expressed as ml/plant.

Essential oil yield/fed was calculated by essential oil yield/plant × number of plants/fed (14222.22 plants).

The data of the two cuts during two seasons were subjected to statistical analysis of variance MSTAT-C (1986). L.S.D. test at 0.05 was found to compare the average means of treatments.

RESULTS AND DISCUSSION

1- Vegetative growth parameters:

Data presented in Tables (1, 2, 3 and 4) show that the vegetative growth traits (plant height, number of main branches/plant, herb fresh weight/plant/cut and /plant/season, as well as, herb fresh weight/fed) were increased by increasing mineral N in the presence of Minia Azotein till 75% N. The fertilization with 100% mineral nitrogen gave the highest values in comparison with other treatments of bio-mineral nitrogen fertilization without significant differences detected between mineral N (100%) and Minia Azotein + mineral N (75%) in the two cuts during both seasons. The response of plant growth in the present investigation as a result of application of mineral N fertilization was also found by Ram *et al.* (2003) and Ibrahim (2010) on geranium, Golcz *et al.* (2006) on sweet basil and Aziz and El-Ashry (2009) on lemon Balm. The beneficial effects of Minia Azotein (N-biofertilizer treatments) on plant growth were obtained by Hemdan (2008) on anise, Helmy (2008) on black cumin and Abdou *et al*. (2014) on sweet basil.

Concerning the effect of ascorbic acid treatments, all previous studied characters were significantly increased in the two cuts during both seasons due to the use of the three concentrations of ascorbic acid in comparison with control. Among various treatments, the high concentrations (150 ppm) gave the highest values comparing with other two concentrations and control. Similar results were obtained by Ismail (2008) on black cumin and Abdou *et al.* (2009) on borage plant.

Results showed a significant interaction between Minia Azotein–mineral N and ascorbic acid treatments. The highest values over all were obtained due to fertilizing

Table 1. Effect of nitrogen fertilization and ascorbic acid on plant height (cm) of geranium (*Pelargonium graveolens*, L.) plants in the first and second cuts during the two seasons (2012/2013 and 2013/2014).

N-fertilization / Ascorbic acid treatments	1st Season					2nd Season				
	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)
					1st Cut					
Control	51.4	55.6	59.8	60.1	56.7	57.1	62.5	65.5	66.6	62.9
AsA. at 50 ppm	55.1	59.3	62.2	63.2	60.0	61.2	67.0	69.3	70.2	66.9
AsA. at 100 ppm	59.0	63.3	66.1	67.0	63.9	65.3	71.4	73.5	74.0	71.1
AsA. at 150 ppm	60.8	65.4	68.1	69.0	65.8	67.5	73.5	75.5	76.0	73.1
Mean (A)	54.1	60.9	64.1	64.8		62.8	68.6	71.0	71.7	
L.S.D. at 5%	A= 2.8		B= 0.9		AB= 1.8	A= 2.2		B= 0.8		AB= 1.6
					2nd Cut					
Control	48.1	51.2	53.3	54.1	51.7	53.1	58.1	60.8	61.5	58.4
AsA. at 50 ppm	51.2	54.7	56.5	57.2	54.9	57.0	62.0	64.5	65.5	62.3
AsA. at 100 ppm	55.3	58.5	60.5	61.1	58.9	60.8	66.0	68.1	69.3	66.1
AsA. at 150 ppm	57.0	60.6	62.4	62.7	60.7	62.8	68.1	70.2	71.3	68.1
Mean (A)	52.9	56.3	58.2	58.8		58.4	63.6	65.9	66.9	
L.S.D. at 5%	A= 1.7		B= 0.7		AB= 1.4	A= 2.1		B= 0.9		AB= 1.8

AsA.= Ascorbic acid M.A.= Minia Azotein (*Azotobacter* strain)

Table 2. Effect of nitrogen fertilization and ascorbic acid on number of main branches/plant of geranium (*Pelargonium graveolens*, L.) plants in the first and second cuts during the two seasons (2012/2013 and 2013/2014).

N-fertilization / Ascorbic acid treatments	1st Season					2nd Season				
	M.A. + 25% N	M.A. + 50% N	M.A. + 75 % N	100% N	Mean (B)	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)
					1st Cut					
Control	9.9	12.1	13.6	14.5	12.5	10.9	13.2	14.2	14.7	13.3
AsA. at 50 ppm	11.1	13.4	14.7	15.2	13.6	12.3	14.7	15.8	16.1	14.7
AsA. at 100 ppm	11.4	13.7	15.0	15.2	13.8	12.6	14.9	16.0	16.0	14.9
AsA. at 150 ppm	11.7	13.7	15.4	15.6	14.1	12.7	15.0	16.1	16.5	15.0
Mean (A)	11.0	13.2	14.7	15.1		12.1	14.5	15.5	15.8	
L.S.D. at 5%	A= 0.5		B= 0.1		AB= 0.2	A= 0.4		B= 0.2		AB= 0.4
					2nd Cut					
Control	10.5	12.6	14.0	14.5	12.9	11.4	13.8	14.7	15.1	13.8
AsA. at 50 ppm	11.9	13.8	15.0	15.4	14.0	12.7	15.1	16.0	16.4	15.1
AsA. at 100 ppm	12.4	14.4	15.7	16.1	14.7	13.3	15.8	16.8	17.0	15.7
AsA. at 150 ppm	12.8	14.9	16.3	16.7	15.2	13.4	15.9	17.2	17.4	16.0
Mean (A)	11.9	13.9	15.3	15.7		12.7	15.2	16.2	16.6	
L.S.D. at 5%	A= 0.5		B= 0.2		AB= 0.4	A= 0.6		B= 0.1		AB= 0.2

AsA.= Ascorbic acid M.A.= Minia Azotein (*Azotobacter* strain)

Table 3. Effect of nitrogen fertilization and ascorbic acid on herb fresh weight/plant (g/plant) of geranium (*Pelargonium graveolens*, L.) plants in the first and second cuts during the two seasons (2012/2013 and 2013/2014).

N-fertilization / Ascorbic acid treatments	1st Season					2nd Season				
	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)
					1st Cut					
Control	490.1	588.2	687.0	697.5	615.7	551.9	657.2	761.6	768.3	684.8
AsA. at 50 ppm	593.1	710.2	825.8	841.8	742.7	605.1	719.3	838.2	850.9	753.4
AsA. at 100 ppm	620.0	741.1	868.5	900.5	782.5	629.1	753.2	879.5	910.0	793.0
AsA. at 150 ppm	641.1	773.5	910.6	935.8	815.3	648.2	780.1	918.8	943.5	822.7
Mean (A)	586.1	703.3	823.0	843.9		608.6	727.5	849.5	868.2	
L.S.D. at 5%	A= 21.9		B= 12.9		AB= 25.8	A= 19.7		B= 12.4		AB= 24.8
					2nd Cut					
Control	532.1	643.2	761.5	768.0	676.2	581.1	672.1	793.2	797.5	711.1
AsA. at 50 ppm	617.1	741.2	865.6	871.3	773.8	626.2	750.1	874.2	880.1	782.7
AsA. at 100 ppm	651.1	781.0	930.2	944.5	826.7	658.9	790.3	937.5	952.6	834.8
AsA. at 150 ppm	672.0	817.0	955.3	971.3	853.9	683.2	826.1	964.8	980.1	863.6
Mean (A)	618.1	745.6	878.2	888.8		637.4	759.7	892.5	902.6	
L.S.D. at 5%	A= 13.6		B= 9.0		AB= 18.0	A= 14.5		B= 8.1		AB= 16.2

AsA.= Ascorbic acid M.A.= Minia Azotein (*Azotobacter* strain)

Table 4. Effect of nitrogen fertilization and ascorbic acid on herb fresh weight/plant/season (kg/plant) and herb fresh weight/fed/season (ton/fed) of geranium (*Pelargonium graveolens*, L.) plants in the first and second cuts during the two seasons (2012/2013 and 2013/2014).

N-fertilization / Ascorbic acid treatments	1st Season					2nd Season				
	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)
					Herb fresh weight/plant/season (kg/plant)					
Control	1.02	1.23	1.45	1.47	1.29	1.13	1.33	1.56	1.57	1.40
AsA. at 50 ppm	1.21	1.45	1.69	1.71	1.52	1.23	1.47	1.71	1.73	1.54
AsA. at 100 ppm	1.27	1.52	1.80	1.85	1.61	1.29	1.54	1.82	1.86	1.63
AsA. at 150 ppm	1.31	1.59	1.87	1.91	1.67	1.33	1.61	1.88	1.92	1.69
Mean (A)	1.20	1.45	1.70	1.74		1.25	1.49	1.74	1.77	
L.S.D. at 5%	A= 0.05		B= 0.02		AB= 0.04	A= 0.04		B= 0.02		AB= 0.04
					Herb fresh weight/fed/season (ton/fed)					
Control	14.51	17.49	20.62	20.91	18.35	16.07	18.92	22.19	22.33	19.91
AsA. at 50 ppm	17.21	20.62	24.04	24.32	21.62	17.49	20.91	24.32	24.60	21.90
AsA. at 100 ppm	18.06	21.62	25.60	26.31	22.90	18.35	21.90	25.88	26.45	23.18
AsA. at 150 ppm	18.63	22.61	26.60	27.16	23.75	18.92	22,90	26.74	27.31	24.04
Mean (A)	17.07	20.62	24.18	24.75		17.78	21.19	24.75	25.17	
L.S.D. at 5%	A= 0.59		B= 0.30		AB= 0.60	A= 0.46		B= 0.32		AB= 0.64

AsA.= Ascorbic acid M.A.= Minia Azotein (*Azotobacter* strain)

geranium plants with either mineral N (100%) or Minia Azotein + mineral N (75%) and spraying plants with ascorbic acid at 150 ppm.

2- Essential oil productivity:

The data presented in Tables (5, 6 and 7) indicate that essential oil %, essential oil yield/plant/cut, essential oil yield/plant and /fed were significantly decreased as a result of fertilizing plants with all used combined fertilization treatments (mineral N + Minia Azotein) comparing with mineral N (100%). It is noticed that the least reduction of values was obtained with mineral N (75%) + Minia Azotein and there were non-significant differences between 100% N and 75% N + Minia Azotein for all previous parameters.

Data presented in Tables (5, 6 and 7) indicated that the treatments of ascorbic acid (50, 100 and 150 ppm) significantly increased essential oil percentage, essential oil yield (per plant/cut, per plant/season and per fed) over the control. Ascorbic acid at 150 ppm was more effective than other treatments. Ascorbic acid has been known as an antioxidant and protects plants against damage resulting from aerobic metabolism, photosynthesis and a range of pollutants. Also, it had promotive effects on essential oil % (Tarraf *et al.,* 1999).

The interaction between fertilization and ascorbic acid treatments was significant for essential oil % and essential oil yield (per plant and per fed) in both seasons. The best interaction in this study was obtained from either fertilizing geranium plants with mineral nitrogen (100%) or with Minia Azotein + 75% N and spraying plants with salicylic acid at 150 ppm.

Hence, it could be recommended that the interaction treatments of Minia Azotein + 75% N (mineral) plus ascorbic acid at 150 ppm had a beneficial effect on growth and essential oil production of geranium plants.

Table 5. Effect of nitrogen fertilization and ascorbic acid on essential oil % of geranium (*Pelargonium graveolens*, L.) plants in the first and second cuts during the two seasons (2012/2013 and 2013/2014).

N-fertilization / Ascorbic acid treatments	1st Season					2nd Season				
	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)
1st Cut										
Control	0.331	0.346	0.374	0.378	0.357	0.333	0.348	0.377	0.380	0.360
AsA. at 50 ppm	0.351	0.356	0.387	0.388	0.371	0.353	0.368	0.399	0.401	0.380
AsA. at 100 ppm	0.357	0.363	0.394	0.398	0.378	0.362	0.378	0.409	0.413	0.391
AsA. at 150 ppm	0.365	0.372	0.401	0.404	0.386	0.369	0.385	0.416	0.419	0.397
Mean (A)	0.351	0.359	0.389	0.392		0.354	0.370	0.400	0.403	
L.S.D. at 5%	A= 0.004		B= 0.002		AB= 0.004	A= 0.004		B= 0.002		AB= 0.004
2nd Cut										
Control	0.319	0.333	0.363	0.366	0.545	0.325	0.337	0.369	0.372	0.351
AsA. at 50 ppm	0.338	0.353	0.384	0.387	0.366	0.348	0.360	0.395	0.397	0.375
AsA. at 100 ppm	0.345	0.360	0.391	0.394	0.373	0.354	0.367	0.401	0.404	0.382
AsA. at 150 ppm	0.351	0.366	0.398	0.399	0.379	0.364	0.377	0.413	0.416	0.393
Mean (A)	0.338	0.353	0.384	0.387		0.348	0.360	0.395	0.397	
L.S.D. at 5%	A= 0.003		B= 0.002		AB= 0.004	A= 0.002		B= 0.005		AB= 0.010

AsA.= Ascorbic acid **M.A.= Minia Azotein (*Azotobacter* strain)**

Table 6. Effect of nitrogen fertilization and ascorbic acid on essential oil yield/plant/cut (ml/plant) of geranium (*Pelargonium graveolens*, L.) plants in the first and second cuts during the two seasons (2012/2013 and 2013/2014).

N-fertilization / Ascorbic acid treatments	1st Season					2nd Season				
	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)
1st Cut										
Control	1.62	2.04	2.57	2.64	2.20	1.84	2.29	2.87	2.92	2.47
AsA. at 50 ppm	2.08	2.53	3.20	3.27	2.76	2.14	2.65	3.34	3.41	2.86
AsA. at 100 ppm	2.21	2.69	3.42	3.58	2.96	2.28	2.85	3.60	3.76	3.10
AsA. at 150 ppm	2.34	2.88	3.65	3.78	3.15	2.39	3.00	3.82	3.95	3.27
Mean (A)	2.06	2.52	3.20	3.31		2.15	2.69	3.40	3.50	
L.S.D. at 5%	A= 0.13		B= 0.07	AB= 0.14		A= 0.12		B= 0.07	AB= 0.14	
2nd Cut										
Control	1.70	2.14	2.76	2.81	3.69	1.89	2.26	2.93	2.97	2.50
AsA. at 50 ppm	2.09	2.62	3.32	3.37	2.83	2.18	2.70	3.45	3.49	2.94
AsA. at 100 ppm	2.25	2.81	3.64	3.72	3.08	2.33	2.90	3.76	3.85	3.19
AsA. at 150 ppm	2.36	2.99	3.80	3.88	3.24	2.49	3.11	3.98	4.08	3.39
Mean (A)	2.09	2.63	3.37	3.44		2.22	2.73	3.53	3.58	
L.S.D. at 5%	A= 0.11		B= 0.06	AB= 0.12		A= 0.11		B= 0.11	AB= 0.22	

AsA.= Ascorbic acid M.A.= Minia Azotein (*Azotobacter* strain)

Table 7. Effect of nitrogen fertilization and ascorbic acid on essential oil yield/plant (ml/plant) and essential oil yield/fed (liter/fed) of geranium (*Pelargonium graveolens*, L.) plants in the first and second cuts during the two seasons (2012/2013 and 2013/2014).

N-fertilization / Ascorbic acid treatments	1st Season					2nd Season				
	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)	M.A. + 25% N	M.A. + 50% N	M.A. + 75% N	100% N	Mean (B)
Essential oil yield/plant (ml/plant)										
Control	3.32	4.18	5.33	5.45	5.88	3.73	4.55	5.80	5.89	4.96
AsA. at 50 ppm	4.17	5.14	6.52	6.64	5.59	4.32	5.35	6.80	6.91	5.80
AsA. at 100 ppm	4.46	5.50	7.06	7.31	6.04	4.61	5.75	7.36	7.61	6.29
AsA. at 150 ppm	4.70	5.87	7.45	7.66	6.38	4.88	6.12	7.81	8.03	6.66
Mean (A)	4.15	5.16	6.57	6.75		4.37	5.43	6.92	7.08	
L.S.D. at 5%	A= 0.20		B= 0.11	AB= 0.22		A= 0.18		B= 0.12	AB= 0.24	
Essential oil yield/fed (liter/fed)										
Control	47.2	59.4	75.9	77.5	83.7	53.0	64.7	82.5	83.7	70.6
AsA. at 50 ppm	59.3	73.2	92.7	94.4	79.5	61.4	76.1	96.7	98.2	82.5
AsA. at 100 ppm	63.4	78.2	100.4	103.9	85.9	65.6	81.7	104.6	108.2	89.5
AsA. at 150 ppm	66.8	83.5	106.0	108.9	90.8	69.4	87.0	111.0	114.2	94.7
Mean (A)	59.0	73.3	93.5	96.0		62.2	77.2	98.5	100.7	
L.S.D. at 5%	A= 2.6		B= 2.4	AB= 4.8		A= 2.4		B= 2.8	AB= 5.6	

AsA.= Ascorbic acid M.A.= Minia Azotein (*Azotobacter* strain)

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تأثير مصادر النتروجين و حمض الأسكوربيك على النمو وإنتاج الزيت الطيار في نباتات العتر

محمود عبد الهادي حسن عبده* و عماد الدين توفيق أحمد* و طارق إبراهيم الدسوقي إسماعيل إبراهيم **

* قسم البساتين، كلية الزراعة، جامعة المنيا، مصر.

** وزارة الزراعة، مصر.

تم إجراء التجربة الحقلية بمشتل نباتات الزينة ومعمل كلية الزراعة جامعة المنيا في موسمي ٢٠١٣/٢٠١٢ و ٢٠١٤/٢٠١٣ لدراسة تأثير النتروجين المعدني والحيوي وحمض الأسكوربيك (٥٠ ، ١٠٠ ، ١٥٠ جزء/مليون) على النمو وإنتاج الزيت لنباتات العتر. أوضحت النتائج أنه لا يوجد فرق معنوي بين النتروجين المعدني (١٠٠%) والمعدني (٧٥%) + المنيا أزوتين على النمو وإنتاج الزيت الطيار للنباتات. تأثير التركيز العالي لحمض الأسكوربيك (١٥٠ جزء/مليون) تفوق على التركيزيين الأخريين (المتوسط والمنخفض) في زيادة النمو وإنتاجية الزيت. تساوت النباتات (النمو وإنتاج الزيت) التي تم تسميدها بالنتروجين المعدني ٧٥% + المنيا أزوتين وتم رشها بـ ١٥٠ جزء/مليون حمض الأسكوربيك مع النباتات التي سمدت بالنتروجين المعدني ١٠٠% مع ١٥٠ جزء/مليون حمض الأسكوبيك.