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SOME CHEMICAL CHANGES OF *LAVENDULA OFFICINALIS* PLANT TREATED WITH NICOTINAMIDE

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ABSTRACT

This study investigated the possibility of cultivation Lavender plant in soilless culture (perlite), irrigation rates (10 or 15 times /day (each time was 10 minutes)), effect of nicotinamide (NA) (vit.B_5) in micro concentrations (75 or 100 ppm), and two methods of NA application (foliar spray and addition in irrigation water (nutrient solution)). Two cuts of lavender (*Lavendula officinalis*) were obtained with 6 months intervals between each cut. The investigated vegetative growth parameters were plant height (cm), number of branches/plant, fresh weight (g/herb), and dry matter percentage. The determined chemical parameters in first and second cuts were crude protein and total carbohydrates, N, P, K percentage (g/100 g DW), total phenols (mg/100 FW), photosynthetic pigments including ch a, b and carotenes (g/100 FW).

Data clearly revealed that irrigation level at 10 times/ day was completely sufficient for obtaining the maximal significant values of plant height and fresh weight/herb, and less number of branches/plants compared with 15 times/day in both cuts. In first cut, treatment of 75 ppm NA resulted in the highest value of fresh weight compared with other NA treatments, plant height significantly decreased due to NA concentrations, whilst numbers of branches significantly increased compared with control. In second cut significant increase in fresh weight were obtained due to application of both concentrations of NA. Adding NA to nutrient solution (75 ppm, for 10 times/ day) led to significant increases in fresh weight of first cut compared with foliar spray. However, in second cut only plant height significantly increased due to foliar spray with NA compared with addition method.

Protein, N, and P, increased significantly by increasing irrigation frequencies up to 15 times / day in both cuts. In first cut, irrigation with 15 times/day caused insignificant variation in total carbohydrates, total

polyphenols, and chlorophylls a & b, significant decrement in K levels, and carotenes increment. However, total carbohydrates, total polyphenols, decreased significantly while K and all photosynthetic pigments did not alter significantly in second cut with 15 times/day irrigation rate. NA treatments caused significant increment in P in both cuts, while K significantly increased with 100 ppm NA in first cut only. All photosynthetic pigments decreased significantly in first cut due to NA applications while, in second cut, chlorophylls a & b showed insignificant variations and only carotenes increased significantly using 100 ppm NA in the same cut.

Keywords: Nicotinamide, *Lavendula officinalis*, growth parameters, chemical parameters

INTRODUCTION

Soilless culture is a technology for growing plants in nutrient solution (water and nutrients) with or without the use of artificial medium (e.g. Sand, Grael, Vermiculite, Rock woo, Peat moss, Sawdust, Perlit, etc.) to provide mechanical support . Soilless culture techniques eliminate the use of soil fumigants as methyl bromide, which can destroy the ozone layer. The effect of different substrates using different irrigation levels on production and quality of carnation was studied to select the best substrate and irrigation level suitable for this substrate (Tüzel *et al*., 2001; and Minuto & Garibaldi, 2005). The soilless culture system (SCS) allows controlling growth factors and cleaning leaf production (it means free chemical leafy vegetables), easing and shortening post harvest handling in process industries (Nicola, 2005).

Water stress affected on chlorophyll and carotenoids content in several plants, contents of chlorophyll a and b on leaf area basis were not significantly altered but the content of ß-carotene was increased by about 25% (Stuhlfauth *et al*., 1990).

Plant height, number of branches, fresh and dry weight of *Lavandula officinalis* L. plants was significantly promoted as a result of foliar application of kinetin and brassinostriod (Youssef and Iman, 1998). Most criteria of vegetative growth were significantly affected by application of the vitamins of nicotinamide to rosemary plants significantly promoted plant height, number of branches, fresh and dry weights of herb. Increasing nicotinamide concentration to 75 mg/l caused increase in the growth of the two cuttings (Youssef and Iman, 2003). The stimulatory effects of nicotinamide may be attributed to its role in increasing pigments, total nitrogen and total carbohydrate of

Lavendula officinalis (Hathout, 1993). The Foliar application of nicotinamide to lemongrass plants significantly promoted vegetative growth increasing total carbohydrates and crude proteins (Tarraf *at el.*, 1999). The use of vitamins enhances vegetative growth of *Rosmarimus officinalis* beside their effects on carbohydrate metabolism (Youssef and Iman, 2003).

Lavender honeys contained gallic acid, Thyme honey was characterized by the presence of rosmarinic acid, heather honey by ellagic acid, citrus honey by hesperetin and lavender honey by naringenin (Andrade *et al.*, 1997).

19 phenolic compounds (flavonoids, phenolic acids and coumarins) fund in *Lavandula officinalis* [*L. angustifolia*], *Lippia citriodora, Mentha piperita* and *Salvia officinalis* (Andrade *et al.*, 1998). *Lavandula angustifolia* is a good source of phenolic metabolites for food, medicine and cosmetic applications. (Al-Amier *et al.*, 1999)

8 phenolic compounds (2-*O*-glucosilcoumaric acid, *o*-coumaric acid, rosmarinic acid, apigenin-7-*O*-glucoside, coumarin, herniarin, luteolin, and apigenin) in *Lavandula* flowers (Areias, 2000).

Species belonging to the family Lamiaceae (*Salvia officinalis, Melissa officinalis, Mentha piperita, Thymus vulgaris, Lavandula officinalis* (*Lavandula angustifolia*), *Rosmarinus officinalis,* and *Satureja hortensis*) and representing the most popular medicinal plants used in Polish phytotheraphy were examined for the content of phenolic acids (PhAs). Two depsides, rosmarinic and chlorogenic acids, as well as eight simple PhAs, protocatechuic, gentisic, *p*-hydroxybenzoic, caffeic, vanillic, syringic, *p*-coumaric and ferulic acids, in different qualitative and quantitative proportions depending on the plant examined were determined (Zgorka and G. Gowniak, 2001).

Total phenols of Lavander (*Lavandula stoechas* L.) have compared our attention, because of their antiocidant activity (Cossu *et al.,* 2003), as well as high reduction power (Heilerova and Culakova, 2005). Gulcine *et al.*, 2004 concluded that, the extracts of lavender had effective reductive potential, free radical scavenging, superoxide anion radical scavenging, and metal chelating activities.

The aim of this work was to study the effect of irrigation schedule and nicotinamide application, on the production and quality

of lavender plant under soilless culturing condition and to visualize the following aspects:

1- The possibility of cultivation Lavender plant in soilless culture (SCS) using perlite as solid support. The irrigation rate or levels were 10 or 15 times /day (each time was 10 minutes).

2- Applying nicotinamide (vit.B_5) in micro concentrations 75 or 100 ppm; as natural growth regulator; through foliar spray or addition to irrigation water (nutrient solution).

MATERIALS AND METHODS

The experiment was conducted at Central Laboratory for Agricultural Climate Research Centre (CLAC), Dokki, Giza governorate, Egypt, under unheated plastic house (9 x 60 x 3.25 m). Seedlings of *Lavendula officinalis* were sown in black polyethylene bags filled with perlite (physical properties of perlite were :- 0-5mm particles size, 89.2 bulk density (mg/L.DW), 90.1% pore space of volume, 32.0% air space of volume and 24.6% easily available water). One plant was sown in each bag which has holes on 5 cm from the bottom to allow the drainage. The drained nutrient solution was collected and returned to the catchment tank with submersible pump to distribute the desired amounts of water to the different treatments. Each five pumps were connected with digital timer to determine the irrigation schedule for each treatment. Nutrient solution was circulated by submersible pump 32-watt capacity. The solution was introduced to the top of the gullies through a small flexible pipe. The nutrient solution was delivered to each bag via dripper two litters / hour. For each bag, fertilization was applied from planting.

The used nutrient solution was adapted from Cooper solution Cooper (1979) (Table A). The solution volume was adjusted twice a week. Electrical conductivity (EC) was maintained between (2.2-2) m.mhos $^{-1}$and pH maintained between (6-6.5).

This study investigated the effect of three nicotinamide concentrations (0, 75 and 100 mg/L), two methods of nicotinamide application; foliar spray and addition in nutrient solution and two irrigation scheduling (10, 15 times/day) to perform twelve treatments. Two cuts of lavender (*Lavendula officinalis*) were obtained with 6 months intervals between each cut from transplanting time (three

replicates of each treatment) and then directed for determination of plant chemical composition.

Table (A): Elements concentration in the nutrient solution

Element	Concentration (ppm)	Element	Concentration (ppm)
N	200	Mn	1.0
P	70	Cu	0.039
K	300	Zn	0.044
Ca	190	B	0.17
Mg	50	Mo	0.1
Fe	5.0		

The chemical composition of herbage

Moisture percentage was calculated according to A.O.A.C., (1990).

Percentage of total carbohydrates

Total carbohydrates were extracted according to A.O.A.C., (1990), hydrolyzed with 1N HC1 by refluxing 6 hr in boiling water bath. The resultant solution was filtered, neutralized and the total volume was made up to 100 ml with distilled water. The resultant total reducing sugars were determined calorimetrically using alkaline potassium ferricyanide reagent.

Determination of total phenols

Extraction has been carried out according to the procedure described by Daniel *et al*., (1972). Known weight (1g)of fresh samples were macerated in 10-20ml 80% ethanol for at least 20 hours at $0C^{o}$, the alcohol was clarified, the remained tissue re-extracted with 10-20ml 80% ethanol for three times. At the end, the clarified extract was completed to 100 ml using 80% ethanol. Total polyphenols have been determined according to A.O.A.C. (1970). One ml of the previous extract and 0.5ml of Folin–Denis reagent mixed in dry test tube. The tube was thoroughly shaken for 3 min., then 1.0 ml of saturated Na_2CO_3 solution was added and mixed followed by the addition of 3 ml distilled water and left for one hour .The Phenolic compounds were determined as catechol using spectrophotometer (Unico-2100.Uv-Vis) system. Developed blue color was measured at 725 nm. For blank, one

ml 80% ethanol solution and reagent 0.5ml of Folin–Denis were used only. The corresponding amount of phenolic compounds was calculated based on a standard solution prepared with pure catechol.

Determination of nitrogen, crude protein, phosphorus, and potassium percentage

A dried sample of 0.1 g was taken in 500 ml kejldahl flash, then added 10 ml of H_2SO_4 conc. and digested till colorless solution appeared. The contents cool down and diluted to about 25 ml with distilled water (solution 1). Total nitrogen and Crude protein were determined in solution (1) according to kejldahl method (A.O.A.C. 1990). Total phosphorus was determined calorimetrically according to Watanabe and Olsen, (1965). Total potassium was determined using flame photometer as described by Chapman and Pratt (1961).

Determination of plant pigments percentage

Chlorophyll a, b and carotenoids were extracted as described by A.O.A.C., (1990), and estimated according to Wettstein, (1957). According to the following procedure:-

Fresh leaf samples (0.5g) were homogenized in a mortar with 85% acetone in the presence of washed dried sand and a little amount of $CaCO_3$ (0.1g). The homogenate was filtered through sintered glass funnel. The residue was washed several times with acetone until the filtrate became colorless. The combined extract was completed up to 50ml. The optical density of this extract was determined using a spectrophotometer (3000 spectoronic) at 662, 644 and 440.5 nm for chl. a, chl. b and carotenoids respectively.

Calculation:

The concentrations of chlorophyll a, b and carotenoids were calculated by means of formula (Wettstein, 1957):-

Chl.a = 9.784 x E 662 - 0.99 x E 644 mg/L

Chl.b = 21.462 x E 644 - 4.65 x E 662 mg/L

Carotenoid = 4.695 x E 440.5 - 0.268 x c (a + b) mg/L

Where: c (a + b) is the sum of chlorophyll a and b concentration in mg/L. The results were calculated as g/100g fresh weight.

Statistical analysis

The obtained data were statistically analyzed using the general linear model procedure described in SAS User's Guide (SAS, 1998), according to the following model: $Y_{ijkl} = \mu + L_i + C_j + M_k + LCM_{ijk} + E_{ijkl}$, where Y_{ijk} = Observed trait, μ = The overall mean, L_i = The

effect of irrigation (i = 1, 2), C_j = The effect of concentration (j = 1, 2, 3), M_k = The effect of methods (k = 1, 2), LCM_{ijk} = Interactions between i the irrigation, j the concentration and the k methods and E_{ijkl} = Random error. Mean differences were tested by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The investigated vegetative growth parameter obtained from two cuts were, plant height (cm), number of branches/plant, fresh weight (g/herb), and dry matter percentage.

The determined chemical parameters in first and second cuts were crude protein and total carbohydrates, N, P, K percentage (g/100 g DW), total phenols (mg/100 FW), photosynthetic pigments including ch a, b and carotenes (g/100 FW).

Vegetative Growth Parameters

The mean of some vegetative growth parameters as influenced by times of irrigation /day, concentrations of nicotinamide and methods of application are listed in table (1) for the first cut, and table (2) in case of the second cut. These parameters include plant height, number of branches, fresh weight, dry matter and moisture percentage.

As general point of view one can conclude the following main aspects.

Effect of irrigation frequencies

Data clearly reveal that irrigation level at 10 times/ day was completely sufficient for obtaining the maximal significant values of plant height and fresh weight/herb, and less number of branches/plants compared with 15 times/day, in case of first cut (Table 1).

Dealing with the second cut (Table 2), also decreasing irrigation level enhanced significantly all vegetative growth parameters than 15 times/day did.

From economical point of view, fresh weight/herb is the most interesting parameter which may affect the yield of essential oil (ml/herb). i.e. in case of 10 times/day, fresh weigh values in first and second cuts were 230.05 and 205.4 g/herb respectively , but by increasing irrigation level to 15 times /day, these values dramatically decreased to 151.6 and 188.3 g/herb respectively .

Effect of nicotinamide application

The interactive statistical analyses reveal the superiority of nicotinamide application at 75 ppm in comparison with the other treatment, especially in case of the first cut (Table 1). Treating with low concentration of nicotinamide resulted in the highest value of fresh weight (228.7 g/herb) compared with control (176.4) and 100 ppm (167.3). Plant height decreased in significant manner due to both concentration of nicotinamide, whilst numbers of branches significantly increased compared with control. In case of the second cut (Table 2), significant increase in fresh weight was obtained due to application of both concentrations of nicotinamide (215.1 and 211.4 g/ herb) compared with control (164.1). No significant changes in fresh weight were achieved by increasing nicotinamide concentration from 75 to 100 mg/L. Nicotinamide application resulted in significant increase in both plant heights (39.6 and 40.9 cm.) And number of branches (45.3 and 48.5/ plant) compared with control (37.9 and 38.6/plant) respectively.

Effect of method of nicotinamide application

In case of first cut (Table1) , data reveal significant increases in fresh weight values due to adding nicotinamide to nutrient solution, compared with foliar spray, as fresh weight values were 203.1 and only 178.6 g/herb respectively. The other growth parameter showed insignificant variation.

Regarding to the second cut (Table 2), only plant height significantly increased due to foliar spray (41.2 cm) compared with addition method (37.8 cm), On the other hand parameters including fresh weight showed non-significant difference between addition and foliar spray method of nicotinamide application.

Dry matter of first cut showed significant increase in case of 75 ppm nicotinamide treatment only, regardless to the irrigation level or method of application. Concerning with the second cut, dry matter increased significantly (26.28%) with decreasing irrigation level to 10 times/ day. On the other hand, it showed the significant lowest value (24.08%) in case of 100 ppm nicotinamide application.

Dealing with the individual treatments: The comparison between 10 and 15 times /day (irrigation level) showed that fresh weight increased with the decreasing of irrigation level. Such observation is clearly noticed in control, as fresh weight decreased

from 239.11 to 113.7 g/ herb (first cut) and from 182.46 to 145.75 g/herb (second cut).

Table (1): Effect of nicotinamide on some vegetative growth parameters of Lavender herbage (first cut)

irrigation	NA concentration	Methods	Height (cm)	N.of branches / plant	Fresh weight(g/herb)	% Dry weight	% Moisture
10 times/day	control	Addition	41.49 ± 0.48	31.00 ± 2.11	239.11 ± 0.76	21.33 ± 2.40	78.67 ± 2.40
		Spray	41.49 ± 0.48	31.00 ± 2.11	239.11 ± 0.76	21.33 ± 2.40	78.67 ± 2.40
	75mg/L	Addition	38.67 ± 0.36	37.16 ± 0.48	320.20 ± 6.12	25.67 ± 1.20	74.33 ± 1.20
		Spray	33.55 ± 0.73	24.66 ± 1.89	237.37 ± 12.11	27.00 ± 1.52	73.00 ± 1.52
	100mg/L	Addition	38.33 ± 0.69	25.66 ± 3.08	207.98 ± 2.36	21.67 ± 0.88	78.33 ± 0.88
		Spray	39.44 ± 0.59	38.33 ± 2.69	136.55 ± 4.94	24.00 ± 0.57	76.00 ± 0.57
15 times/day	control	Addition	35.16 ± 0.29	25.66 ± 0.77	113.73 ± 8.80	24.00 ± 0.57	76.00 ± 0.58
		Spray	35.16 ± 0.29	25.66 ± 0.77	113.73 ± 8.80	24.00 ± 0.57	76.00 ± 0.58
	75mg/L	Addition	35.17 ± 0.76	44.83 ± 6.06	146.06 ± 4.45	30.00 ± 1.15	70.00 ± 1.15
		Spray	34.77 ± 0.46	35.67 ± 3.06	209.51 ± 11.72	20.00 ± 1.15	80.00 ± 1.15
	100mg/L	Addition	31.44 ± 0.59	33.66 ± 1.73	189.52 ± 5.11	24.33 ± 0.88	75.67 ± 0.88
		Spray	31.11 ± 0.67	50.88 ± 1.38	135.47 ± 4.19	23.33 ± 0.88	76.67 ± 0.88
Main effects :							
Effect of irrigation							
10 times/day			38.4[a]	31.90[b]	230.05[a]	23.5[b]	76.5[a]
15 times/day			33.7[b]	38.06[a]	151.6[b]	24.2[a]	75.7[a]
Effect of concentration							
control			36.3[a]	28.3[b]	176.4[c]	22.6[c]	77.3[a]
75mg/L			35.02[b]	35.5[a]	228.7[a]	25.6[a]	74.3[b]
100mg/L			35.08[b]	37.1[a]	167.3[b]	23.3[b]	76.6[a]
Effect of Methods							
A			36.3[a]	32.9[a]	203.1[a]	24.5[a]	75.5[a]
S			35.9[a]	34.3[a]	178.6[b]	23.2[a]	76.7[a]
Probability							
L			0.0001	0.0043	0.0001	0.3224	0.3224
C			0.0001	0.0002	0.0001	0.0102	0.0102
M			0.1825	0.3722	0.0003	0.1254	0.1254
L*C*M			0.0001	0.0001	0.0001	0.0021	0.0021

Where: A= Addition, S= Spray, L_i = effect of irrigation (i = 1, 2), C_j = effect of concentration (j = 1, 2, 3), M_k = effect of methods (k = 1, 2), LCM_{ijk} = Interactions between i irrigation, j concentration and k methods.

Table (2): Effect of nicotinamide on some vegetative growth parameters of Lavender herbage (second cut)

irrigation	NA concentration	Methods	Height (cm)	N.of branches / plant	Fresh weight(g/herb)	% Dry weight	%Moisture
10 times/day	control	Addition	39.56 ± 0.80	44.33 ± 4.81	182.47 ± 2.97	27.33 ± 2.19	72.67 ± 2.19
		Spray	39.56 ± 0.80	44.33 ± 4.81	182.47 ± 2.97	27.33 ± 2.19	72.67 ± 2.19
	75mg/L	Addition	37.67 ± 1.39	65.11 ± 2.23	181.72 ± 14.19	25.00 ± 0.58	75.00 ± 0.58
		Spray	46.22 ± 4.05	36.33 ± 0.84	230.20 ± 11.96	29.33 ± 0.33	70.67 ± 0.33
	100mg/L	Addition	41.56 ± 3.13	44.55 ± 3.27	195.71 ± 5.25	23.33 ± 0.67	76.67 ± 0.67
		Spray	50.67 ± 2.69	41.67 ± 1.17	260.26 ± 21.72	25.33 ± 0.67	74.67 ± 0.67
15 times/day	control	Addition	36.33 ± 1.35	33.00 ± 1.54	145.75 ± 18.04	24.33 ± 0.33	75.67 ± 0.33
		Spray	36.33 ± 1.35	33.00 ± 1.54	145.75 ± 18.04	24.33 ± 0.33	75.67 ± 0.33
	75mg/L	Addition	38.17 ± 1.06	54.50 ± 5.29	206.33 ± 12.13	29.67 ± 0.88	70.33 ± 0.88
		Spray	36.56 ± 0.95	36.11 ± 5.28	242.17 ± 24.44	21.67 ± 1.45	78.33 ± 1.45
	100mg/L	Addition	33.72 ± 0.49	39.33 ± 5.36	236.17 ± 9.38	24.67 ± 1.76	75.33 ± 1.76
		Spray	37.89 ± 3.18	55.67 ± 5.89	153.67 ± 5.18	23.00 ± 1.16	77.00 ± 1.16
Main effects:							
Effect of irrigation							
10 times/day			5.08^{b}	6.5^{b}	9.2^{a}	5.2^{a}	3.98^{a}	5.09^{a}
15 times/day			9.6^{a}	8.6^{a}	9.5^{a}	3.9^{b}	4.34^{a}	3.45^{b}
Effect of concentration							
control			9.2^{a}	7.50^{a}	8.5^{b}	5.6^{a}	3.6^{b}	5.46^{a}
75mg/L			7.3^{b}	7.55^{a}	12.8^{a}	4.2^{a}	4.6^{a}	3.21^{b}
100mg/L			5.5^{b}	7.6^{a}	6.8^{b}	3.9^{b}	4.1^{a}	4.1^{a}
Effect of Methods							
A			8.01^{a}	7.4^{a}	10.1^{a}	4.4^{a}	4.27^{a}	4.2^{a}
S			6.75^{b}	7.7^{a}	8.6^{b}	4.8^{a}	4.04^{a}	4.3^{a}
Probability							
L			0.0001	0.0001	0.0642	0.0001	0.01759	0.00001
C			0.0001	0.9438	0.0001	0.0001	0.00152	0.00001
M			0.0001	0.5559	0.0001	0.0092	0.03856	0.01583
L*C*M			0.0001	0.0418	0.0001	0.0001	0.00018	0.00001

Where: A= Addition, S= Spray, L_i = effect of irrigation (i = 1, 2), C_j = effect of concentration (j = 1, 2, 3), M_k = effect of methods (k = 1, 2), LCM_{ijk} = Interactions between i irrigation, j concentration and k methods.

Irrigation lavender plant with nutrient solution contained 75 ppm nicotinamide for 10 times/ day resulted in the highest fresh

weight (320 g/herb) in case of first cut (Table 1). Finally the promotive effect of nicotinamide application on vegetative growth has been proved by Hathout (1993) concerning with tomato plant, Youssef and Iman (2003) dealing with rosemary plant.

Changes in some biochemical parameters

The present study has put stress on some biochemical constituents to obtain good idea about the suitable conditions for cultivating Lavender plant into perlite soilless culture. The changes in crude protein, total carbohydrates, and total polyphenols percentage have been listed in Table (3), whilst those of N, P, K in Table (4) and photosynthetic pigments in Tables (5, 6).

In general, data reveal that, these constituents showed variable responses according to, irrigation frequencies, as well as, methods of application and concentrations of nicotinamide and due to plant age (first or second cut). However, one can conclude the main following statements:

Effect of irrigation frequencies

In case of first cut, only crude protein, N, P, carotenes increased in significant manner with increasing irrigation frequencies from 10 times to 15 times / day. On the other hand total carbohydrates, total polyphenols, chlorophyll a and b showed insignificant variations (Mahmoud *et al.*, 1992), potassium (K) showed an opposite trend and decreases significantly due to increasing irrigation rate to 15 times / day.

Dealing with the second cut (advance in plant age), crude protein, N, and P increased significantly in case of higher irrigation rate (15 times / day) than the lower one did. On the other hand total carbohydrates, total polyphenols, behaved the opposite trend as they decreased significantly in case of irrigation with the nutrient solution for 15 times/day compared the lower irrigation rate. Potassium and all photosynthetic pigments did not alter significantly due to increasing irrigation rate (Ram *et al.*, 1995).

The comparison between first and second harvest (cut) showed in case of 10 times/day, such increment in crude protein, N, total polyphenols, K; and such decrement in total carbohydrates, all photosynthetic pigments. The most pronounced increment has been observed in case of potassium followed by total polyphenols. In case of 15 times/day, crude protein, total carbohydrates, total polyphenols,

N, P. Chlorophyll a, and carotenes showed variable decreases with advancing plant age, i.e. in second cut compared with the first one. The most dramatic increase has been observed in case of potassium regardless the irrigation frequencies applied (10 or 15 times / day). The increases in nitrogen and consequently crude protein and phosphorous with increasing irrigation rate with the nutrient solution may be reasonable as it allow higher absorption rate of both N and phosphorous compared with lower irrigation rate (10 times / day) (Ram *et al.*, 1995).

Effect of nicotinamide application

Total nitrogen and in turn crude protein decreased significantly with increasing nicotinamide concentration e.g. crude protein values were 9.2, 7.3 and 5.5% in control, 75,100 ppm nicotinamide treatments respectively in first cut. On the other hand they did not show significant differences in second cut.

Total polyphenols showed significant increases in first cut, whilst they decreased in significant manner in second cut compared with control treatment. Phosphorous showed significant increment by treating Lavander plants with nicotinamide and this hold true for both first and second cut. Potassium; increased significantly by treating with 100 ppm nicotinamide in first cut. On the other hand no significant differences were obtained between nicotinamide treatments in the second cut. Photosynthetic pigments: their response differed from one cut to another. In case of first cut, all photosynthetic pigments decreased significantly due to nicotinamide application compared with control treatment. Also increasing nicotinamide concentration from 75 to 100 ppm did not alter their values in significant manner. On the other hand, in second cut, both chlorophyll a and b showed non significant variations due to application of nicotinamide compared with control. Only carotenes increased significantly and reached their maximal value using 100 ppm.

Effect of method of application

Neither foliar spray or addition of nicotinamide to the nutrient solution resulted in any significant differences in all photosynthetic pigments in both first and second cut, with only one exception in case of carotenes of the second cut, as their values was significantly higher in addition technique than foliar spray did.

Table (3): Effect of nicotinamide on some chemical parameters of Lavender herbage (first and second cut).

irrigation	NA concentration	Methods	% Protein *		% Carbohydrate*		%Phenols (mg/100g FW)	
			First cut	Second cut	Frits cut	Second cut	First cut	Second cut
10 times/day	control	Addition	3.56 ± 0.02	6.253 ± 0.4	6.95 ± 0.04	5.91 ± 0.00	2.47 ± 0.56	6.51 ± 0. 062
		Spray	3.56 ± 0.02	6.253 ± 0.4	6.95 ± 0.04	5.91 ± 0.00	2.47 ± 0.56	6.51 ± 0. 062
	75mg/L	Addition	6.73 ± 0.27	7.003 ± 0.437	15.64 ± 0.23	2.147 ± 0.177	5.53 ± 0.32	3.57 ± 0. 10
		Spray	4.80 ± 0.14	5.98 ± 0.29	9.62 ± 0.11	6.007 ± 0.097	4.41 ± 0.27	4.16 ± 0. 20
	100mg/L	Addition	5.56 ± 0.25	6.093 ± 0.889	11.62 ± 0.57	3.993 ± 0.053	4.21 ± 0.05	4.47 ± 0. 05
		Spray	6.28 ± 0.04	5.667 ± 0.293	4.70 ± 0.20	7.62 ± 0.28	4.78 ± 0.25	5.31 ± 0. 20
15 times/day	control	Addition	15.01 ± 0.03	8.75 ± 0.254	10.10 ± 0.26	5.44 ± 0.47	4.81 ± 0.66	4.42 ± 0. 08
		Spray	15.01 ± 0.03	8.75 ± 0.254	10.10 ± 0.26	5.44 ± 0.47	4.81 ± 0.66	4.42 ± 0. 08
	75mg/L	Addition	11.09 ± 0.26	6.853 ± 0.293	11.23 ± 0.06	6.897 ± 0.569	4.44 ± 0.54	2.48 ± 0. 07
		Spray	6.73 ± 0.04	10.437 ± 1.598	14.82 ± 0.05	1.98 ± 0.01	4.17 ± 0.21	2.61 ± 0. 26
	100mg/L	Addition	6.14 ± 0.02	7.833 ± 1.31	5.47 ± 0.17	2.013 ± 0.043	4.16 ± 0.44	3.63 ± 0. 11
		Spray	4.14 ± 0.09	9.04 ± 1.02	5.57 ± 0.32	2.147 ± 0.177	3.63 ± 0.24	2.97 ± 0. 10
Main effects:								
Effect of irrigation								
10 times/day			5.08^{b}	6.5^{b}	9.2^{a}	5.2^{a}	3.98^{a}	5.09^{a}
15 times/day			9.6^{a}	8.6^{a}	9.5^{a}	3.9^{b}	4.34^{a}	3.45^{b}
Effect of concentration								
control			9.2^{a}	7.50^{a}	8.5^{a}	5.6^{a}	3.8^{b}	5.46^{a}
75mg/L			7.3^{b}	7.56^{a}	12.8^{a}	4.2^{b}	4.6^{a}	3.21^{b}
100mg/L			5.5^{b}	7.6^{a}	6.8^{b}	3.9^{b}	4.1^{a}	4.1^{a}
Effect of Methods								
A			8.01^{a}	7.4^{a}	10.1^{a}	4.4^{b}	4.27^{a}	4.2^{a}
S			6.75^{b}	7.7^{a}	8.6^{b}	4.8^{a}	4.04^{a}	4.3^{a}
Probability								
L			0.0001	0.0001	0.0642	0.0001	0.01759	0.00001
C			0.0001	0.9438	0.0001	0.0001	0.00152	0.00001
M			0.0001	0.5559	0.0001	0.0092	0.03556	0.01583
L*C*M			0.0001	0.0418	0.0001	0.0001	0.00016	0.00001

Where:* Fresh weight bases, A= Addition, S= Spray, L_i = effect of irrigation (i = 1, 2), C_j = effect of concentration (j = 1, 2, 3), M_k = effect of methods (k = 1, 2), LCM_{ijk} = Interactions between i irrigation, j concentration and k methods.

Table (4): Effect of nicotinamide on NPK of Lavender herbage (first and second cut)

irrigation	NA concentration	Methods	% Nitrogen *		% Phosphorus *		% Potassium *	
			First cut	Second cut	First cut	Second cut	First cut	Second cut
10 times/day	control	Addition	0.560 ± 0.006	1.09 ± 0.064	0.607 ± 0.026	0.377 ± 0.009	1.72 ± 0.032	4.243 ± 0.566
		Spray	0.560 ± 0.006	1.00 ± 0.064	0.607 ± 0.026	0.377 ± 0.009	1.72 ± 0.032	4.243 ± 0.568
	75mg/L	Addition	1.007 ± 0.003	1.12 ± 0.07	0.997 ± 0.026	0.39 ± 0.012	2.68 ± 0.011	4.667 ± 0.027
		Spray	0.670 ± 0.035	0.957 ± 0.047	0.796 ± 0.026	0.32 ± 0.02	1.06 ± 0.011	4.413 ± 0.326
	100mg/L	Addition	0.820 ± 0.009	1.283 ± 0.142	0.997 ± 0.026	0.487 ± 0.036	4.02 ± 0.018	5.207 ± 0.432
		Spray	1.110 ± 0.052	0.933 ± 0.047	0.993 ± 0.026	0.36 ± 0.023	3.84 ± 0.025	4.953 ± 0.461
15 times/day	control	Addition	2.170 ± 0.127	1.4 ± 0.04	1.020 ± 0.023	0.437 ± 0.023	1.90 ± 0.007	4.88 ± 0.492
		Spray	2.170 ± 0.127	1.4 ± 0.04	1.020 ± 0.023	0.437 ± 0.023	1.90 ± 0.007	4.88 ± 0.492
	75mg/L	Addition	1.357 ± 0.090	1.097 ± 0.047	0.663 ± 0.038	0.477 ± 0.022	1.35 ± 0.014	4.463 ± 0.178
		Spray	1.330 ± 0.156	1.67 ± 0.256	1.063 ± 0.062	0.503 ± 0.027	1.43 ± 0.008	5.427 ± 0.027
	100mg/L	Addition	1.437 ± 0.020	1.253 ± 0.21	0.670 ± 0.017	0.707 ± 0.132	2.36 ± 0.008	4.807 ± 0.378
		Spray	0.757 ± 0.038	1.447 ± 0.166	0.737 ± 0.023	0.433 ± 0.075	1.29 ± 0.008	4.78 ± 0.211
Main effects:								
Effect of irrigation								
10 times/day			0.79[b]	1.04[b]	0.83[b]	0.38[b]	2.4[a]	4.62[a]
15 times/day			1.62[a]	1.37[a]	0.92[a]	0.49[a]	1.7[b]	4.87[a]
Effect of concentration								
Control			1.3[a]	1.2[a]	0.81[b]	0.40[b]	1.8[b]	4.5[a]
75mg/L			1.2[b]	1.2[a]	0.92[a]	0.42[a]	1.6[b]	4.7[a]
100mg/L			1.03[c]	1.2[a]	0.89[a]	0.49[a]	2.6[a]	4.9[a]
Effect of Methods								
A			1.3[a]	1.19[a]	0.89[a]	0.47[a]	2.3[a]	4.71[a]
S			1.1[b]	1.23[a]	0.86[a]	0.40[a]	1.8[b]	4.7[a]
Probability								
L			0.0001	0.0001	0.0001	0.0003	0.00001	0.2945
C			0.0001	0.9436	0.0001	0.046	0.00001	0.4022
M			0.0001	0.5551	0.0781	0.0183	0.00001	0.7495
L*C*M			0.0001	0.0418	0.0001	0.0694	0.00001	0.5155

Where:* Fresh weight bases, A= Addition, S= Spray, L_i = effect of irrigation (i = 1, 2), C_j = effect of concentration (j = 1, 2, 3), M_k = effect of methods (k = 1, 2), LCM_{ijk} = Interactions between i irrigation, j concentration and k methods.

Table (5): Effect of nicotinamide on photosynthetic pigments of Lavender herbage (first cut)

Irrigation	NA concentration	Methods	% Chl.a*	% Chl.b*	% Carotenes*	% Chl.(a+b)*	Chl.a/b	% Total Pigments*
10 times/day	control	Addition	0.137 ± 0.003	0.077 ± 0.003	0.053 ± 0.003	0.2137	1.786	0.2667
		Spray	0.137 ± 0.003	0.077 ± 0.003	0.053 ± 0.003	0.214	1.779	0.267
	75mg/L	Addition	0.183 ± 0.007	0.087 ± 0.009	0.110 ± 0.012	0.27	2.103	0.38
		Spray	0.113 ± 0.009	0.067 ± 0.003	0.033 ± 0.003	0.18	1.687	0.213
	100mg/L	Addition	0.160 ± 0.006	0.087 ± 0.003	0.060 ± 0.006	0.247	1.839	0.307
		Spray	0.150 ± 0.023	0.070 ± 0.012	0.033 ± 0.003	0.22	2.143	0.253
15 times/day	control	Addition	0.200 ± 0.000	0.110 ± 0.006	0.133 ± 0.009	0.31	1.818	0.443
		Spray	0.200 ± 0.000	0.110 ± 0.006	0.133 ± 0.009	0.31	1.818	0.443
	75mg/L	Addition	0.090 ± 0.006	0.057 ± 0.003	0.023 ± 0.003	0.147	1.579	0.17
		Spray	0.147 ± 0.003	0.073 ± 0.003	0.050 ± 0.000	0.22	2.014	0.27
	100mg/L	Addition	0.090 ± 0.000	0.050 ± 0.000	0.030 ± 0.000	0.14	1.800	0.17
		Spray	0.140 ± 0.006	0.070 ± 0.010	0.093 ± 0.003	0.21	2.000	0.303

Main effects

Effect of irrigation			
10 times/day	0.14[a]	0.077[a]	0.057[b]
15 times/day	0.14[a]	0.078[a]	0.077[a]
Effect of concentration			
control	0.16[a]	0.093[a]	0.093[a]
75mg/L	0.13[b]	0.070[b]	0.054[b]
100mg/L	0.13[b]	0.069[b]	0.054[b]
Effect of Methods			
A	0.14[a]	0.077[a]	0.066[a]
S	0.14[a]	0.077[a]	0.066[a]
Probability			
L	0.6393	0.7546	0.0001
C	0.0001	0.0001	0.0001
M	0.3519	1.000	0.5054
L*C*M	0.0001	0.0001	0.0001

Where:* Fresh weight bases, A= Addition, S= Spray, L_i = effect of irrigation (i = 1, 2), C_j = effect of concentration (j = 1, 2, 3), M_k = effect of methods (k = 1, 2), LCM_{ijk} = Interactions between i irrigation, j concentration and k methods.

Table (6): Effect of nicotinamide on photosynthetic pigments of Lavender herbage (second cut)

Irrigation	NA concentration	Methods	% Chl.a*	% Chl.b*	% Carotenes*	% Chl.(a+b)*	Chl.a/b	% Total Pigments*
10 times/day	control	Addition	0.12 ± 0.015	0.077 ± 0.007	0.047 ± 0.007	0.197	1.558	0.244
		Spray	0.12 ± 0.015	0.077 ± 0.007	0.047 ± 0.007	0.197	1.558	0.244
	75mg/L	Addition	0.15 ± 0.015	0.08 ± 0.006	0.06 ± 0.006	0.230	1.875	0.29
		Spray	0.127 ± 0.033	0.077 ± 0.032	0.04 ± 0.006	0.204	1.649	0.244
	100mg/L	Addition	0.14 ± 0.01	0.07 ± 0.00	0.057 ± 0.003	0.210	2.000	0.267
		Spray	0.13 ± 0.00	0.07 ± 0.00	0.053 ± 0.003	0.200	1.857	0.253
15 times/day	control	Addition	0.117 ± 0.018	0.077 ± 0.022	0.05 ± 0.006	0.194	1.519	0.244
		Spray	0.117 ± 0.018	0.077 ± 0.022	0.05 ± 0.006	0.194	1.519	0.244
	75mg/L	Addition	0.16 ± 0.017	0.08 ± 0.012	0.06 ± 0.006	0.240	2.000	0.3
		Spray	0.117 ± 0.003	0.067 ± 0.009	0.05 ± 0.00	0.184	1.748	0.234
	100mg/L	Addition	0.15 ± 0.00	0.093 ± 0.003	0.05 ± 0.006	0.243	1.613	0.323
		Spray	0.13 ± 0.017	0.08 ± 0.00	0.053 ± 0.009	0.210	1.625	0.283
Main effects								
Effect of irrigation								
10 times/day			0.131^{a}	0.075^{a}	0.050^{a}			
15 times/day			0.131^{a}	0.078^{a}	0.057^{a}			
Effect of concentration								
control			0.118^{a}	0.076^{a}	0.048^{b}			
75mg/L			0.138^{a}	0.076^{a}	0.052^{b}			
100mg/L			0.137^{a}	0.076^{a}	0.060^{a}			
Effect of Methods								
A			0.139^{a}	0.079^{a}	0.058^{a}			
S			0.123^{b}	0.074^{b}	0.048^{b}			
Probability								
L			0.9526	0.5318	0.0536			
C			0.1607	0.967	0.0153			
M			0.0859	0.5385	0.0056			
L*C*M			0.8957	0.9592	0.2007			

Where:* Fresh weight bases, A= Addition, S= Spray, L_i = effect of irrigation (i = 1, 2), C_j = effect of concentration (j = 1, 2, 3), M_k = effect of methods (k = 1, 2), LCM_{ijk} = Interactions between i irrigation, j concentration and k methods.

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بعض التغيرات الكيميائية لنبات اللافنديولا المعامل بواسطة النيكوتين أميد

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تناول هذا البحث دراسة أمكانية زراعة نبات اللافندرفي ببيئة البرليت بدلاً من التربة العادية.حيث عُومِلت النباتات (بعد تقسيمها إلي أثنَتَي عشرةَ مجموعة كل مجموعة بها ثلاثة مكررات) بواسطة ثلاثة تركيزات من النيكوتين أميد كمنظم نمو طبيعي (فيتامين ب5) (0 و 75 و 100 جزء في المليون) عن طريق الرش أو الأضافة إلي المحلول المغذي وذلك بمعدلين رش ورقي أو ري مختلفين (10 و 15 مرة في اليوم) تم أخذ حشتين من الأعشاب النامية تحت هذه الظروف بمعدل حشة كل ستة أشهر. تم إجراء بعض القياسات الخضرية للتعرف علي جودة النمو مثل أرتفاع النبات ، عدد الأشطاء ، الوزن الطازج ، و المادة الجاف. كما تم دراسة بعض التغيرات الكيميائية في كلا من الحشتين مثل نسب البروتين الخام ، الكربوهيدرات الكلية ، الفسفور والنيتروجين و البوتاسيوم ، الفينولات الكلية ، بالأضافة الي صبغات البناء الضوئي (كلوروفيل ا و ب ، الكاروتينات).

وكانت أهم النتائج المتحصل عليها كما يلي:

- كانت معدلات الري المنخفضة (10 مرات / يوم) كافية تماماً للحصول علي قيم معنوية عالية لأرتفاع النبات و الوزن الطازج مع أقل عدد أشطاء في كلا من الحشتين مقارنتاً بمعدل الري المرتفع (15 مرة / يوم).
- أظهرت أعشاب الحشة الأولي و التي عُومِلت بالنيكوتين أميد بتركيز 75 جزء في المليون أعلي قيم للوزن الطازج مع أنخفاض أرتفاع النبات بصور واضحة و لكن مع زيادة عدد الأفرع لكل نبات مقارنتاً بالكنترول.
- إضافة النيكوتين أميد بتركيز 75 جزء في المليون للمحلول المغذي و بمعدل 10 مرات / يوم أدت إلي زيادة معنوية في الوزن الطازج للحشة الأولي مقارنتاً بالرش الورقي لنفس التركيز و نفس معدل الري.
- حدثت زيادة معنوية في نسب كلاً من البروتين الخام ، النيتروجين ، و الفسفور وذلك بزيادة معدل الري من 10 إلي 15 مرة / يوم في كلا من الحشتين.
- في الحشة الأولي كانت التغيرات في نسب المواد الكربوهيدراتية الكلية ، الفينولات الكلية ، و الكلوروفيلات (أ و ب) غير معنوية لكن في البوتاسيوم حدث إنخاض معنوي و زيادة ملموسة في نسبة الكاروتينات عند معدل ري 15 مرة / يوم.

- أدت المعاملة بالنيكوتين أميد إلي حدوث إنخفاض معنوي في نسب الكربوهيدرات و الفينولات الكلية في الحشة الثانية و لم يحدث تغيير معنوي في مستويات كلاً من البوتاسيوم و صبغات البناء الضوئي.
- أدت المعاملة بالنيكوتين أميد (بتركيزات 75 و 100 جزء في المليون) إلي حدوث زيادة معنوية في نسبة الفسفور في كلاً من الحشتين بينما زادت نسبة البوتاسيوم في الحشة الأولي المعاملة بالنيكوتين أميد بتركيز 100 جزء في المليون.
- أدت المعاملة بالنيكوتين أميد إلي حدوث إنخفاض معنوي في نسب صبغات البناء الضوئي في الحشة الأولي بينما أظهرت الكلوروفيلات (أ و ب) تغيرات معنوية في الحشة الثانيةبينما أدت المعاملة بالنيكوتين أميد بتركيز 100 جزء في المليون) إلي حدوث زيادة معنوية في نسبة الكاروتينات في نفس الحشة.

و أهمية هذا البحث تمثلت في التعرف علي أفضل ظروف نمو نتيجة المعاملات السابقة لأنتاج أعشاب اللافندر والتي تُستخدم في إستخلاص زيوتها العطرية ذات القيمة الطبية و العلاجية العالية.

قام بتحكيم هذا البحث:ا. د. محمد فتحي عبد الحميد و ا. د. مصطفي إبراهيم ثروت