Journal homepage www.jzs.univsul.edu.iq
Journal of ZankoySulaimani
Part-A- (Pure and Applied Sciences)

Effect of some local compost mixtures and nitrogen fertilizer on the growth, yield and oil content of marjoram (*Origanum majorana* L.) plant

Yousif Hussen Hammo[1], Zainab Sabah Lazim[2] & Zhala Muhammad Ahmad[2]

[1] *College of Agriculture and Forestry - Duhok University, Duhok-Iraq.*
[2] *College of Agriculture- Sulaimani University Bakrajo Street, Sulaimaniyah-Iraq.*
E-mail: yousif.hammo@uod.ac, zaynab.lazim@univsul.edu.iq and zhala.ahmad@univsul.edu.iq

Article info

Original: 23/12/2017
Revised: 08/01/2018
Accepted: 06/02/2018
Published online:

Key Words:
Origanum majorana L Nitrogen fertilizer
Local compost

Abstract

This factorial experiment was carried out during spring season 2014 at the Department of Horticulture, College of Agricultural Sciences, University of Sulaimani, to study the influence of three concentrations of nitrogen fertilizer (0, 100, 200 mg.L^{-1}N) and four kinds of growing media (A1=100% river soil without local composet), (A2= 25% local compost: 75% river soil), (A3= 50% local compost: 50% river soil) and (A4=75% local compost: 25% river soil) on the growth, yield and volatile oil of Majoram (*Origanum majorana* L). The experiment was conducted in Randomized Complete Block Design with three replications; means were compared according to Duncan's test ($P \leq 0.05$). The results showed that plants fertilized with(100 and 200 mg.L^{-1}N) gave significant increases in plant high, growth index, vegetative dry weight, volatile oil percentage, volatile oil yield and (N%, P%, K%) compared to the control. On the other side, the plants that planted in A3 and A4 media showed significant increases in plant height, growth index, vegetative dry weight, root dry weight, volatile oil percentage, volatile oil yield and (N%, P% and K%) compared to A1 and A2. Regarding to the interaction between nitrogen fertilization and media there were significant effects on all vegetative characters and chemical characters, especially the effect of combinations between 100 mg.L^{-1}N and A3 composed media (50:50 local compost + river soil).Which was predominated all other combinations.

Introduction

Marjoram (*Origanum majorana*) is one of the most commercially important medicinal and aromatic plants, this plant is a perennial herb belonging to Lamiaceae family which was known to the ancient Egyptians and is still widely cultivated today in its native and also in the Mediterranean countries. It's uses not restricted only to add flavor to meat dishes and in making salamis and other sorts of sausages, but also as a miraculous herb with the power to heal practically various diseases, moreover their essential oils which contain up to 2%, possess biological activity notably as antibacterial, antifungal as well as antioxidant properties***[1], [2]***and ***[3].*** The active oil ingredients act as digestion, relieve flatulence and as an intestinal antispasmodic, and also stimulate the secretion of bile ***[4].***

Organic fertilization is a very important method of providing plants with their nutritional requirement without having undesirable impacts on the environment, so as to produces the safe and the best product in both quality and quantity for medicinal and aromatic plants, it is very important to use the organic manures (compost) ***[5].*** El- Ghabdan et.al., (2002) ***[6]***found that soil amended with the highest level of compost 37m^3/ha and a mixture of N_2- fixing bacteria showed increments in plant growth characters on marjoram plants. Also, Mahfouz (2003) ***[7]***found that, the best plant height, number of branches, fresh and dry weights of roots of Marjoram were recorded for the treatment of full dose of N and P and biofertilizer than the control plants. Moreover, Dewider (2007) ***[8]***found that the combination between compost and biofertilizers increased plant fresh and dry weights in the fourth cuts of marjoram plants compared to the other treatments.

Also it was found that the highest values of essential oil percentage of *Origanum majorana* appeared with chemical fertilization, while the highest yield of the essential oil per feddan was observed in treatment of biofertilization combined with full dose of organic manure or chemical fertilization treatment ***[9]***. Kandeel and Sharaf (2003) ***[10]***stated that the highest oil percentage and oil yield/ha of marjoram plants were obtained with plants inoculated pre-sowing with three bacterial partners (biological fertilizers) and half of the recommended field rate of the inorganic N, P and K fertilization, and it was indicated that the application of organic manure (farmyard manure and poultry manure at a rate of 75 m^3/ha as fertilizer of each as an organic fertilizer to marjoram plants recorded the maximum values of herb fresh and dry yield, N, P and K contents, volatile oil percentage, oil yield per plant and per hectare, while in the late cut, the highest values in this respect were obtained by farmyard manure application ***[11]***. The goal of this project was to evaluate the effect of local compost mixtures and nitrogen fertilizer on marjoram growth, yield and volatile oil and to find if the using of organic compost will minimize N doses as much as possible in condition of improving the growth and the yield at the same time .

Materials and methods

The experiment was carried out in the greenhouse of Agriculture College/ University of Sulaimani during the season (2014) to study the influence of local compost and nitrogen fertilizer on the growth, yield and volatile oil of marjoram (*Origanum majorana* L.). Seeds which were obtained from the herbal grocery in Baghdad were planted in trays by using peatmoss as agriculture media. After one month and at the 1st of Oct., the seedlings were transplanted in 15cm diameter pots each pot obtained one treatment wich was a combination between four composts namely; [0% local compost: 100% river soil (A_1), 25% local compost: 75% river soil (A_2), 50% local compost: 50% river soil (A_3), and 75% local compost: 25% river soil (A_4)] as the first factor with either (0, 100 or 200) mg L^{-1}N as the second factor levels in the form of urea which added every month .

The local compost mixtures which were produced in the field of Agriculture College in Sulaimani University, consisted of equal volumes of (animals manure: saw dust: hay: leave mold: lawn clipping) and prepared by mixing the main components of the media in polyethylene black bags then adding some catalysts or stimulants (50g dry yeast bread, 500g urea, and 500g table sugar) per each cubic meter, then watered and closed tightly with constant stirring every two weeks, and after three months, the fermentation media become ready to be used as amendment to the growing media in the previous percentages. Some chemical properties of the compost were determined as shown in the table below:-

Table-1: Some chemical characteristics of the media.

Media	***Local compost %***	***pH***	***EC ds.m^{-1}***	***$CaCO_3$%***	***N mg.l^{-1}***	***K mg.l^{-1}***	***P mg.l^{-1}***	***Organic mater***
A_1	***0% compost: 100% River soil***	*7.8*	*0.4*	*20*	*600*	*47*	*19*	*1.17*
A_2	***25% compost: 75% River soil***	*7.8*	*0.4*	*14*	*800*	*109*	*75*	*1.4*
A_3	***50% compost: 50% River soil***	*7.8*	*0.5*	*11*	*770*	*192*	*129*	*1.62*
A_4	***75% compost: 25% River soil***	*7.9*	*0.5*	*10*	*850*	*210*	*149*	*1.75*

The experiment was laid out according to Randomized Complete Block Design with 12 treatment combinations and three replicates i.e. 36 pots with two plants for each one. The following data were recorded, plant height (cm), number of branches/plant, vegetative dry weight(g), growth index (cm^3) according to ***[12]***, and growth index according to the equation :-

$$\text{Growth index } (cm^3) = 3.14\{[(\text{less width} + \text{large width of plant})/2]/2\}^2 \times \text{plant height}$$

Total chlorophyll (mg. 100gm^{-1} F.W.) using spectrophotometeric method ***[13]***, volatile oil percentage which was extracted by water distillation(Modified Clevenger method) and then dried over anhydrous sodium sulphate and determined according to ***[14]*** and the oil yield per plant was calculated according to the equation :

The amount of volatile oil (g)/plant = production plant leaf green * Percentage of volatile oil

Data analyzed statistically; using SAS program, mean values were compared by Duncan's multiple range test at (P≤0.05) ***[15].***

Results

1. Vegetative growth characteristics

The nitrogen fertilization as shown in table (2) caused significant increases in plant height, growth index and vegetative dry weight. The highest significant percentages (13.87, 14.3%) (13.88, 14.29%) and (11.64, 8.02%), respectively were obtained when the plants were fertilized with (100 and 200 mg.L^{-1}N), respectively in comparison with control, on the other hand, the root dry weight was not affected as a result of nitrogen treatments.

On the other side, the plants that grown in A_3 and A_4 media showed significant increases in plant height, growth index, vegetative dry weight and root dry weight as shown in table (2) and the highest percentages (37.18, 33.60%), (37.17, 33.61%), (44.85,40.37%) and (60.08, 69.38%), respectively in A_3 and A_4 were resulted in comparison with control and A_2. The interaction between nitrogen fertilization and media had significant effect on all vegetative characters especially plants that grown in A_3 media and fertilized with (100 mg.L^{-1}N), the highest percentage of there increases in plant height (58.99%), growth index (58.98%) and vegetative dry weight (64.94%) were observed in comparison with control, however, the highest value of root dry weight (5.09gm) was obtained from non-fertilized plants grown in A_3 media.

Table- 2: Effect of media and nitrogen fertilizer on some growth characters of marjoram plant.

Characters		***nitrogen concentrations (mg.L^{-1})***			***media***
	Media	***0***	***100***	***200***	***effect***
Plant height (cm)	*A_1*	*22.68f*	*25.29ef*	*25.78e*	*24.58c*
	A_2	*26.54e*	*30.43cd*	*32.15b-d*	*29.71b*
	A_3	*29.97d*	*36.06a*	*35.14a*	*33.72a*
	A_4	*31.29b-d*	*34.04ab*	*33.21a-c*	*32.84a*
	nitrogen effect	*27.62b*	*31.45a*	*31.57a*	
Growth index (cm^3)	*A_1*	*4005.9f*	*4466.8ef*	*4552.8e*	*4341.8c*
	A_2	*4688.2e*	*5374.1cd*	*5678.5b-d*	*5246.9b*
	A_3	*5292.9d*	*6368.5a*	*6206.0a*	*5955.8a*
	A_4	*5526.0b-d*	*6012.3ab*	*5865.1a-c*	*5801.2a*
	nitrogen effect	*4878.2b*	*5555.4a*	*5575.6a*	
Vegetative dry weight (gm)	*A_1*	*9.07c*	*9.72c*	*10.04c*	*9.61c*
	A_2	*10.88c*	*13.10ab*	*13.26ab*	*12.42b*

	A_3	13.01b	14.96a	13.79ab	13.92a
	A_4	13.45ab	14.02ab	13.02b	13.49a
	nitrogen effect	11.60b	12.95a	12.53a	
Root dry weight (gm)	A_1	2.48b	2.64b	2.62b	2.58b
	A_2	3.66ab	4.08ab	3.59ab	3.78a
	A_3	5.09a	3.96ab	3.35ab	4.13a
	A_4	3.46ab	4.76a	4.89a	4.37a
	nitrogen effect	3.67a	4.86a	3.61a	

A1= 0 local compost: 100 river soil, A2= 25 local compost: 75 river soil, A3= 50 local compost: 50 river soil, A4= 75 local compost: 25 river soil).

2. Chemical characters

The results shown in table (3) confirm that the highest rates of volatile oil percentage, volatile oil yield, nitrogen percentage, phosphorus percentage and potassium percentage were recorded in plants that fertilized with (100 and 200 mg.L^{-1}N) which were: (0.94 and 0.91%), (0.309 and 0.290 ml.$plant^{-1}$), (1.38 and 1.4%), (0.218 and 0.215%) and (1.54 and 1.56%), respectively.

In regard to the effect of different media, the plants that grown in A_4 media predominated compared to other media in the volatile oil percentage, obtained (1.01%). Volatile oil yield (0.342ml.$plant^{-1}$), nitrogen percentage (1.52%), phosphorus percentage (0.243%) and potassium percentage (1.62%) were recorded in plants grown in A_4 media.

Table-3: Effect of media and nitrogen fertilizer on some chemical characters of marjoram plant

characters	media	nitrogen concentrations ($mg.L^{-1}$)			media effect
		0	100	200	
Volatile oil Percentage	A_1	0.69f	0.79d-f	0.77ef	0.75c
	A_2	0.76ef	0.93b-d	0.89b-e	0.86b
	A_3	0.87c-e	0.99a-c	0.92b-d	0.92b
	A_4	0.92b-d	1.03ab	1.09a	1.01a
	nitrogen effect	0.81b	0.94a	0.91a	
Volatile Oil yield (ml $plant^{-1}$)	A_1	0.155c	0.191c	0.192c	0.179c
	A_2	0.207c	0.308ab	0.297ab	0.271b
	A_3	0.282b	0.370a	0.317ab	0.323a
	A_4	0.309ab	0.363a	0.354ab	0.342a
	nitrogen effect	0.238b	0.309a	0.290a	
Nitrogen percentage	A_1	1.06e	1.16de	1.22d	1.15d
	A_2	1.17de	1.37c	1.36c	1.30c
	A_3	1.35c	1.45bc	1.40c	1.40b

	A_4	1.38c	1.55ab	1.62a	1.52a
	nitrogen effect	1.24b	1.38a	1.40a	
Phosphorus percentage	A_1	0.150f	0.163ef	0.170e	0.161d
	A_2	0.190d	0.220c	0.220c	0.210c
	A_3	0.217c	0.233bc	0.223c	0.224b
	A_4	0.223c	0.250ab	0.260a	0.243a
	nitrogen effect	0.195b	0.218a	0.215a	
Potassium percentage	A_1	1.24g	1.35e-g	1.42d-f	1.33c
	A_2	1.31gf	1.531b-d	1.526b-d	1.46b
	A_3	1.513b-d	1.620a-c	1.571bc	1.57a
	A_4	1.48c-e	1.66ab	1.74a	1.62a
	nitrogen effect	1.39b	1.54a	1.56a	

(A_1= 0 local compost: 100 river soil, A_2= 25 local compost: 75 river soil, A_3= 50 local compost: 50 river soil, A_4= 75 local compost: 25 river soil)

The interaction between the levels of the two factors showed a positive linear trend and significant increases in volatile oil percentage, nitrogen percentage, phosphorus percentage and potassium percentage, which were (57.97%), (52.83%), (73.33%) and (40.32%), respectively were noticed in A_4 and 200mg.L^{-1}that relatively compared with control. In another hand the plants that grown in A_3 media and fertilized with (100mg.L^{-1}N) gave the highest increase percentage in volatile oil yield (138.71%) compared with control.

Discussion

The increase in marjoram plant height due to application of local compost might be attributed to the effect of organic fertilizer that improves physical, chemical, and biological properties of soil; that is, increasing soil organic matter, cation exchange capacity, and water holding capacity and availability of mineral nutrients and, this in turn, increases plant height. These results are in harmony with those obtained by ***[16]*** and ***[17]*** on marjoram, they indicated that fertilization with organic manures at the highest rate increased plant growth.

Similar trends were observed with N, P and K uptake because N, P and K uptake by marjoram were greater with dual application of biofertilization and organic manure than sole treatments with chemicals ***[9].*** El- Ghabdan et.al., (2002) reported that marjoram treatment with compost and nitrogen fertilizer led to an increase in macro-nutrients uptake ***[6]***. These increases might be related to the synergistic effects of compost and microorganisms on micro-nutrients production and availability to crops. Furthermore, it can be explained as a result of the increase of the permeability of plant membranes due to humate application which caused in improve growth of various groups of beneficial microorganisms, accelerate cell division, increased root growth and all plant organs for a number of horticultural crops***[18]***.

The positive result for nitrogen fertilizer might explained due to the largely levels of nitrogen that use in this experiment which is largely used for protein synthesis and had favorable effect on cell elongation and multiplication resulting in increased plant height. Also they might be returned to a consequence of nitrogen influence on photosynthesis, the amount of photo assimilates that are produced by dry matter partitioning then organs development ***[19], [20]*** and ***[21],*** or might be explained by the important role of nitrogen in the synthesis of the plant constituents and limiting the conditions which increase the volatile oil production in annual herbal ***[22].***

References

[1] Baratta, M. T., Dorman, H. J. D., Deans, S. G., Figueiredo, A. C. Barroso, J. G. and Ruberto, G. "*Antimicrobial and antioxidant properties of some commercial essential oils*" Flavour Fragrance J., Vol.(13), pp.235-244. (1998).

[2] Tiziana, B. M. and Dorman, D. H. J. "*Antimicrobial and antioxidant properties of some commercial oleoresin*", Flavor and Fragrance J., Vol.(13), pp.235-44. (1998).

[3]Verma, R., Verma, R. K., Chauhan, A. and Yadav, A. "*Changes in the essential oil composition of Major anahortensis Moench.cultivated in India during plant ontogeny*", J. Serb. Chem. Soc., Vol.(75), No.4, pp. 441-447. (2010).

[4] Frantisek, S. and Voclav, G. "*A concise guide in colour herbs*": Designed and produced by Artia for the Hamlyn publishing Group Limted, London, New York, Sydney and Toronto, P. 148. (1975).

[5] El-Sayed, A.A., Aly, M.K. and Abd El-Gawad M.H. "*Response of coriander plants to some phosphorus, zinc and yeast treatments*" : Proceedings of the 2nd International Conference of Horticulture Science,Kafr El-Sheikh, Tanta Univ. Egypt, 434-446. (2002).

[6] El-Ghadban, E. A., Ghallab, E. A. M. and Abdelwahab, A. F. "*Effect of organic fertilizer (Biogreen) and biofertilization on growth, yield and chemical composition of Marjoram plants growth under newly reclaimed soil conditions*", 2nd Congress of Recent Technologies in Agriculture, pp. 334-361. (2002).

[7] Mahfouz, S. A. S. "*Effect of biofertilization on growth and oil production of marjoram (MajoranahortensisMoench.) plant*", Ph. D. Thesis, Fac. Agric., Cairo Univ. (2003).

[8]Dewidar, A. A. A. "*Post-harvest studies on some aromatic plants*", Ph.D. Thesis, Fac. Agric., Kafr El-Sheikh Univ., Egypt. (2007).

[9]Zaghloul, R.A., El-Husseiny, T.M., Hanafy, E. A., Rahal, A. G. and Abdelrahman, H.M. "*Effect of Biofertilization and Organic Manuring on Soil Dehydrogenase Activity, Macronutrients and Essential Oil Content of Marjoram*", Egypt. J. Microbiol.Special Issue."13th Conf. of Microbiol.", pp. 15-32. (2010).

[10]Kandeel, A. M. and Sharaf, M. S. "*Productivity of Majoranahortensis, L. plants as influenced by the interactions between mineral and biological fertilization*" J. Agric., Sci., Mansoura Univ., Vol.(28), No.2, pp.1373. (2003).

[11]Al-Fraihat, A. H., Al-Dalain, Y. A. S., Al-Rawashdeh, Z. B., Abu-Darwish, M. S. and Al-Tabbal, J. A. "*Effect of organic and biofertilizers on growth, herb yield and volatile oil of marjoram plant grown in Ajloun region, Jordan*" Journal of Medicinal Plants Research, Vol.(5), No.13, pp. 2822-2833. (2011).

[12]Hidalgo, P. "*Earthworm castings as a substrate amendment for poinsettia and chrysanthemum production*", Ph.D. dissertation, Mississippi State University, Mississippi State, MS. USA. (2001).

[13]Wintermans, J. F. G. and Demots, A. "*Spectrophotometery characteristics of chlorophyll (a) and (b) and their phenophytins in ethanol*", *Bio chem. Bio phys. Acta.,* Vol.(109), pp. 448-453. (1965).

[14] Guenther , E. "*The Essential Oil*": Vol. V. R. E. Krieger publishing Company, Huntyngton , New York . PP. 350 .U.S.A.1975 .

[15] SAS. "*Statistical Analysis System"*, SAS Institute Inc., Cary, Nc. USA. (2001).

[16] El-Ghadban, E.A. E. "*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. (1998).

[17] Abo, M.A.I. "*The effect of organic and bio-fertilization sources on the growth and active constituents of Majoranahortensis L*", plant. MSc Thesis, Fac. Agric., Al-Azhar Univ. (2008).

[18]Pioncelot, R.P. 1993.The use of a commerical organic biostimulant for bedding plant production J.

[19]Panchabhai, D. M., Bachkar, B. R., Ghawade, S. M. and Wankhade, S. G. "Effect of nitrogen and phosphorus on growth and seed yield of Ashwagandha (*Withaniasomnifera* L.)", Orissa Journal of Horticulture, Vol.(33), No.1, pp.11-15. (2005).

[20]Dordas C. "*Dry matter, nitrogen and phosphorus accumulation, partitioning and remobilization as affected by N and P fertilization and source sink relations*", Eur. J. Agron., Vol.(30), pp.129-139. (2009).

[21] Dordas, C.A., Las, S., M. T., B. N. "*Application of liquid cattle manure and inorganic fertilizers affect dry matter, nitrogen accumulation, and partitioning in maize*", Nutr.Cycl.Agroecosyst., Vol.(80), pp. 283-296. (2008).

[22] Jones, I. B., Wolf. B. and Milles, H. A. "*Plant analysis handbook*": Macro- Micro Publishing. Inc., pp. 213. (1991).