UNDER PEER REVIEW

Original Research Article

Comparative of the yield and essence of peppermint (*Mentha piperita* L.) at first and second harvest time under the effect of organic and chemical fertilizers

Abstract:

This study compared organic and chemical fertilizers on qualitative yield and essence amount of peppermint. The experiment was carried out as randomized complete design in agricultural farm center, Sari, at 2013. ~~There are 7 treatments and 4 replications at the present study.~~ ~~Treatment~~ were included as control, vermi-compost, composed sheep manure and basic chemical fertilizers ~~which are~~ N60, P50, K60; N60,P80,K60; N90,P50,K80 and N90,P80,K80. The results showed that ~~the~~ all measured characteristics were influenced by both organic and chemical fertilizers at the ~~both~~ two harvest time ~~which had significant difference compared to the control, statistically.~~ The values of the ~~all measured~~ quantitative and qualitative characteristics were also more at the first harvest ~~time~~ than the second harvest ~~time~~. At the first harvest ~~time~~, the maximum value of ~~the~~ dry and wet yield and the maximum value and yield of the essence were attained by using chemical fertilizers at the rate of N90,P80,K80 ~~and sheep manure, respectively~~. At the second harvest time, ~~the~~ all measured properties such as dry and wet yield and the amount of the essence and essence yield were ~~obtained~~ by vermi-compost; ~~is because of gradual composition and release the nutrients of vermi-compost at this time. Thus, to obtain the maximum value and yield of the essence of the peppermint as medicine plant, the use of vermin-compost is recommended under the climate condition of the studied region.~~

Key words: ~~Organic and chemical fertilizer, Yield, Essence, Peppermint.~~

UNDER PEER REVIEW

Introduction

At the present century, so many researches have been done on medicine plants which could be produced new plant medicines. Peppermint is one of the restricted medicine plants that its remedy range on the human healthy is more than others. An effective material of peppermint plant is included essence as essential oil (%1-2), Tanon, Flavonoid, Colien and bitter materials. Medicine effects of this plant is concerned to chemical compounds of essence in leaves which is more than 20 types such as Menthol (%40-60), Menthofuran, Menthone, Piperitone, Pulygone and Cineole. So, the factors which affect on the essence content of the plant; must be attended as growth restricted factors like warm or cool stresses, nutrient deficiency into the soil, water deficiency and etc. (Omidbeygi, 2000). One of the most important programs in the management of crop plant cultivation especially in medicine plants cultivation is investigation of the plant nutrition. An adequate nutrient and water supply into the soil is needed to healthy growth and produce more effective materials for medicine plant especially aromatic and essence-bearing plants like peppermint. Among the essential elements macro and also micronutrients such as N, P, K, S, Fe and Zn are necessary to suitable growth and increase essence content and wet or dry yield of medicine plants. To provide these essential elements, not only chemical fertilizer but also the use of manure fertilizers is recommended which are included macro and also micro nutrients. (Qasempour Alamdari, 2004). About %30 of the agricultural soils of the world face the lack of micro-elements. In addition to the frequent use of super-phosphate fertilizers the plantation at short intervals also causes a decrease in the density of micronutrients in arable soils. The plant growth is also affected in soils deficient in micronutrients even the use of N, P and K fertilizers cannot help in increasing the plant yield. By observing the plant growth one can evaluate the micronutrient deficiency. Each element has a role in the plant nourishment and certain types of crop plants are susceptible to stunted growth if the required micronutrients

UNDER PEER REVIEW

are not made available. Mehrafarin and et al. (2011), reported that the maximum wet and dry yield of peppermint was attained when nitroxin fertilizer as bio-fertilizer applied at the rate of 8 kg ha^{-1}. Niyakan and et al. (2004), resulted that the use of both nitrogen and phosphorous fertilizers increase essence content and also leaf surface of the peppermint plant. Mahmood and et al. (2009) reported that the use of nitrogen fertilizer as urea and phosphorous as P_2O_5 increased dry matter and essence yield this plant. Daramol (2011) expressed that biomass yield and dry weight of peppermint increased by using compost and manure fertilizer at the rate of 1-2 kg and 250-500 g per pot, respectively. The use of chemical fertilizers in the arable soils of the world is imbalanced and does not take into account the actual necessary need of the crop plant or the nature of the soil. Regarding to the effects of macro and micro-nutrients on the medicine plants cultivation and qualitative and quantitative characteristics of effective substances especially essence, the present research is devoted more to the study of chemical and manure on yield and essence content of peppermint plant.

Materials and Method:

The present experiment was done in Sari agricultural farm, Dodangeh region (long. 52^0 15' E. to lat. 36^0 15' N), in northern part of Iran at 2013, where the general altitude is about 705 m above the sea level. The mean precipitation and daily mean temperature during growth season of peppermint plant in the studied region is 94.5 mm and 31.19 ^{0}C, respectively. The experiment was carried out as randomized complete design with 7 treatments and 4 replications. Treatment were included as control, vermin-compost, composed sheep manure and basic chemical fertilizers which are N60,P50,K60; N60,P80,K60; N90,P50,K80 and N90,P80,K80. Initially, the studied soil and sheep and vermin-compost (as plant sources) fertilizers were tested at laboratory to determine the element contents and other their chemical and physical properties which are shown in Table 1.

Table 1. Element content and chemical and physical properties of the studied soil, sheep and vermi-compost fertilizers.

Soil Texture	Cu (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Mg (%)	Ca (%)	N (%)	K (ppm)	P (ppm)	Organic Carbon (%)	Organic matter (%)	pH	E.C (mmohs /cm)	Base Saturation (%)	Depth	Properties
Sand-Loam	0.7	2.6	11.3	15.1	0/04	-	0.128	137	14.3	1.28	2.2	7.4	3.5	40	30-0	**Soil**
-	21	43	428	12.5	0/41	2.32	1.1	0.28	0.44	14.2	24.42	7.42	5.25	-	-	**Vermi-compost**
-	19	25	290	1110	0/36	1.32	2.1	2.79	0.46	28.2	48.5	7.56	25.3	-	-	**Sheep**

UNDER PEER REVIEW

All studied plants as seedling were cultivated into the pots (size 30*40cm^2) ~~on~~ May 2013 ~~which~~ located on the farm (outdoor condition). Each pot was ~~included~~ 10 kg soil and chemical fertilizer (were chosen as treatments) ~~and~~ sheep and vermi-compost fertilizers (both at the rate of 20 ton ha^{-1} equals 80 g per pot) were ~~also added in per selected pot as treatment. Then, all the p~~ots were irrigated two times per week and were also weeded out during growth period. First and second harvest~~ing times were done at~~ August and November 2013. All harvested plants were dried under shadow conditions and then 100 ~~gr~~ of it was selected to get essence by ~~Clevenger system~~. Gas chromatography system was also used to determine the essence composition. The measured characteristics ~~at the present study were~~ included wet yield, dry yield, the amount of essence and essence yield at two harvesting times. Data were analyzed ~~following~~ the analysis of variance technique (ANOVA) by ~~using Microsoft-MSTAT-C~~ and the mean differences were adjudged by Dancans' multiple range tests (DMRT) at the level of ~~%~~5 ~~probably~~ (Gomez & Gomez, 1984). ~~Microsoft-Excel was used for drawing graphs.~~

Results and Discussion:

The results showed that ~~the effect of~~ treatments ~~on~~ all the measured characteristics of peppermint was very significant at the first and second harvest~~ing times, statistically~~ (Table 2). It means that all organic and chemical fertilizers increased wet and dry yield and the amount and yield of essence significantly at two harvesting times. Coefficient of variation ~~is~~ less than ~~%~~14 at all the measured characteristics which is showed the experiment was ~~done~~ carefully.

The results showed that nitrogen element existing chemical and inorganic fertilizers ~~affects significantly~~ on all the measured characteristics compared to the control pot. ~~The effect of nitrogen fertilizer on these properties is more than other element which is existing fertilizers.~~ The ~~obtained~~ results ~~at the present~~ study ~~is~~ in agreement with observations by Mahmood ~~and~~

UNDER PEER REVIEW

et al. (2009). They investigated the effect of nitrogen fertilizer on the growth and essence yield of peppermint and announced that dry matter and essence yield was significantly increased when nitrogen fertilizer applied. There is not nitrogen element into the essence composition, but the use of this element causes increasing extraction gland of essence at the leaves of peppermint (Marotti and et al., 2994). It is because of producing and consuming of simple glucoses and increase vegetative growth and developing leaf surface (Brown, 2003).

UNDER PEER REVIEW

Table- 2. Square mean of the effect of chemical and organic fertilizers on wet and dry yield and the amount and yield of essence of peppermint at different harvesting times

S.O.V	Df	Wet yield (first harvest)	Wet yield (second harvest)	Dry yield (first harvest)	Dry yield (second harvest)	Essence amount (first harvest)	Essence amount (second harvest)	Essence yield (first harvest)	Essence (yield second harvest)
Treatment	6	2747722**	6740.3**	33161**	1060.9**	0.7157**	0.0124**	44.365**	0.045**
Error	21	6.16507	23.774	723.21	23.464	0.0395	0.0029	0.9787	0.001
C.V(%)	0	7.22	3.39	6.36	6.61	7.84	13.85	9.11	13.65

**: very significant at the level of %1.

UNDER PEER REVIEW

Comparative of the qualitative and quantitative characteristics of peppermint showed that all the measured characteristics at second harvesting time is less than first harvesting time, statistically (Table 3). It is due to less vegetative growth period, less sunlight and temperature amount and less photosynthesis and gross production at second harvesting time. Regarding to Table 3, the maximum wet (2657 kg/ha) and dry (524 kg/ha) yield of peppermint was obtained by chemical fertilizer as 90-80-90 at first harvesting time. Increasing quantitative yield of peppermint by chemical fertilizer is because of existence of nitrogen element which caused increase vegetative growth, leaf surface and the number of extraction gland. The maximum percentage of essence (3.15) and essence yield (14 liter/ha) was attained by sheep manure at first harvesting time that is because of existence of more microelements in sheep manure compound compared to other fertilizers. Microelements are involved in chemical compound of essence. As it can be seen at Table 3, all the measured characteristics such as wet and dry yield and the amount of essence and its yield were influenced when manure fertilizers applied. The maximum values of these characteristics are related to vermi-compost fertilizer due to existence of more microelements at its compound. This fertilizer will be decomposed and released microelements gradually during first harvesting time that will be more taken up by plant at second harvesting time. On the other word, decomposing and releasing nutrient elements of vermi-compost fertilizer take more time compared to chemical and sheep manure fertilizers. Accordingly, vermi-compost has been affected on peppermint at second harvesting time and increased quantitative and qualitative yield and essence percentage and its yield. Dalvand and et al. (2011) and Mehr-afarin and et al. (2010) have investigated the effect of bio and manure fertilizers on morphological traits and essence amount of peppermint and resulted that these fertilizers increased dry yield and the percentage of essence which is in agreement with the obtained results at the present study. The maximum essence percentage belongs to treatment chemical fertilizer as 90-50-80

UNDER PEER REVIEW

compared to the other chemical fertilizers which is because of existence of more nitrogen and potassium elements in this treatment. These findings are in agreement with those reported by Niyakan and et al. (2004). They reported that wet and dry yield and also the amount of essence were increased using nitrogen and potassium elements at more content compared to the less content. The reason of the effect of nitrogen on wet and dry weight is existence of it in the chemical compound of some molecules like Protein, amino acid and nucleic acid (Zhao and at al., 2006 and Kolata, 1992). So at the first harvesting time, quantitative yield (wet and dry yield) was influenced by chemical fertilizers due to existent of more nitrogen (organic carbon=%28) and potassium content in this fertilizer, and qualitative yield (the amount and yield of essence) was affected when manure fertilizer especially sheep fertilizer was applied which is because of existing much microelements at this fertilizer compared to other ones. Some researchers (Clark and et al., 1999, Singh and et al., 2003, Fernander and et al., 2006, Gerder and et al., 1993 and Arabasi and et al., 2005) expressed that using nitrogen fertilizer the amount of essence of some medical plants will be increased which is in agreement with the result of the present research. According to mean comparison (Table 3), lowering range of the amount of essence of peppermint by chemical fertilizer is more than manure fertilizer at the second harvesting time. It means that the amount of essence at second harvesting time is less than first harvesting time when chemical fertilizer has been used. For example, the amount of attained essence by vermi-compost and chemical fertilizer (as 60-80-60) at second harvesting time has been decreased 1.7 and %2.2 compared to first harvesting time, respectively. As can be seen in Fig.1, mean wet yield of peppermint affected by chemical fertilizer (2430 kg/ha) is 2.5 times more than affected by organic fertilizer (1002 kg/ha) at first harvesting time. Mean dry yield of peppermint affected by chemical fertilizer (463.5 kg/ha) is a little more than affected by organic fertilizer (434.5 kg/ha) at first harvesting time. On the other word, mean dry yield by chemical fertilizer is %20 of mean wet yield; while it is

UNDER PEER REVIEW

%50 for organic fertilizer which is regard able among agronomic and medical plants. It can be concluded that great part of wet weight of peppermint plant which was influenced by chemical fertilizer is included water and dry yield amount will be much lowered after drying. Mean wet and dry yield affected by organic fertilizer is more than chemical fertilizer at second harvesting times, but attained mean dry yield by both organic and chemical fertilizers are about %50 of wet yield.

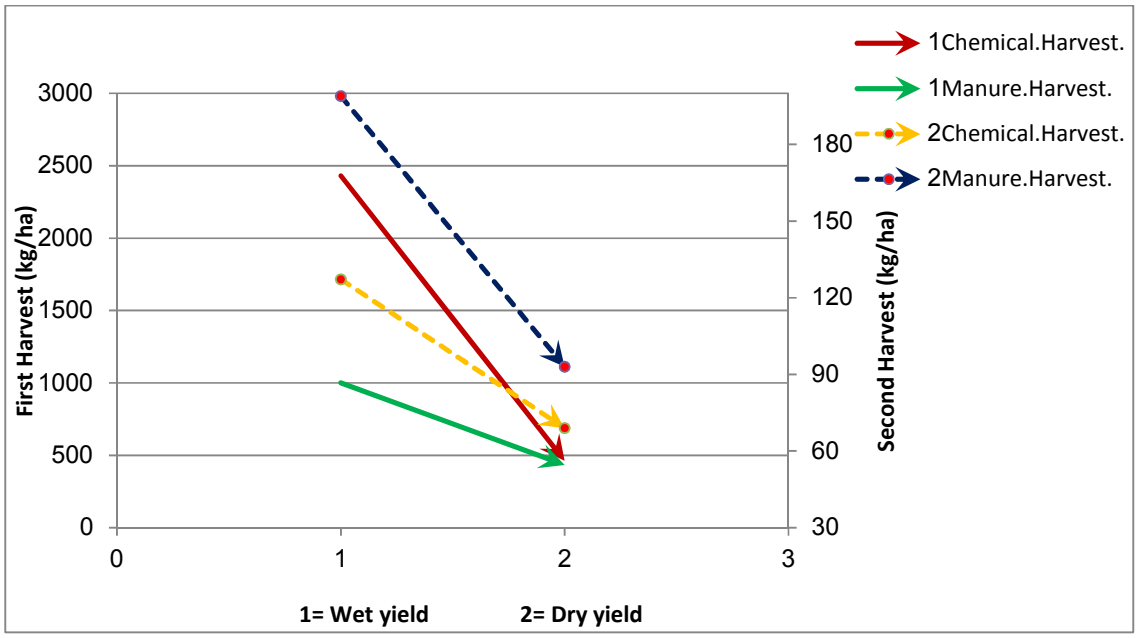
Table-3. Mean comparison of wet and dry yield and the amount and yield of essence of peppermint at different harvesting times under the effect of chemical and organic fertilizers

Measured Traits

Treatments	Wet yield first harvest(kg/ha)	Wet yield second harvest(kg/ha)	Dry yield first harvest(kg/ha)	Dry yield second harvest(kg/ha)	Essence amount first harvest(%)	Essence amount second harvest(%)	Essence yield first harvest(lit/ha)	~~Essence yield second harvest~~(lit/ha)
Control pot	704^{g*}	99^{g}	234g	49.5^{g}	1.85^{g}	0.33^{cde}	4.32g	0.16^{fg}
Vermi-compost	1042^{e}	**207^{a}**	423^{cde}	**96.8^{a}**	2.2^{f}	**0.48^{a}**	9.29^{f}	**0.46^{a}**
Sheep manure	981^{ef}	191^{b}	446^{bc}	90^{ab}	**3.15^{a}**	0.45^{ab}	**14^{a}**	0.41^{ab}
Mean Manure	**1002.5**	**199**	**434.5**	**93.4**	**2.67**	**0.46**	**11.64**	**0.34**
N60-P80-K60	2241^{bcd}	113^{ef}	419^{cdef}	60.8^{f}	2.65^{bc}	0.35^{cd}	11.1^{d}	0.21^{def}
N60-P50-K60	2410^{ba}	136^{d}	432^{cd}	68.8^{de}	2.5^{cde}	0.35^{cd}	10.8^{de}	0.24^{cde}
N80-P50-K90	2414^{b}	145^{c}	479^{b}	76.3^{c}	2.85^{b}	0.38^{bc}	13.6^{ab}	0.28^{c}
N80-P80-K90	**2657^{a}**	115^{e}	**524^{a}**	70.3^{cd}	2.55^{bcd}	0.38^{bc}	12.8^{abc}	0.26^{cd}
Mean Chemical	**2430.5**	**127.25**	**463.5**	**69.05**	**2.63**	**0.36**	**12.07**	**0.24**

~~A given means per each column with the same letters, have not significant difference, statistically ($p<0.05$).~~

UNDER PEER REVIEW



UNDER PEER REVIEW

~~medical and organic plant, the use of vermin-compost is recommended under the climate condition of the studied region.~~

References:

OmidBeygi, R. 2000. Production and processing of medical plants. 2nd valium. 5th Edn. Qods Razavi publication. Mash-had, Iran. (In Persian)

vandi, Y., Sadeqi, A., Asadi, Gh. And Karimi, A., 2011. Effect of Streptomyse and different amount of vermi-compost on yield and essence of peppermint (*Mentha piperita*) under farm condition. Iranian 7th congress of horticulture sciences. http://www.civilica.com/Paper-BAGHBANI07-BAGHBANI07_890.html. (In Press)

Mehrafarin, A., Naqdi Badi, H., Pour hadi, M., Hadavi, A., Qavami, N. and Kadkhoda, Z., 2010. Response of photochemistry and agronomy of peppermint to use of bio-fertilizer and Urea fertilizer. Medical plant Journal. 2(1): 63-74.

Niyakan, M.m Khavarinezhad, R. and Rezaee, M., 2004. Effect of different proportion of basic fertilizers N, P and K on wet and dry weight and leaf surface and essence amount of peppermint (*Mentha piperita*). Iranian aromatic and medical plants research journal. 20(2): 131-148.

pasi, D. and E., Bayram. 2005. The effect of nitrogen fertilization and different plant densities on some Agronomic and Technologic characteristic of (Ocimum basilicum L.). Essential Oil Research 17: 203-205.

Brown L.2006. Mint soil fertility research plant medica. 63 (4):356-9

Brown, B., 2003. Mint soil fertility research in the PNW. Western Nutrient Management Conf. 5 (3): 54-60.

Clark, R.J. and R., Menary. 1999. The effect of irrigation and nitrogen on yield and composition of peppermint oil (*Mentha piperita* L.). Applied-Plant

UNDER PEER REVIEW

Science 62(2): 68-71.

ramol, olumide samuel,2011. Effects of organic fertilizers on growth and yield of MINT(*Mentha piperita*).Department of horticulture.

ander, C.H. 2006. Nitrogen and water management for medicinal and aromatic plants. Acta Horticulture.132 (2): 203-215.

Gerder, H.V., H., Vangelder and N., Mucciarelli. 1993. Influence of nitrogen fertilizer application level on oil production and quality in Mentha spp. Applied Plant Science, 92(2): 68-71.

nez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research (2nd Edn.). John Wiley sons, New York, Chichester, Bribane, Toronto, Singapore.

a, E., Beresniiewicz, A., Krezel, J., Nowosielshi, L., and Slow, O. 1992. Slow release fertlizers on organic carriers as the source of N for vegetable crops production in the open field. Acta- Horticaulhtre 339: 241-249.

od s. Asafar, younis m., al-hassan. 2009. Effect of nitrogen and phosphorus fertilizers on growth and oil yield of indigenous Mint(Mentha longifolia L.). Biotechnology.3.380-384

i, M., Bertea, C.M. and Mucciarelli, M., 2007. Anatomy, Physiology, Biosynthesis, Molecular Biology, Tissue Culture and Biotechnology of Mint Essential Oil Production: 41-87. In: Lawrence, B.M., (Ed.). Mint: the Genus Mentha. Taylor and Francis Publishers, London, 576p.

Marotti, M., Piccaglia R., Crout, W., Craufutd K., and Deans, S., 2004. Effect of planting time and mineral fertilization on peppermint (*Mentha piperita* L.) essential oil composition and its biological activity. Flavor and Fragrance Journal 9(3): 125-129.

, o. Tabara, V. 2011. Research on the quality yield of herbal MINT(Mentha

UNDER PEER REVIEW

viperita L.) under the influence of mineral and organic fertilization in climate condition n S.C.D.A.LOVRIN, Buletinul AGIR nr.

Singh, V.P., Chatterjee, B.N. and Singh, P. 2003. Response of mint species to nitrogen fertilization. Journal of Agricultural Science 113(2): 267-271.

Zhao, j. 2006. The effect of nitrogen fertilization on spearmint. Journal of Essential oil Research. 18: 452-455 .