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The Effect of Vermicompost Application on Growth Characteristics and Essential Oil of Basil (*Ocimum basilicum* L.)

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ABSTRACT

In accordance to evaluating different levels of vermicompost bio manure on growth and essential oil of medical plant of basil, an experiment was conducted in 2012 in Academic Centre for Education, Culture and Research (ACECR), Kermanshah, Iran on factorial experiment based on complete block design in 3 replications. Treatments were three levels of vermicompost (included 0, 5 and 10 ton in hectare) and 3 ecotype (Kermanshah, Shiraz and Andimeshk). Results showed that the highest yield of bush dry matter (16.29 g/plant) and highest essential oil yield (88.61 litters per hectare) was earned in Shiraz ecotype with application of 10 ton per hectare vermicompost. It seems that biologic fertilizers (vermicompost) are suitable alternative of chemical fertilizer and could be used in sustainable agriculture systems.

Keywords: Basil, Essential oil, *Ocimum basilicum*, Vermicompost.

INTRODUCTION

Basil (*Ocimum basilicum* L.) is one of the main medical plants that planted all over the word. It is Herbaceous, annual, scented and 20-60 cm height. *O. basilicum* is a medical plant that has a wide use in pharmaceutical industry. It is originated from North West of India, North East of Africa and Middle of Asia (Klimankova et al., 2008). *O. basilicum* used in traditional medicine it is used as sputum, carminative, stomach pain relief, antiparasitic, orexigenic, stimulant and is effective in improved lung disease (Lima et al., 2004). *O. basilicum* essential oil has antifungal, antibacterial and insect repellent property and used widely in food, sanitary and perfumery industry (Omidbaigi, 1997). Regarding to the damaging environmental effects of conventional agriculture due to uncontrolled use of chemical inputs, it is most important to attention to the alternative agriculture system. One of the essential bases of sustainable agriculture is the use of bio fertilizer in agro ecosystems with the purpose of eliminate chemical fertilizer application.

The use of bio fertilizer such as vermicopmost in organic systems, in addition to maintain the environment safety, can cause increase in quality and yield stability especially in medicine plant production (Sharma, 2002). The use of biologic manure is regarding as an effective way for Maintain soil quality that cause increase useful reactions between plant and microorganisms in rhizospher and then increase plant ability for absorb minerals (Kokalis-(Buerelle et al., 2006). Some studies have reported that vermicompost can increase the

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quantity and quality of essential oil in basil (Singh and Ramesh, 2002; Anwar et al., 2005; Geetha et al., 2009).

In addition it is increase nitrogen and phosphorus availability because of nitrogen fixation and phosphorus solubility (Prabha et al., 2007). Previous study by Anwar et al. (2005) showed that vermicompost application increase essential oil, linalool and methyle kavicol. .

In according to many studies that shown medicine plant in natural and agro ecosystems that use of sustainable systems because of accordance to natural condition and crop quality bear the best condition for crop production and maximum essential oil produce in this condition (Sharifi Ashor-Abadi, 1998.). Therefore, the current study was conducted to study the biologic fertilizer like vermicompost on vegetative growth and amount of essential oil in some ecotypes of basil.

MATERIAL AND METHODS

This experiment was conducted to determine different levels of vermicompost (organic fertilizer) on growth and essential oil percentage of different green basil ecotypes in 2012 in Academic Centre for Education, Culture and Research (ACECR), Kermanshah, Iran. This field is located in 34º– 23ºN of latitude and 47º–3ºE altitude. According to data from meteorological station of Kermanshah (1951-2006) Annual perception is 444.7 mm, average of annual temperature is 14.3 and total annual vapour is 2000 mm (Meteorological Station of Kermanshah 1951-2006). Organic matter and nutrient was evaluated, before conducting the experiment some samples was taken randomly from 30 cm depth of soil. Some physiological and chemical properties of soil and vermicompost were shown in Table (1).

Table 1. Physical and chemical properties of soil in the experimental site and vermicompost.

Sample	pH	EC	O.C	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
		ds/m	%	mg/kg								
Soil	7.3	0.92	0.7	8.22	17	726	-	-	7.4	8.9	0.67	2.6
Vermicompost	7.5	5.33	10.53	8200	4600	4400	4.6	1.5	1.9	638	123	25

Treatments that nourish with vermicompost include using 5 (v5) and 10 (v10) ton/ha and without using or control in company with three ecotype of basil that include Kermanshah (Ek), Shiraz (Esh) and Andimeshk (Ea). This experiment was done in factorial experiment in the base of complete block design with three replications. Soil preparation and plotted was done in April. All experimental plotted was sown in 6 rows and 50 cm apart. Approximately one month before sowing, vermicompost treatment was added to soil and plotted was plug with hand Shovel in 15 cm depth. The first irrigation was after planting and was irrigated every five day. Cleaning the plots from weeds was done with hand in two times. In experimental period don't use chemical fertilizer and pesticide. When bushes fully flowered, with select 3 plants randomly from each plot the internode distances, plant height, fresh and dry weight, leaf number and leaf area was measured and their means was regarded. The yield and essential oil percentage was calculated. Essential oil of different treatment was measured after fully flowering after drying in shade with Water Distiller machine in 4 hours. Essential oil yield was calculated with multiple essential oil percentage to dry matter yield (Barthet and Daun, 2002). Data analysis and means comparison was done with MSTAT-C software. Also for mean comparison least significant

differences (LSD) test was used in 5 percent of probability.

RESULTS AND DISCUSSION

Internode intervals

Results of variance analysis showed that different levels of vermicompost had not significant effects on internode intervals. Moreover, it was significantly affected among different ecotypes in aspect of internodes intervals (Table 2). Maximum intervals (3.863 cm) were earned in kermanshah ecotype (Table 4). Thus it seems that internode intervals had genetic origin.

Plant height

Results of variance analysis showed that different levels of vermicompost significantly effect plant height (Table 2). Maximum plant height (54.3 cm) obtained when 10 ton/ha vermicompost was used. This treatment had increased 17.16% compared with the control and 3.38%. Increase in plant height in vermicompost application might be because soil structure, increase water maintains capacity and nutrient supply increased. Tahami-Zarandi (2010) reported that application of organic and biologic manure increase basil plant height. Therefore the current results indicated that vermicompost could increase nitrogen accumulation in plant due to increase nutrient maintain capacity and plant growth regulator and ultimately this cause to promote plant growth and height. Also vermicompost could have positive effects on basil biomass production and improve plant height in accordance to high capacity of water absorption and could supply micro, a micro nutrient for photosynthesis.

Plant dry weight

Results in Table (3) showed a significant effect of vermicompost and ecotype on plant dry weight in 1% level of probability. Maximum plant dry matter was obtained in 10 ton vermicompost application (Table 4). Compare to control treatment and five ton application، it showed 41.35 and 25.43 percent increase, respectively. Analysis of mean ecotype showed that maximum dry matter weight (12.3 g) was in shiraz ecotype. There was not any significant effect in Shiraz and kermanshah ecotypes (Table 4). Interplay between ecotype and vermicompost, had significant effected. Maximum dry weight (16.92 g) was reported with application of 10 ton/ha vermicompost in shiraz ecotype. Also the least value (4.297g) was in andimeshk ecotype was 5 ton/ha vermicompost application (Table 5). Applying suitable levels of vermicompost cause increase photosynthesis and dry matter due to improve microbial activity and plant growth regulators, and this could increase plant dry matter. Similar to the current study, Liuc and Pank, (2005) reported that organic fertilizers could increase biomass production and extracted in medical plant production.

Table 2. Effect of different vermicompost levels and ecotype on growth parameters and essential oil content of basil (*Ocimum basilicum* L.)

		Mean square						
S.O.V	**df**	**Inter nodes**	**Plant Height**	**Dry weight**	**leaf number**	**Leaf area**	**Oil**	**Oil yield**
Replication	2	0.033^{ns}	90.78^{ns}	4.867^{ns}	3.444^{ns}	249.778^{ns}	0.023^{ns}	171.8^{ns}
Vermicompost	2	0.288^{ns}	636.188^{*}	130.671^{**}	11515.11^{**}	32314.778^{**}	1.23^{**}	4165.988^{**}
Ecotype	2	0.492^{*}	176.562^{ns}	161.807^{**}	4793.444^{**}	17624.333^{**}	0.245^{**}	2708.996^{**}
Interaction	4	0.149^{ns}	69.003^{ns}	67.977^{*}	1991.222^{*}	7790.611^{*}	0.023^{ns}	1046.809^{**}
Error	16	0.12	108.751	15.914	612.444	1817.653	0.016	171.549
CV(%)		10.35	20.54	36.95	15.8	16.12	8.19	36.5

ns: Non significant , *, **: Significant at 5% and 1% probability levels, respectively

Table 3. Mean comparison of Effect of different vermicompost levels and ecotype on growth parameters and essential oil content of basil (*Ocimum basilicum* L.)

Treatment (Vermicompost ton/ha)	**Internodes (cm)**	**Plant height (cm)**	**Dry weight (g/plant)**	**leaf number (per plant)**	**Leaf area (cm^2/p)**	**Oil (%v/w)**	**Oil yield (L/ha)**
Control (0.0)	3.143^{b}	44.98^{b}	7.641^{b}	118.4^{b}	200.1^{b}	1.161^{c}	18^{a}
5 ton/ha	3.39^{ab}	52.46^{a}	9.716^{ab}	162.2^{a}	274.6^{a}	1.511^{b}	29.9^{b}
10 ton/ha	3.491^{a}	54.3^{a}	13.03^{a}	182.7^{a}	315.3^{a}	1.9^{a}	59.76^{a}

Mean in each column with the same letters are not significantly different at 5% level of probability.

V0 :vermicompost Non)Control(

V5 :vermicompost 5ton/ha

V10 :vermicompost 10ton/ha

Leaf number

Results of variance analysis of leave number showed that the main effects of vermicompost and ecotype in 1%. Maximum leaf number (182.7) obtained with 10 ton/ha vermicompost application and the minimum (118.4) was with zero application (control). Moreover, there was no significant effects between 5 and 10 ton/ha fertilizer treatments (Table 3). Means comparison of the main effect of ecotype on this trait showed that the maximum leaf number (167.7) is for Shiraz ecotype and the lowest (130.6) one belongs to andimeshk ecotype. There were not significant difference between the two cultivar Shiraz and kermanshah. While maximum leaf number (211) was obtained in shiraz ecotype with applying 10 ton per hectare vermicompost application. There was not any significant effects between 5 and 10 ton/ha application of vermicompost in shiraz and kermanshah ecotypes. Minimum leaf number (107.7) was in shiraz ecotype and without applying vermicompost (Tabel 5). Moreover, soil physical condition improved and vital process of soil, in a suitable environment for root growth could increase shoot growth and dry matter production.

Leaf area

Results of variance analysis of leaf area showed that the main effects of different levels of vermicompost and ecotype are significant on leaf area in 1 % and interaction of then in 5% of probability (Table 3). Maximum leaf area (315.3 cm^3) was obtained with 10 ton/ha vermicompost and the minimum (200.1 cm^3) were obtained with control treatment (Table 3). The main effects of ecotype on this trait showed that maximum leaf area (279 cm^3) was with Shiraz ecotype and also the minimum value (215 cm^3) was in andimeshk ecotype. Also there were not any significant differences between Shiraz and kermanshah ecotype (Table 4). Means comparison of leaf area in contraction with ecotype and vermicompost showed that maximum leaf area (381 cm^3)was earn with applying 10 ton vermicompost in Shiraz ecotype and the minimum one (192.3 cm^3) was obtained with Shiraz ecotype without vermicompost treatment. There was not any significant between 5 and 10 ton/he vermicompost treatments when in Shiraz and kermanshah ecotype with applying 5 ton/ha in Shiraz ecotype (Table 5). Also increasing vermicompost increased biomass and leaf area because it increased absorbance, maintain and supply humidity and nutrient like nitrogen, phosphorus and potassium.

Essential oil percentage

Variance analysis showed that the effect of vermicompost and ecotype is significant in this trait (Table 1). Maximum essential oil amount (1.9 % of weight) was obtained without the used of vermicompost. Means comparison of ecotypes revealed that maximum essential oil value (1.678) is in Kermanshah ecotype and lowest one (1.35) is in andimeshk ecotype. There was a significant difference between the three ecotypes (Table 4). Vermicompost could improve physical condition and soil vital process, in addition it provides a good condition for root growth, cause increase dry matter production, total yield and essential oil percentage that ultimately increase essential oil yield.

Essential oil yield

Means comparison revealed that essential oil yield (59.76lit/he) was obtained with the use of 10 ton per hectare vermicompost manure (Table 3). Evaluation of the main effects of ecotype on this trait showed that maximum essential oil yield (47.98 lit/he) was produced with Shiraz ecotype. There were not any significant effects between shiraz and kermanshah ecotypes (Table 4). With comparison of interlay of ecotype and vermicompost on essential oil yield showed that maximum essential oil content (88.61 lit/he) was obtained in Shiraz ecotype and applying 10 ton/he vermicompost. However, there were not any significant effects between Shiraz and kermanshah ecotypes with applying 10 ton/he vermicompost. Also the minimum essential oil yield (11.41 lit/he) was obtained in plots treated with 5 ton/he vermicompost and andimeshk ecotype (Table 5).

Conclusion

Soil supplemented with vermicompost had intensifying effects on microbial activity and increase nutrient availability and finally, had positive effects on basil yield. In an experiment proved that different levels of vermicompost and phosphate solubility bacteria could promote *Foeniculum vulgare* yield (Darzi and Hajseyedhadi, 2003).

Results showed the significant prominence vemicompost rather control treatment. Because of decreased uses chemical inputs for medicine plants production and its derivate is necessary for its safety, so positive response of basil to vermicompost is so hopeful to its constant production. Prominent vermicompost treatments to control showed that the use of vermicompost in sustainable agricultural systems, in

addition to improve structure and microbial activity of soil could supply water, micro and macro elements. This use to increase vegetative growth and essential oil yield in comparison plants in compare to no usage of vermicopmost fertilizer.

Conclusively, the results of the current experiment show that vermicompost effects on the quantity and quality of the essential oil in *O.basilicum* and thus, have considerable potential for providing nutritional elements in essential oil production of basil, especially for the sustainable production systems.

Table 4. Mean comparison of Effect of ecotype on growth parameters and essential oil content of basil (*Ocimum basilicum* L.)

Ecotype	Internodes (cm)	Plant height (cm)	Dry weight (g/plant)	leaf number (per plant)	Leaf area (cm^2/p)	Oil (%v/w)	Oil yield (L/ha)
Ek	3.611 ^{a}	57.26^{a}	12.08^{a}	165.1^{a}	278^{a}	1.678 ^{a}	43.67^{a}
Esh	3.197^{b}	48.77 ^{ab}	12.3 ^{a}	167.7^{a}	279^{a}	1.544^{b}	47.98^{a}
Ea	3.217^{b}	45.71^{b}	6.01 ^{b}	130.6^{b}	215^{b}	1.35^{c}	16.01^{b}

Mean in each column with the same letters are not significantly different at 5% level of probability.

Ek :Kermanshah ecotype

Esh :Shiraz ecotype

Ea :Andimeshk ecotype

Table 5. Mean comparison of interaction in vermicompost levels and ecotype on growth parameters and essential oil content of basil (*Ocimum basilicum* L.)

Treatment	Internodes (cm)	Plant height (cm)	Dry weight (g/plant)	leaf number (per plant)	Leaf area (cm^2/p)	Oil (%v/w)	Oil yield (L/ha)
V_0E_k	3.31	54.89	8.727^{bcd}	127.7^{c}	193^{c}	1.233 ^{de}	21.38^{bcd}
V_0E_{sh}	3.183	40.77	6.107 ^{cd}	107.7 ^{c}	192.3^{c}	1.167^{de}	14.74^{d}
V_0E_a	2.937	39.28	8.09 ^{bcd}	120 ^{c}	215^{c}	1.083^{e}	17.87^{cd}
V_5E_k	3.66	54.89	11.24^{abc}	176.3 ^{ab}	302.7^{b}	1.7 ^{b}	37.71^{bc}
V_5E_{sh}	3.347	51.98	13.61 ^{ab}	184.3 ^{ab}	317.7^{ab}	1.5^{bc}	40.59^{b}
V_5E_a	3.163	50.52	4.297 ^{d}	126 ^{c}	203.3^{c}	1.33^{cd}	11.41^{d}
$V_{10}E_k$	3.863	62	16.53^{a}	191.3 ^{a}	338.3^{ab}	2.1 ^{a}	71.93^{a}
$V_{10}E_{sh}$	3.06	53.56	16.92 ^{a}	211^{a}	381^{a}	1.967^{a}	88.61^{a}
$V_{10}E_a$	3.55	47.33	5.64 ^{cd}	145.7^{bc}	226.7^{c}	1.633^{b}	18.74^{bcd}

Mean in each column with the same letters are not significantly different at 5% level of probability.

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تأثير اضافة السماد الحيوي الفيرميكمبوست على خصائص النمو و الزيوت الطيارة في نبات الريحان (*Ocimum basilicum* L.))

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ملخــص

بالنسبة لتقدير المستويات المختلفة من السماد الحيوي فيرميكومبوست على نمو نبات الريحان والزيوت الطيارة الموجودة فية، فقد تم عمل تجربة في 2012 في المركز الاكاديمي للتعليم، و الثقافة و البحث، في كرمنشاه، ايران، على تجربة متعددة العوامل تعتمد على نظام الاحصائي للكتلة الكاملة بمعدل 3 مكررات. تم عمل 3 معاملات من الفيرميكومبوست تشمل (0، 5 و 10 طن في الهكتار) و 3 مناطق جغرافية (كرمنشاه، شيراز، و انديمشك). بينت النتائج أن أعلى محصول للمادة الجافة (16.29 غم/نبات) وأن أعلى محصول للزيوت الطيارة (88.61 لتر / هكتار) تم الحصول علية في اقليم شيراز مع اضافة 10 طن/هكتار من مادة فيرميكومبوست. من الواضح ان المخصبات البيولوجية (فيرميكومبوست) هي البديل المناسب للمخصبات الكيمائية و يمكن استخدامها في الأنظمة الزراعية المستديمة.

الكلمات الدالة: الريحان، الزيوت الطيارة، *Ocimum basilicum*، السماد الحيوي الفيرميكومبوست.

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