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Influence of Vermicompost Rates on Growth and Volatile Oils of Sweet Basil

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ABSTRACT

Sweet basil is an annual plant from Lamiaceae family. Application of biological fertilizers such as vermicompost in organic agriculture increases the quality of plants and prevents environmental pollutions and ecological injuries. This experiment was carried out as a completely randomized design (CRD), with five treatments (0, 2, 4, 6 and 8% cow manure vermicompost, by weight) and three replications. The highest shoot fresh weight (15.91 g/plant) was obtained in 8% vermicompost rate which was not significantly different when compared to 6% rate. The highest value of the shoot dry weight (3.02 g/plant) was achieved on 8% vermicompost rate which was not significantly different when compared to 4% and 6% rates. Essential oil yield was the maximum (0.68%) at 8% rate. Qualitative analysis of essential oils resulted in identification of thirty eight components. The major components were geranial, neral and methyl chavicol.

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INTRODUCTION

High application of chemical fertilizers has negative effects on physical, chemical and biological properties of soil and may cause the soil erosion (Davarinejad, G., 2004). In many cases application of chemical fertilizers make environmental pollutions and ecological injuries that increase the production expenses (Ghost, B.C., 1998). Nowadays there is more attention to replacing chemical fertilizers with biological fertilizers (Kader, M.K., 2002). Vermicompost is a kind of compost which is produced from organic matter break up, by interaction of microorganisms and species of earthworm (Sallaku, G., 2009). Application of biological fertilizers like vermicompost in organic implanting system, increase the quality of plants especially in medicinal plants (Sharma, A.K., 2002). Sweet basil (*Ocimum basilicum* L.), n=48, belongs to Lamiaceae family is an annual plant which have green, broad and polar leaves. Active substances of sweet basil are essential oils that have medicinal properties. Simon *et al.* (1990) reported that the rate of sweet basil oils is 0.5 to 1.5% according to the continental conditions (Simon, J.E., 1990). Studying on the *Matricaria chamomilla* L. showed that application of vermicompost increase the height, early flowering, flower performance, receptacle length and receptacle diameter significantly (Azizi, M., 2008). Application of vermicompost increased the essential oils of *Cymbopogon winterianus* (Tanu, A., 2004). Other researches indicated that application of vermicompost can increase the dry weight of sweet basil and also increase the essential oil of fennel (*Foeniculum vulgare* Mill) significantly (Moradi, R., 2011).

This study was conducted to evaluate the effects of different rates of vermicompost on growth and volatile oils of sweet basil.

MATERIALS AND METHODS

This study was performed as outdoor pot experiment, in Shiraz, state of Fars, Iran on May 2012. This experiment was carried out as a completely randomized design (CRD), with five treatments (0, 2, 4, 6 and 8% cow manure vermicompost, by weight) and three replications. Each replication contained 5 pots and each pot contained 4 plants. Sweet basil seeds provided from Iranbazar Agriculture Institute. The pots were filled up by a mixture contained 3/5 soil and 2/5 sand (v/v). The mixture of pots were tested before applying treatments and the texture was loamy with PH=7.7, total N=trace, available P=3.0 mg/kg, available K=100.0 mg/kg and EC=2.37 dS/m. Analysis of cow manure vermicompost indicated PH=7.54, N=1.57%, P=0.32%, K=0.78%, Cu=40 ppm, Zn=128 ppm, Fe=1850 ppm, Mn=358 ppm and EC=13.18 dS/m.

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Plants were harvested in full blooming stage. Shoot height and fresh weights of shoot and root were measured. Shoots were dried at room temperature and roots were dried at 55°C for 72 hours.

Isolation of essential oils was performed using hydrodistillation of dried sample of shoots using a Clevenger-type apparatus over 3 hours. The oils were dried over sodium sulphate.

Gas Chromatography (GC) analysis was performed on an Agilent technologies model (7890A) equipped with flame ionization detector and capillary column HP-5 (30 m × 0.32 mm, 0.25 μm film thicknesses). The chromatographic conditions were as follows: The oven temperature increased from 60 to 210°C at a rate of 3°C/min. The injector and detector temperatures were 280 and 290°C, respectively. N₂ used as the carrier gas (1 ml/min). Essential oil was also analysed by GC-MS (Agilent Technologies-5975C-MS, 7890A-GC) operating at 70e V ionization energy, equipped with a HP-5 capillary column (phenyl methyl siloxane (30 m × 0.25 mm, 0.25 μm film thickness) with He as the carrier gas and a split ratio of 1:50. The retention indices for all the components were determined according to the Van Den Doll method using n-alkanes as standard. The compounds were identified by comparison of retention indices (RRI- AP-5) with those reported in the literature and by comparison of their mass spectra with the Wiley and mass finder 3 libraries or with the published mass spectra.

The data were subjected to analysis of variance (ANOVA) using SPSS computer software and means compared with DNMRT at 5% level of probability.

RESULTS AND DISCUSSION

Shoot height:

The maximum shoot height (78.35 cm) was achieved on 8% vermicompost rate that was not significantly different when compared to 6% rate (Table 1).

Nutrient deficiency causes a decline in plant height. Vermicompost increase the bacterial activity, water holding capacity of soil, provide and make available the nutrients for plant root, producing the plants growth stimulus (Tomati, U., 1988). Vermicompost increase the photosynthesis (Beyk Khurmizi, A., 2010), so plant growth and shoot height increase. Application of vermivash in *Diffenbachia amonea* media (Mahboub Khomami, A., 2005), and application of vermicompost in fennel (Darzi, M.T., 2006) increased the plant height significantly when compared to control plants.

Shoot fresh and dry weights:

The highest shoot fresh weight (15.91 g/plant) was obtained in 8% vermicompost rate which was not significantly different when compared to 6% rate. The highest value of the shoot dry weight (3.02 g/plant) was achieved on 8% vermicompost rate which was not significantly different when compared to 4% and 6% rates (Table 1).

Vermicompost increases the leaf surface that cause more light absorption and more organic matter synthesis (Sallaku, G., 2009). Application of 10-20% pig vermicompost increased the fresh weight of tomato shoot (Atiyeh, R.M., 2004). Increasing of vermicompost at tomato medium resulted in the higher shoot fresh weight (Arouiee, H., 2010).

Application of vermivash in *Diffenbachia amonea* medium (Mahboub Khomami, A., 2005) and application of 10 ton vermicompost per hectare in tomato and pepper (*Capsicum annum*) media (Arancon, N.Q., 2006; Arancon, N.Q., 2005) increased the plant dry weight significantly. Using of 20% vermicompost in tomato medium increased the dry weight and leaf index up to 40% (Scott, M.A., 1988).

Root fresh and dry weights:

Root fresh and dry weights were the maximum (1.37 and 0.37 g/plant, respectively) at 8% vermicompost rate which was not significantly different when compared to 4% and 6% rates (Table 1). Presence of micro and macro elements in vermicompost such as phosphorus, increases root biomass. Vermicompost enzymes also have important role in resolution of soil organic matter and make available the nutrients that are necessary for root growth. Other studies showed that application of biologic fertilizers extend the root growth because they contain *Azotobacter* (Skinner, F.A., 1987). Atiyeh *et al.* (2001) indicated that root expansion was better because vermicompost have high porosity and aeration (Atiyeh, R.M., 2001). In a study regarding sweet basil (*Ocimum basilicum* L.), the maximum dry weight was obtained together with vermicompost (Azizi, M., 2005).

Table 1: The effects of vermicompost rates on growth characteristics of sweet basil.

Vermicompost rates	Shoot height (cm)	Shoot fresh weight (g/plant)	Shoot dry weight (g/plant)	Root fresh weight (g/plant)	Root dry weight (g/plant)
Control	50.95 d	8.75 c	1.01 c	0.67 c	0.17 c
2%	66.00 c	11.91 b	1.76 b	1.06 b	0.27 b
4%	69.15 bc	12.58 b	2.23 ab	1.25 ab	0.32 ab
6%	76.30 ab	15.23 a	2.66 ab	1.32 ab	0.36 a
8%	78.35 a	15.91 a	3.02 a	1.37 a	0.37 a

In each column, means with the same letters are not significantly different at 5% level of Duncan's new multiple range test.

Essential oil yield and components:

The highest value of essential oil yield (0.68%) was achieved on 8% rate of vermicompost (Table 2).

Essential oils quantity of some medicinal plants is influenced by soil conditions specially soil nutrient. Vermicompost provides N for plants which have important role at essential oil production. Essential oils are terpenoid compounds that need NADPH and ATP for their biosynthesis. N and P are major elements for forming them (Loomis, W.D. and R. Corteau, 1972). Vermicompost can increase the essential oils in plants with providing more N and P. Application of vermicompost in fennel medium (Moradi, R., 2011) and application of vermicompost, micorrhiza and biologic phosphate fertilizer in fennel medium (Darzi, M.T., 2006), and using of vermicompost in sweet basil (*Ocimum basilicum L.*) medium (Anwar, M., 2005) increased the essential oils yield.

Qualitative analysis of essential oils resulted in identification of thirty eight components (Table 2).

In control treatment, 99.52% of the essential oils were identified. The major components were geranial (37.3%), neral (30.1%), methyl chavicol (15.5%), (E)-caryophyllene (2.0%), nerol (1.4%) and (E)- γ -bisabolene (1.3%).

In 2% rate, 99.98% of the essential oils were identified. The major components were geranial (33.0%), neral (26.3%), methyl chavicol (17.2%), nerol (3.0%), (E)-caryophyllene (2.8%), geraniol (2.8%), germacrene D (2.0%) and (E)- γ -bisabolene (1.9%).

Identification of oil components at 4% rate showed 99.02% of oil constituents. The major components were geranial (40.1%), neral (31.7%), nerol (3.7%), methyl chavicol (3.4%), (E)-caryophyllene (3.0%), (E)- γ -bisabolene (2.1%), germacrene D (2.0%) and geraniol (1.6%).

In 6% rate, 99.35% of the essential oils were identified. The major components were geranial (35.6%), neral (27.9%), methyl chavicol (8.1%), (E)-caryophyllene (3.7%), nerol (3.3%), germacrene D (2.5%), geraniol (2.3%) and (E)- γ -bisabolene (2.2%).

Identification of oil constituents at 8% rate revealed 99.41% of oil components. The major components were geranial (28.4%), methyl chavicol (25.1%), neral (22.1%), (E)-caryophyllene (3.3%), nerol (2.7%), (E)- γ -bisabolene (2.5%), geraniol (2.4%) and germacrene D (2.2%).

Table 2: The chemical components of sweet basil oil in different vermicompost rates.

No	RI	Component name	Control	2%	4%	6%	8%
1	932	α -Pinene	0.4	0.4	0.4	0.4	0.4
2	972	Sabinene	t	0.4	t	t	t
3	976	β -Pinene	0.2	0.2	0.2	0.2	0.2
4	988	6-Methyl-5-hepten-2-one	1.1	0.5	0.5	0.4	0.4
5	996	3-Octanol	0.1	0.1	0.1	0.9	0.1
6	1003	n-Octanal	0.1	0.1	0.1	0.1	0.1
7	1008	(3Z)-Hexenyl acetate	0.1	0.1	0.1	0.1	0.1
8	1027	Limonene	0.1	0.1	0.1	0.1	0.1
9	1034	1,8-Cineole	0.1	0.1	0.1	0.1	0.1
10	1045	(E)- β -Ocimene	0.3	0.2	0.1	0.1	0.1
11	1070	n-Octanol	-	0.3	0.2	0.3	0.3
12	1101	Linalool	0.1	0.1	0.1	1.5	0.1
13	1140	Cis-P-Mentha-2,8- dien-1-ol	0.3	0.2	0.2	0.2	0.1
14	1145	Cis-Verbenol	0.3	0.2	0.3	0.3	0.2
15	1151	Trans-Verbenol	0.7	0.5	0.8	0.7	0.5
16	1165	Cis-Chrysanthenol	1.2	0.9	1.2	1.1	0.8
17	1183	Iso-Menthol	1.7	1.2	1.5	1.5	1.1
18	1203	Methyl chavicol	15.5	17.2	3.4	8.1	25.1
19	1212	Aceticacid octyl ester	0.1	0.7	0.5	0.8	0.8
20	1234	Nerol	1.4	3.0	3.7	3.3	2.7
21	1251	Neral	30.1	26.3	31.7	27.9	22.1
22	1261	Geraniol	0.5	2.8	1.6	2.3	2.4
23	1282	Geranial	37.3	33.0	40.1	35.6	28.4
24	1349	α -Cubebene	-	-	0.1	0.1	0.1
25	1365	Neryl acetate	0.6	0.8	1.0	1.1	0.8
26	1375	α -Copaene	0.1	0.2	0.2	0.2	0.2
27	1385	Geranyl acetate	0.4	0.7	0.8	0.8	0.6
28	1390	β -Cubebene	0.2	0.3	0.3	0.4	0.3
29	1406	Methyl eugenol	0.1	0.1	-	0.2	0.3
30	1420	(E)-Caryophyllene	2.0	2.8	3.0	3.7	3.3
31	1435	Trans- α -Bergamotene	0.5	0.6	0.7	0.8	0.8
32	1454	α -Humulene	1.0	1.2	1.4	1.7	1.6
33	1481	Germacrene D	1.2	2.0	2.0	2.5	2.2
34	1507	γ -Cadinene	-	0.1	0.2	0.2	0.2
35	1523	δ -Cadinene	-	-	0.1	0.1	0.1
36	1542	(E)- γ -Bisabolene	1.3	1.9	2.1	2.2	2.5
37	1563	(E)-Nerolidol	0.1	-	-	-	-
38	1586	Caryophyllene oxide	0.2	0.3	0.3	0.4	0.3
		Oil yield (%)	0.49	0.53	0.62	0.62	0.68

t: trace (< 0.05%); RI: retention index

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