Effects of Organic and Chemical Fertilizers on Quantitative and Qualitative Characteristics of Peppermint (Mentha piperita L.)

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ABSTRACT: In order to investigate the effect of organic and chemical fertilizers on quantitative and qualitative characteristics of peppermint (Mentha piperita L.), a field experiment was conducted in year of 2013 at research farm of Islamic Azad University of Shirvan, by using a randomized complete block design with three replications. The experimental treatments included: vermicompost, urban waste compost, farmyard manure, each one in 3 levels and nitrogen with phosphate chemical fertilizer. The results of this study showed that, 10 ton/h vermicompost, 10 ton/h urban waste compost and 50 ton/h farmyard manure produced 14.9%, 13.9% and 24% more height than chemical fertilizer. Using 10 ton/h vermicompost, 10 ton/h urban waste compost and 30 ton/h farmyard manure produced 33, 33 and 29.6% more leaf area compared with chemical fertilizer. Using 10 ton/h vermicompost and urban waste compost also showed higher leaf number per plant. Branch number in 10 ton/h vermicompost was 64% more than chemical fertilizer. Applying 10 ton/h vermicompost, 10 ton/h urban waste compost and 50 ton/h farmyard manure showed 28.5%, 28% and 34.7% more dry weight than chemical fertilizer. The highest essence of plant was obtained as a result of using 14 tons per hectare vermicompost that led to a significant increase up to 37% compared with chemical fertilizer. According to results of this experiment Peppermint medical plant showed better reaction to application of, 10 ton/h vermicompost, 10 ton/h urban waste compost and 50 ton/h farmyard manure. Of course because of environmental and metrological variation more study can be further considered.

Key words: Organic manure, chemical fertilizer, Peppermint, Essence.

INTRODUCTION

In sustainable agriculture, an agro ecosystem can be compared with a living organism and all parts of this system include, soil, crop, microorganism and microclimate, impose action and interaction effect on each other. To have a stable system, all part of it, have to be in acceptable environmental condition. More crops production not to be accompanied with soil loses. Providing human need not to be accompanied with natural loses and also natural conservation not to be accompanied with decreasing crops production (Mahmoudi et al, 2008). In spite of significant and positive effect of chemical fertilizer on crops production it also imposed some negative effect on natural recourses and provide ecological problems (Kaviani et al, 2008). This is one of reason that scientists are searching for alternative source of fertilizer to replace with chemical fertilizer in organic farming to produce safe food with lower destructive side effect on ecosystems.

Peppermint (Mentha piperita L.) belongs to the family of Lamiaceae, is a herbaceous plant, perennial with rhizome (Begay, 2005; and Ghahraman, 1994). Since two thousand years ago, the different species of Peppermint is used as a spice and medicine. Leaves and shoots of the plant and essence have many therapeutic properties, such as a stomach tonic antispasmodic, analgesics topical pain, antiseptic, antibacterial, antifungal (Franzios et al, 1997; Mimica-Dukic et al, 2008; Zaller, 2007).

The use of mineral fertilizers is the fastest way to supply nutrients for plant (Mando et al, 2005) But long-term studies have shown that excessive use of chemical fertilizers, can reduce crop yield due to soil acidification, loss of soil biological activity, loss of soil physical properties and soil nutrient imbalance (Adediran et al, 2004). In many cases, the use of chemical fertilizers causes environmental pollution and ecological damage that increase their production costs. To reduce these risks, the use of alternative sources such as...
Organic inputs, come in to attention that can provide plant nutrients and will affect on soil physical properties (Samavat et al, 2001; Murty et al, 1998). Organic manure are the source of nutrients that don’t originated from industrial chemical. In organic manure application, the importance of soil structural properties, is more important than their effects on nutrients (Astaraee et al, 1996; Kamkar et al, 2008).

The use of organic materials such as farmyard manure, compost and vermicompost as an alternative source of chemical fertilizer increased the yield of fennel (foeniculum vulgare mill), (Darzi et al, 2008; Moradi, 2009) black cumin (Nigella sativa L.) (Akbarnezhad et al, 2010) and ( Silybum marianum L.) (Yazdani Buick et al, 2010).

The results of some study have shown that organic fertilizers decreased bulk density and increased soil moisture (Azizi Agh Ghale, 2001). Organic manure also reduced soil PH and increased the electrical conductivity and the ability of absorbing soil nutrients (Davar nezhad et al, 2002). Farmyard manure or the compost that derived from them are another source of organic material that is commonly used in sustainable soil management. Application of these materials have a beneficial effects on physical properties of soil, including soil permeability increment, soil bulk density decrement, water retention, improved microbial activity and increasing the amount of soil nutrients availability (Mohanty et al, 2006). In a study Saeed Nezhad and Rezvani Moghadam ( 2010), showed that the highest thousands kernel weight of Cumin belonged to compost treatment. After compost, vermicompost, sheep manure and cow manure produced higher thousands kernel weight respectively. They also reported that vermicompost produced the highest biological (1065 kg/h) and seed yield (477 kg/h). Effect of vermicompost was also significant on medicinal plant of Sweet fennel height, leaves percent and branch number compared with check (Rezvani Moghadam etal, 2009). Amin Gafouri et al ( 2010) also reported that among organic manure, vermicompost treatment showed significant effect on Sesame seed yield. The aim of this study was also to investigate the effect of organic and chemical fertilizers on quantitative and qualitative properties of peppermint medical plant.

MATERIALS AND METHODS

In order to study the effect of organic manure on quantitative and qualitative characteristics of peppermint (Mentha piperita L.), an experiments was performed in growing season of 2013 at the research farm of Islamic Azad University, Shirvan branch (located at at 15 km from Shirvan latitude 37:21 and longitude 58:04 and 1114 meters height above sea level). The experimental design was randomized complete block design with three replications. Experimental treatments were control (Using no fertilizer), 6, 10, 14 ton/h vermicompost, 6,10,14 ton/h urban waste compost, 30, 50, 70 ton/h farmyard manure and 70 kg/h nitrogen chemical fertilizer. Amount of nitrogen in the first level of each organic manure including of, 6 ton/h vermicompost, 6 ton/h urban waste compost and 30 ton/h farmyard manure was equal with chemical nitrogen fertilizer( 70 kg/h). The properties of organic manure and experiment soil shown in table 1 and 2. To prepare the experiment land, moldboard plow with 30 cm depth was used. After plowing two times disk were used in order to loosen the clods. Eventually leveling and plotting was done. Length and width of each plots in order were 2 and 1.5 meter. In each plot four rows was created. Distance between each rows was 50cm. Distance of plant on rows was 15cm, and the seedling were planted with hands on rows. The 4-leaf seedlings were bought from Mashhad University Research Farm and was transferred to the experiment plots. After cultivation and land preparing immediately surface irrigation was done to prepare the soil for seedling transferring. Around 6 hours after irrigation seedling transferred to experimental plot and planted by hand. After planting every 7 days, irrigation was done by special irrigation tube at the rate of 30mm water each time. During the growing season some traits such as, plant height, number of branch per plant, number of nod on main stem, number of leaves per plant, leaf area, wet and dry weight and essence were recorded. The data analyzed using Excel and Mstatc software and means comparison was done by Duncan multiple test range.

Table 1. The properties of organic manure

<table>
<thead>
<tr>
<th></th>
<th>Compost</th>
<th>Vermicompost</th>
<th>Farmyard manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Percentage of moisture</td>
<td>10-20</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>2-PH</td>
<td>6-8</td>
<td>7.3</td>
<td>-</td>
</tr>
<tr>
<td>3-Electrical conductivity (Ds/m)</td>
<td>6</td>
<td>1.97</td>
<td>-</td>
</tr>
<tr>
<td>4-percentage of neutral solutes materials</td>
<td>3-12.5</td>
<td>14.3</td>
<td>-</td>
</tr>
<tr>
<td>5- percentage of organic carbon</td>
<td>19-22</td>
<td>19.7</td>
<td>-</td>
</tr>
<tr>
<td>6- percentage of organic Nitrogen</td>
<td>1.3</td>
<td>1.3</td>
<td>0.25</td>
</tr>
<tr>
<td>7- percentage of organic material</td>
<td>30-40</td>
<td>39</td>
<td>-</td>
</tr>
<tr>
<td>8- percent of Ash</td>
<td>50-55</td>
<td>48</td>
<td>-</td>
</tr>
<tr>
<td>9-C/N ratio</td>
<td>13.5-18.5</td>
<td>12.9</td>
<td>12</td>
</tr>
<tr>
<td>10-percentage of phosphor</td>
<td>1-1.22</td>
<td>-</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Table 2. Characteristics of experiment soil

<table>
<thead>
<tr>
<th>Depth of sampling (cm)</th>
<th>Clay (%)</th>
<th>Silt (%)</th>
<th>Grit (%)</th>
<th>Nitrogen (mg/kg)</th>
<th>Phosphor (mg/kg)</th>
<th>Potassium (mg/kg)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30</td>
<td>30</td>
<td>30</td>
<td>40</td>
<td>0.049</td>
<td>7.05</td>
<td>325</td>
<td>7.69</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Plant height

Effect of organic manure was significant (P≤1%) on plant height (table 3).

Table 3. Analysis of variance of recorded traits of peppermint

<table>
<thead>
<tr>
<th>Sources of variation</th>
<th>Plan height</th>
<th>Leaf area</th>
<th>Number of leaves per plant</th>
<th>Number of nodes per plant</th>
<th>Number of lateral branches per plant</th>
<th>Wet weight of plant</th>
<th>Dry weight of plant</th>
<th>Essence percent</th>
<th>Essence yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block</td>
<td>61.45</td>
<td>0.001**</td>
<td>1632.4*</td>
<td>0.20**</td>
<td>124.5*</td>
<td>33.86*</td>
<td>0.57**</td>
<td>0.006</td>
<td>0.0005</td>
</tr>
<tr>
<td>Treatment</td>
<td>72.42</td>
<td>2.87</td>
<td>1622.5*</td>
<td>12.96*</td>
<td>366.0*</td>
<td>69.87*</td>
<td>3.65</td>
<td>0.46</td>
<td>0.0008</td>
</tr>
<tr>
<td>Error</td>
<td>8.90</td>
<td>0.15</td>
<td>1647.6</td>
<td>2.45</td>
<td>30.70</td>
<td>16.61</td>
<td>0.59</td>
<td>0.002</td>
<td>0.0001</td>
</tr>
<tr>
<td>Coefficient of variation(%)</td>
<td>7.29</td>
<td>8.56</td>
<td>19.20</td>
<td>9.93</td>
<td>17.22</td>
<td>13.51</td>
<td>12.09</td>
<td>5.34</td>
<td>16.32</td>
</tr>
</tbody>
</table>

*, **, ns: significant at 5%, 1% levels of probability and no significant difference respectively.

Among organic manure treatments, 50 ton/h farmyard manure showed highest effect on plant height and compared with check (No usage of fertilizer) caused a 63% increment of plant height. Increasing farmyard manure from 50 to 70 ton/h significantly decreased plant height (fig 1).

![Figure 1: Effect of different fertilizer treatments on peppermint plant height](image)

Fertilizer treatments

Beside 50 ton/h farmyard manure, 10 ton/h vermicompost, 10 ton/h urban waste compost produced 14.9% and 13.9% more height than chemical fertilizer (fig 1). The positive effect of organic manure on plant height can derived from providing equilibrium plant nutrients and imposed a direct effect on number of nod and inter nod length that finally lead to increasing plant height. In this respect Tahami Zarandi et al (2010) observed the greatest increase in plant height of basil in usage of 7 ton/h vermicompost and he stated that providing balance nutrients and gradual nutrient release from organic sources during period of growth can be positive role in enhancing the growth of basil. Gutierrez et al (2007) also reported effective role of vermicompost in increasing plant height of Tomato. As shown in fig 1 there are no significant differet among 6, 10and 14 ton/h vermicompost and 6, 10 and 14 ton/h urban waste compost. This may be due to supplying enough nutrients with 6 tons per hectare application of urban waste compost and vermicompost.

Leaf area and number of leaves per plant

Analysis of variance showed a significant effect (P≤1%) of treatments on the area and number of leaves per peppermint plant (table 3). As shown in fig 2, all treatments produced more leaf area compared with
control and chemical fertilizer treatments. 10 ton/h vermicompost, 10 ton/h urban waste compost and 30 ton/h farmyard manure produced 33, 33 and 29.6% more leaf area compared with chemical fertilizer.

![Figure 2. Effect of different fertilizer treatments on leaf area of peppermint](image)

In this regard it has been reported that in comparison with chemical fertilizers, nutrients in organic manure, are used by plants more efficient (Halajnia et al, 2007). Moreover nutrients balance in organic manure are important factor that can affect on plant growth and development compared with chemical fertilizer. Rezvani moghadam et al (2009) reported significant effect of vermicompost on percentage of Sweet fenel leaves.

Same as leaf area in plant, effect of treatments on number of leaves per plant was also significant (P≤ 1%) (table 3). Despite of no significant differences between the control and chemical fertilizer treatments, Using 10 ton/h vermicompost, 14 ton/h vermicompost, 10 ton/h urban waste compost, 14 ton/h urban waste compost, 50 ton/h farmyard manure and 70 ton/h farmyard manure produced significantly higher leaf number compared with control and chemical fertilizer (fig 3).

![Figure 3. Effect of different fertilizer treatments on leaf number of peppermint](image)

Presence and balancing of nutrients such as nitrogen and micro nutrients impose a direct effect on the structure of chlorophyll and protein synthesis that led to the development of vegetative growth and leaf area in plant (Adediran et al., 2004). This response is related to plant metabolism. Because supplying the needs of plant in terms of elements such as nitrogen and photosynthetic production that causes vegetative growth increment, such as leaf number and leaf area (Begay, 2005).

Number of nodes and number of lateral branches per plant

Number of nodes per plant also significantly (P≤1%) affected by treatments (table 3). Among the treatments, 14 tons per hectare vermicompost, 30 and 50 tons per hectare farmyard manure in spite of no significant different with chemical fertilizer, showed the most number of nodes per plant (fig 4). Using 14 ton/h
vermicompost and 30, 50 ton/h farmyard manure produced 20%, 22% and 28% more nod per plant than chemical fertilizer.

Figure 4. Effects of different fertilizer treatments on the number of nodes per peppermint plant

All treatments produced more branch compared with control an chemical fertilizer treatments. Second level of vermicompost (10 ton/h), urban waste compost (10 ton/h) and farmyard manure (50 ton/h) increased branch number per plant compared with first level of these organic manure, but increasing vermicompost and urban waste compost from 10 to 14 ton/h and farmyard manure from 50 to 70 ton/h reduced branch number per plant. but The highest number of branches per plant was observed in 10 tons per hectare vermicompost that was significantly 64% more than chemical fertilizer (fig 5). Ositive effect of vermicompost on plant branch reported by another scientists (Rezani moghadam et al, 2009).

Figure 5. Effects of different fertilizer treatments on number of branches per peppermint plant

Wet and dry weight of plant

The result of the variance analysis indicated a significant effect (P≤1%) of treatments on dry and wet weight of plant (table 3). Based on the results presented in figures 6, 10 ton/h vermicompost, 10 ton/h urban waste compost and 50 ton/h farmyard manure showed significantly higher wet weight compared with chemical fertilizer but all other treatments produced higher wet weight compared with control and chemical fertilizer with no significant difference. Using 10 ton/h vermicompost, 10 ton/h urban waste compost and 50 ton/h farmyard manure produced 24%, 33.8% and 28.6% more wet weight than chemical fertilizer respectively.
As shown in fig 7, using 6, 10, 14 ton/h vermicompost, 10 ton/h urban waste compost, 30, 50, and 70 ton/h farmyard manure showed more dry weight than other treatments. But overlay among vermicompost and farmyard manure using 6 ton/h vermicompost, and 50 ton/h farmyard manure are the best treatments in case of dry weight production. Among urban waste compost treatments in spite of no significant different, 10 ton/h, showed higher dry weight than 6 and 14 ton/h, have ever applying 6 ton/h vermicompost, 10 ton/h urban waste compost and 50 ton/h farmyard manure showed 27%, 28% and 34.7% more dry weight than chemical fertilizer. Griffe et al (2003) also observed increasing of dry weight of peppermint because of application of vermicompost. Singh and Bysin (1998) reported positive affect of compost on increasing of dry weight and production of some medical plant. The use of organic materials such as farmyard manure, compost and vermicompost as an alternative source of chemical fertilizer increased the yield of fennel (foeniculum vulgar mill), (Darzi et al, 1387; Moradi, 1388) black cumin (Nigella sativa L.) (Akbarnezhad et al, 1389) and ( Silybum marianum L.) (Yazdani Buick et al, 1389) . Amin Gafouri et al ( 2010) also reported that among organic manure, vermicompost treatment showed significant effect on Sesame seed yield.

**Percent of essence**
Percentage of essence in peppermint plant were influenced significantly(P≤1%) by fertilizer treatments (table 3). Among all treatments a significant difference was observed compared with control and chemical fertilizer. The highest increasing of essence of plant was obtained as a result of using 14 tons per hectare vermicompost (fig8). Application of 14 tons per hectare vermicompost compared with chemical fertilizer, led to a significant increase up to 37% of plant essence. Among urban waste compost The difference of 6 ton/h with 10 and 14 ton/h were significant but the difference between 10 and 14 ton/h were not significant. Therefore using 10 ton/h urban waste compost is better than other urban waste treatments to produce essence. There were no significant different among 30, 50 and 70 ton/h farmyard manure that indicated the priority of 30 ton/h
farmyard manure to produce essence. Darzi et al (2008) also reported that vermicompost increased Fennel essence percentage.

![Figure 8](image)

**Figure 8.** Effects of different fertilizer treatments on the percentage of peppermint essence

Totally increasing in growth and quality of plant is because of supplying nutrients as a result of organic manure usage that causes improving of growth and absorption of nutrients from soil. Organic manure by influencing recirculation of nutrients and organic matter in agriculture ecosystems, can increase soil fertility and enable it to produce stable production (Mando et al., 2005; Mohanty et al., 2006). Moreover, compost and vermicompost can impose a positive effect on improving soil chemical properties by gradual releasing of nutrients and they also improve soil physical condition (Davar nezhad et al., 2002; Darzi et al, 2008). Khandan and Astaraee (2005) reported that the use of compost and vermicompost have positive role on improving soil physical and chemical properties by increasing water holding capacity and soil permeability and aeration. So improving soil physical and chemical conditions by using of organic manure could ultimately led to a significant effect on improving of plant growth and development.

Generally according to results of this study using 10 ton/h vermicompost, 10 ton/h urban wast compost and 50 ton/h farmyard manure showed more positive effect on recorded traits of peppermint than other treatments.

**REFERENCES**


