Effect of Biofertilization and Organic Manuring on Soil Dehydrogenase Activity, Macronutrients and Essential Oil Content of Marjoram


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Two field experiments were carried out at an organic farm (Minoufia Governorate) during 2005-2006 and 2006-2007 seasons to study the interaction effect of biofertilization and organic manuring on dehydrogenase, polyphenol oxidase and peroxidase activity, macronutrients uptake, oil yield and oil composition of marjoram. Greater activities of dehydrogenase, peroxidase and polyphenol oxidase were obtained in soil and marjoram treated with combination of biofertilizers and organic manure than soil treated with biofertilizers or organic manure. The greatest activities of peroxidase and polyphenol oxidase were obtained with the treatment of biofertilization combined with full dose of organic manure. Similar results trend was 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 other treatments. There is no significant difference between oil yield obtained with chemical fertilization treatment and biofertilizers combined with full dose of organic manure treatment. Fourteen compounds, accounting for more than 97% of the total volatiles components in most marjoram samples were detected and identified. Dual application of organic manure and biofertilization to soil and marjoram produced maximum percent of terpinen-4-ol (the major compound in marjoram oil) compound in marjoram.

Keywords: Marjoram, Biofertilization, Organic manuring, T. Harzianum, Dehydrogenase, Macronutrients uptake, Marjoram essential oil, Yield and oil composition.

Marjoram (Majorana hortensis) is known to the ancient Egyptians and has been used as a food flavour and medicinal herb. Essential oil has been known since antiquity to possess biological activity, notably antibacterial, antifungal as well
as antioxidant properties (Tiziana & Dorman, 1998). El-Ghadban *et al.* (2002) reported that marjoram treatment with compost and biofertilizer led to an increase in macro-nutrients uptake. These increases might be related to the synergistic effects of compost and microorganisms on micro-nutrients production and availability to crops. Application of biofertilizers (*Azotobacter chroococcum, Azospirillum lipoferum, Paenibacillus polymyxa* and *Bacillus megaterium*) increased nitrogen, phosphorus and potassium content in marjoram herb (Mahfouz, 2003).

Biofertilizers consist of beneficial microorganisms which accelerate and improve plant growth and protect plants from pests and diseases. (Abou-Aly *et al.* (2006). To overcome the ecological problems resulting from the loss of plant nutrients and to increase crop yield, microorganisms may enhance availability of nutrients to plants and provide sustainable solutions for present and future agricultural practices. Gailite *et al.* (2005) reported that the content of both peroxidase and polyphenol oxidase activities in bean leaves increased following cultivation in the presence of plant growth promoting rhizobacteria. In addition, the essential oil components of rosemary were increased with the application of biofertilizers (Leithy *et al*., 2006). Combined treatment of soil with biofertilizers and compost gave better oil constituents of marjoram than those obtained from either N2 fixers (*Azospirillum brasiliense, Azotobacter chroococcum* and *P. polymyxa*), *B. circulans* or compost (Gharib *et al.* (2008). Azizi *et al.* (2008) reported that essential oil yield of chamomile was increased with the increase in compost dose.

Therefore, this research was carried out to study the effects of organic manure and biofertilizers on marjoram oil yield, oil composition and enzyme activities.

**Materials and Methods**

Two field experiments were carried out at organic farm in Minoufia Governorate, Egypt, during 2005/2006 and 2006/2007 seasons. This experiment was designed to study the interaction effect of organic farming agents on some enzymes activity and active substances of marjoram. Seeds of marjoram were obtained from Medicinal and Aromatic Research Dept., A.R.C., Ministry of Agriculture.

**Experimental soil**

Soil samples obtained from different field places were mixed. Soil samples were subjected to physical and chemical analyses as follows. Physical and chemical analyses are presented in Table 1.

The main characteristics of used compost which obtained from organic farm in Minoufia Governorate, Ghareeb Sons Farms, are given in Table 2.
TABLE 1. Mechanical and chemical analysis of the experimental soil.

| Particle size distribution | Coarse sand % |  6.59  |
|                          | Fine sand %  |  27.64 |
|                          | Silt %       |  12.60 |
|                          | Clay %       |  53.17 |
| Textural class           | Clay         |  8.03  |
| pH                       | 2.02         |
| Electrical conductivity (dS/m) | 2.12 |
| Organic matter %         | Ca^{++}      | 12.1   |
|                          | Mg^{++}      |  5.8   |
|                          | Na^{+}       |  0.44  |
|                          | K^{+}        |  1.86  |
| Soluble cations meq / L  | HCO_{3}^{-}  |  4.40  |
|                          | CO_{3}^{2-}  |   0    |
|                          | Cl^{-}       |  11.2  |
|                          | SO_{4}^{2-}  |   4.6  |
| Soluble anions meq / L   | N            | 1730   |
|                          | total        | 53.64  |
|                          | available    | 561.2  |
|                          | P            | 130.94 |
|                          | total        | 3500   |
|                          | available    | 1612.8 |

TABLE 2. Chemical analysis of the compost used in this experiment. Compost was obtained from Ghareeb Sons Farms located in Minoufia Governorate.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td>8.11</td>
</tr>
<tr>
<td>Electrical conductivity (1:5 extract)</td>
<td>dS/m</td>
<td>8.21</td>
</tr>
<tr>
<td>Organic matter</td>
<td>%</td>
<td>21.57</td>
</tr>
<tr>
<td>Organic-C</td>
<td>%</td>
<td>12.54</td>
</tr>
<tr>
<td>Total-N</td>
<td>%</td>
<td>1.21</td>
</tr>
<tr>
<td>C/N ratio</td>
<td>-</td>
<td>10.36</td>
</tr>
<tr>
<td>Total-P</td>
<td>%</td>
<td>0.91</td>
</tr>
<tr>
<td>NH_{4}^- N</td>
<td>ppm</td>
<td>274.7</td>
</tr>
<tr>
<td>NO_{3}^- N</td>
<td>ppm</td>
<td>50.1</td>
</tr>
</tbody>
</table>

Physical and chemical analyses of soil and compost were carried out according to the method described by Page et al. (1982).

Experimental design

Treatment were distributed in a randomized complete block design with three replicates. The experimental plot area was 10.5 m² (3 x 3.5 m). This experiment included the following treatments:

T1: Control (non-fertilized and non-inoculated).

T2: Chemical fertilization (recommended doses of chemical fertilization N, P and K).
The biocontrol agent of *Trichoderma harzianum* was added to all investigated treatments.

**Inocula preparation**

Inocula of *Paenibacillus polymyxa*, *Bacillus megaterium* var. *phosphaticum*, *Bacillus circulans* and *Trichoderma harzianum* were prepared in nutrient broth (Cross *et al*., 1968), Modified Bunt and Rovira broth (Abdel-Hafez, 1966), Alexandrov (Zahra, 1969) and gliotoxin fermentation media (Brain & Hemming, 1945), respectively.

**Cultivation process**

Prior to cultivation, plant bed was prepared. Seeds of marjoram were sown in prepared seed beds on 15/10/2005 and 15/10/2006 of both study seasons. After 50-60 days, seedlings 10-15 cm tall were individually transplanted in experimental field.

Chemical fertilizers were supplemented with a full dose of inorganic nitrogen (50 kg N/fed) as ammonium sulphate, inorganic phosphorus (25 kg P\(_2\)O\(_5\)/fed) as super phosphate and potassium (40 kg K\(_2\)O/fed) as potassium sulphate. The chemical fertilizers were applied in two equal doses, *i.e.* at vegetative and flowering stages.

Compost was added as organic manure to the soil at a rate of recommended dose (8 ton/fed), \(\frac{3}{4}\) dose and \(\frac{1}{2}\)dose before planting.

**Biofertilizers and biocontrol agent application**

Except for control treatment, transplants of marjoram were inoculated by dipping the root system in mixture of cell suspension of *P. polymyxa* H1 (7x10\(^{11}\)c.f.u./ml), *B. megaterium* var *phosphaticum* (8.3x10\(^{11}\)c.f.u./ml), *B. circulans* (4.1x10\(^{11}\)c.f.u./ml) and *T. harzianum* (5x10\(^7\) spores/ml) for 60 min before transplanting. Sucrose solution (30%) was added as an adhesive agent prior to inoculation. The same prepared inocula were added to the soil with irrigated water (100/ml for plot) three times throughout the growing seasons.

**Determinations**

- Dehydrogenase activity (DHA) was assayed in soil according to Thalmann (1967).
- Nitrogen, phosphorus and potassium percentage were determined in shoots according to the method described by A.O.A.C. (1980), A.P.H.A. (1992) and...
Dewis & Freitas (1970), respectively, after that the micro-nutrients uptake per plant was calculated.

- Peroxidase and polyphenol oxidase in plant were determined according to the method described by Allam & Hollis (1972) and Matta & Dimond (1963), respectively.
- Essential oil of air dried herb was extracted by water distillation for 3 hr and then dried over anhydrous sodium sulphate and determined according to Guenther (1961). The oil yield per plant and feddan were calculated.

**Analysis of essential oil composition of marjoram**

Essential oil samples were analyzed by GC–MS in Institute of Ecological Chemistry and Waste Analysis Technical University, Braunschweig, Germany according to Vera & Chane-Ming (1999).

**Statistical analysis.**

Obtained data were statistically analyzed according to Gomez & Gomez (1984). For comparison between means, Duncan's multiple range test was used (Duncan, 1955).

**Results and Discussions**

**Effect of biofertilization and organic manuring on dehydrogenase activity of the soil**

Data presented in Fig. 1 showed that DHA is widely varied among the studied treatments. Lower DHA was measured in soil treated with chemical fertilizers than soil treated with biofertilizers and/or compost. This result was in accordance with Krishnakumar et al. (2007) who reported that application of NPK fertilizers on soil reduces soil DHA significantly than soils treated with organic manure.

Higher records of DHA were observed in inoculated treatments inoculated with mixture of biofertilizer strains than soil treated with organic manure only.

The higher records of DHA with biofertilization are likely be due to the effective role of inoculation for enhancing colonization of introduced biofertilizers for plant roots. Moreover, the inoculation might lead to the accumulation of available nutrients and stimulate the microorganisms in rhizosphere.

Moreover, data showed that soil treated with combination of biofertilizer strains and compost resulted in higher DHA than soil treated with either biofertilizers or compost each one individually. Similar trend of results was observed by García-Gil et al. (2000) who reported that DHA was higher in organic manure treatments than soil treated with chemical fertilizer, indicating that increase in microbial activities may have occurred due to increase in available carbons from biodegradable organic manure.

Fig. 1. Effect of biofertilization and organic manuring on dehydrogenase activity in soil cultivated with marjoram.

Data revealed that the soil treated with biofertilizer strains and *T. harzianum* combined with full dose of compost gave the highest values of DHA. The elevated DHA may be due to the effect of organic manure on growth of indigenous microorganisms and introduced biofertilizer strains and activities.

This result is in accordance with Balakrishnan et al. (2007) who found that the application of compost in combination with phosphate solubilizing bacteria significantly increased soil microflora such as bacteria, fungi and actinomycetes and soil enzyme activities such as dehydrogenase and phosphatase.

Effect of biofertilization and organic manuring on N, P and K uptake

Obtained data (Fig. 2) showed that N,P and K uptake significantly increased in plants grown in soil amended with compost than soil treated with biofertilizer strains.

Fig 2. Effect of biofertilization and organic manuring on N, P and K uptake.
The enhancement of macronutrients uptake caused by organic manure may be due to the increase in available nitrogen, phosphorus and potassium.

Macronutrients uptake by marjoram were higher in case of dual application with biofertilizers and compost than macronutrients uptakes obtained in either biofertilizers or compost. Increase in macronutrients uptake may be due to increase in macronutrients availability in soils treated with biofertilizers and organic manure. These results agree with those obtained by Rashed (2002) who reported that biofertilizers combined with organic manure increased the content of nitrogen, phosphorus and potassium uptakes by plants.

In addition, increase in macro-nutrients uptake may be due to effect of compost and microorganisms on root surface area per unit of soil volume and water-use efficiency (El-Ghadban et al., 2002), which directly affects the physiological processes and nutrients absorption.

Macro-nutrients content of marjoram shoots were higher in the 2nd season than in the 1st one. This difference between the two seasons may be due to the changes in the climatic conditions.

Effect of biofertilization and organic manuring on polyphenol oxidase and peroxidase activity in marjoram leaves

Data recorded in Fig. 3 clearly indicated that soil treated with either biofertilizers or organic manure had increased the activity of peroxidase and polyphenol oxidase.

Fig. 3. Effect of biofertilization and organic manuring on polyphenol oxidase and peroxidase activity (as absorbance . g⁻¹ fresh weight leaves of marjoram).

Chemical fertilization gave lower values of both peroxidase and polyphenol oxidase than soil treated with either biofertilizers or compost. This result could be attributed to the effect of microorganisms in compost or biofertilizers which have been demonstrated to induce systemic resistance including enhanced production of peroxidase and polyphenol oxidase. This result is in agreement with Gailite et al. (2005) who reported that the activity of both peroxidase and polyphenol oxidase increased in bean leaves after the treatment with plant growth promoting rhizobacteria (PGPR).

Marjoram inoculation with biofertilizer strains significantly increased the peroxidase and polyphenol oxidase activity compared to the control. These results are in harmony with those reported by Wei et al. (1991) and M’Piga et al. (1997) who demonstrated induction of systemic disease resistance in plant by PGBR. It may be due to their ability to increase peroxidase and polyphenol oxidase levels. Gamil (1995) proved that inoculation with Paenibacillus polymyxa increased peroxidase and polyphenol oxidase activity of squash leaves. Increasing the peroxidase and polyphenol oxidase activity in the PGP treated plants may play either a direct or indirect role in the suppression of pathogen development in the host (Chen et al., 1998). Also, marjoram treatment with biofertilizers strains and organic manure gave greater records of polyphenol oxidase and peroxidase activities compared to treatments with either biofertilizer strains or organic manure. Marjoram inoculation with the biofertilizers combined with full dose of compost significantly increased the peroxidase and polyphenol oxidase activities.

**Effect of biofertilization and organic manuring on oil percentage and oil yield of marjoram shoot**

Data in Table 3 clearly showed that the mean values of essential oil of marjoram and oil yield per feddan were strongly affected by treatment with biofertilizers and/or amendment with compost compared with their corresponding controls. Increasing the quantity of organic manure in combination with biofertilizers led to an increase in essential oil percentage and oil yield of marjoram in both seasons. Similar trend of result was obtained by Edris et al. (2003).

Plants inoculation with biofertilizer strains resulted in significant increase of volatile oil percentage and oil yield per feddan compared to the control. In addition, inoculated plants with biofertilizer strains combined with full dose of compost resulted in 55.4 and 41.13 % increase in oil yield over plants with full doses of compost without inoculation in first and second season, respectively.

The highest values of essential oil percentage were obtained with chemical fertilization treatment although there was no significant difference in oil yield results between chemical fertilizer and biofertilizer with full dose of organic manure.
TABLE 3. Effect of biofertilization and/or organic manuring on oil percentage and oil yield of marjoram.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Oil percentage</th>
<th>Oil yield (L / fed.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First season</td>
<td>Second season</td>
</tr>
<tr>
<td>Control*</td>
<td>0.70 f</td>
<td>0.90 g</td>
</tr>
<tr>
<td>Chemical fertilization</td>
<td>1.50 a</td>
<td>1.60 a</td>
</tr>
<tr>
<td>Biofertilization**</td>
<td>1.04 e</td>
<td>1.30 f</td>
</tr>
<tr>
<td>Biofert. + compost (1/2 dose)</td>
<td>1.20 d</td>
<td>1.39 e</td>
</tr>
<tr>
<td>Biofert. + compost (3/4 dose)</td>
<td>1.30 e</td>
<td>1.44 c</td>
</tr>
<tr>
<td>Biofert. + compost (full dose)</td>
<td>1.40 b</td>
<td>1.50 b</td>
</tr>
<tr>
<td>Full dose of compost</td>
<td>1.30 e</td>
<td>1.40 d</td>
</tr>
</tbody>
</table>

* Control: Non-fertilized and non-inoculated.
** Biofertilizers content: P. polymyxa H1 + B. megaterium var. phosphaticum + B. circulans

From obtained results, it could be concluded that application of biofertilizers in combination with compost increased essential oil percentage and oil yield per feddan. Since, there isn’t significant difference between this treatment and chemical fertilization one. The increase in oil yield might be due to either increase in vegetative growth or changes in leaf oil gland population and monoterpenes biosynthesis.

Effect of biofertilization and organic manuring on essential oil composition of marjoram

Fourteen compounds accounting for more than 97 % of the total volatiles in most marjoram shoot were detected and identified. The oil composition as affected by biofertilization and organic manuring. Summary of the predominant compounds in marjoram oil are presented in Table 4 as measured by gas mass chromatography (Fig. 4 a-g). Obtained data revealed that dual application of compost and biofertilization recorded the highest percentage of terpinen-4-ol (the major compound in marjoram oil), y-, α-terpinene, α-pinene, myrcene, sabinene, α-terpineol, (+)-2-carene and linalool accompanied by a decrease in the proportions of phellandrene and limonene compared to either compost or biofertilization treatments individually.

Biofertilization treatment produced the highest percentage of caryophyllene but the lowest percent of sabinene.

TABLE 4. Effect of biofertilization and/or organic manuring on composition of essential oil of marjoram.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Oil components (%)</th>
<th>Retention time (min)</th>
<th>Control</th>
<th>Chemical fertilization</th>
<th>Biofertil. + compost (1/2 dose)</th>
<th>Biofertil. + compost (3/4 dose)</th>
<th>Biofertil. + compost (full dose)</th>
<th>Full dose of compost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Myrcene</td>
<td>7.69</td>
<td>1.29</td>
<td>0.7</td>
<td>1.4</td>
<td>1.5</td>
<td>1.56</td>
<td>1.29</td>
</tr>
<tr>
<td></td>
<td>(+)-2-carene</td>
<td>8.02</td>
<td>0.22</td>
<td>0.58</td>
<td>-</td>
<td>0.7</td>
<td>-</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>α-terpinene</td>
<td>8.57</td>
<td>22.97</td>
<td>20.91</td>
<td>23.41</td>
<td>19.48</td>
<td>23.53</td>
<td>24.08</td>
</tr>
<tr>
<td></td>
<td>Limonene</td>
<td>8.79</td>
<td>3.57</td>
<td>3.88</td>
<td>2.58</td>
<td>3.27</td>
<td>2.95</td>
<td>2.23</td>
</tr>
<tr>
<td></td>
<td>Linalool</td>
<td>13.37</td>
<td>1.72</td>
<td>1.37</td>
<td>1.75</td>
<td>1.05</td>
<td>1.56</td>
<td>2.74</td>
</tr>
<tr>
<td></td>
<td>p-cymene</td>
<td>16.13</td>
<td>0.8</td>
<td>0.62</td>
<td>0.68</td>
<td>0.7</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>Terpinen-4-ol</td>
<td>17.00</td>
<td>44.55</td>
<td>46.65</td>
<td>45.57</td>
<td>44.07</td>
<td>45.37</td>
<td>47.66</td>
</tr>
<tr>
<td></td>
<td>α-terpineol</td>
<td>17.65</td>
<td>7.51</td>
<td>7.76</td>
<td>7.52</td>
<td>6.72</td>
<td>7.64</td>
<td>8.18</td>
</tr>
<tr>
<td></td>
<td>Phellandrene</td>
<td>19.3</td>
<td>0.29</td>
<td>0.31</td>
<td>0.64</td>
<td>0.19</td>
<td>0.59</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>Sabinene</td>
<td>20.19</td>
<td>1.18</td>
<td>1.43</td>
<td>0.61</td>
<td>1.33</td>
<td>0.81</td>
<td>1.48</td>
</tr>
<tr>
<td></td>
<td>α-pinene</td>
<td>21.9</td>
<td>0.58</td>
<td>0.75</td>
<td>0.52</td>
<td>0.48</td>
<td>0.9</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td>Camphene</td>
<td>23.9</td>
<td>0.33</td>
<td>0.34</td>
<td>0.3</td>
<td>0.19</td>
<td>0.4</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>Caryophyllene</td>
<td>24.5</td>
<td>0.94</td>
<td>0.72</td>
<td>1.35</td>
<td>0.53</td>
<td>1.1</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>y-terpinene</td>
<td>28.6</td>
<td>4.85</td>
<td>5.74</td>
<td>5.2</td>
<td>4.64</td>
<td>5.46</td>
<td>6.03</td>
</tr>
<tr>
<td></td>
<td>Unidentified</td>
<td>-</td>
<td>9.2</td>
<td>8.24</td>
<td>8.47</td>
<td>15.2</td>
<td>7.7</td>
<td>2.83</td>
</tr>
</tbody>
</table>

Moreover, chemical fertilization markedly increased the proportion of camphene and (+)-2-carene compared to other treatments. Edris et al. (2003) found that the relative percentage of certain constituents of marjoram essential oil were affected by fertilization type and level. Also, obtained data showed that (+)-2-carene compound was absent in the treatments of biofertilization, biofertilization + 3/4 dose and full dose of compost treatment. On the contrary, compost treatment recorded the highest percentage of phellandrene and limonene, whereas, camphene disappeared.

The major compound in marjoram oil is terpinen-4-ol is the major compound in marjoram oil followed by α-terpinene, α-terpineol, y-terpinene, limonene, linalool, myrcene, sabinene, caryophyllene, α-pinene, (+)-2-carene and camphene.

Retention time (min)

Fig 4-a. Gas liquid chromatography spectra of the essential oil components in marjoram grown under control treatment.

Retention time (min)

Fig 4-b. Gas liquid chromatography spectra of the essential oil components in marjoram grown under chemical fertilization treatment.

Fig 4-c. Gas liquid chromatography spectra of the essential oil components in marjoram grown under biofertilization treatment.

Fig 4-d. Gas liquid chromatography spectra of the essential oil components in marjoram grown under biofertilization+compost (1/2 dose) treatment.

Fig 4-e. Gas liquid chromatography spectra of the essential oil components in marjoram grown under biofertilization+compost (3/4 dose) treatment.

Fig 4-f. Gas liquid chromatography spectra of the essential oil components in marjoram grown under biofertilization+compost (full dose) treatment.

Retention time (min.)

Fig 4-g. Gas liquid chromatography spectra of the essential oil components in marjoram grown under full dose of compost treatment.

Conclusion and Recommendation

In view of the obtained results, it can be concluded that the dual application of biofertilization and organic manuring had great effect on dehydrogenase, peroxidase, polyphenol oxidase, macronutrients uptake, essential oil percentage and oil yield/ fed of marjoram. According to the obtained results, it can be recommended that combination of biofertilization and organic manuring together can substitute chemical fertilization in marjoram farming.

References


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تأثير التسمنيد الحيوي والعصوي على نشاط بعض الإيزيمات
ومحتوى نبات البردقوش من العناصر المغذية والزيت العطري

راشد عبدالفتاح زغلول, هاني محمد حسن, إحسان أحمد حلمي, رشاد عبد الفتح سالم, إشعاف علي شرارة, وهاوي محمد أحمد عبدالزحمه
كلية الزراعة, جامعة بني سويف, بني سويف, الأراضي والبيئة, مركز
بحوث الزراعة الجيزة, مصر.

Paenibacillus polymyxa H1, Bacillus megaterium var. phosphaticum and Bacillus circulans
والنضج على نباتات البردقوش Trichoderma harzianum في وجود فطر
الإيزيمات محتوى نبات البردقوش من العناصر المغذية والزيت العطري.

أظهرت النتائج ما يلي:

أظهرت النتائج ارتفاعا في نشاط إيزيم المعطيات عند تطبيق النترية بحلول سلالات السنن المغذية مقارنة مع عناصر النترية في السنن العضوية.

أوضح النتائج أيضا أن تطبيق نبات البردقوش سلالات السنن العضوية أدى إلى زيادة نشاط إيزيم polyphenol oxidase و peroxidase في النباتات العضوية مقارنة بالنباتات غير المحملة. كما أن النتائج تeği السنن العضوية مع إضافة العناصر العضوية إلى زيادة polyphenol oxidase و peroxidase مقارنة باستخدام كل منها على حدة.

أيضا أوضحت النتائج زيادة محتوى النباتات من النيتروجين والفسفور والبوتاسيوم الممصص عند تطبيق بحلول سلالات السنن العضوية إضافة السنن العضوية مقارنة باستخدام كل منها على حدة. كما أظهرت النتائج أن على تركيز من هذه النباتات تطبيق بحلول سلالات السنن العضوية استخدم الجرعة الكاملة من السنن العضوية الصناعي.

وبخخص محصول الزيت أوضح النتائج أن نسبة النترية لمحصول
الزيت قد زادت معاوية عند تطبيق بحلول سلالات السنن العضوية مع إضافة
السنن العضوية الصناعي مقارنة بقيمة المعاملات.

ومن الجدير بالذكر أن على نسبة مئوية لتزيت قد ظهرت عند تطبيق النترية بالسنن العضوية. في حين أوضحت النتائج أنه لا يوجد فرقا معنويًا تمتص النترية بين النباتات المنتجة بالنماذج الكيميائي (الزراعة العضوية) والنباتات المنتجة تحت ظروف الزراعة العضوية. من خلال تحليل نباتات استخدم أجهزة مراقبة
الكلوروفيل. مثلاً، قدرية تظهر 14 مركب مثلاً في المواد العضوية بالزيت
الطريقي. وقد أوضحت النتائج أن مكونات النترية تتغير بشكل معين بالنترية
والعوامل، حيث أدى إنتاج البردقوش باستخدام النترية العضوية إلى
ارتفاع محتوى النتر من terpinen-4-ol وهو المركب الرئيسي في تركيب
الزيت العطري.