Available online at http://www.ijabbr.com

International journal of Advanced Biological and Biomedical Research

Volume 2, Issue 6, 2014: 2077-2085

Effects of plant growth promoter bacteria on biomass and yield of basil (Ocimum basilicum L.)

Nazanin Roshanpour, Mohammad Taghi Darzi*, Mohammadreza Haj Seyed Hadi

Faculty of Agriculture, Department of Agronomy, Roudehen Branch, Islamic Azad University, Roudehen , Iran

ABSTRACT

The main objective of this study was to determine the effects of plant growth promoter bacteria on biomass and yield of basil. The experiment was carried out as randomized complete blocks design with eight treatments and three replications at research field of Agriculture Company of Ran in Firouzkuh of iran in 2012 . The treatments were [1] Azotobacter chroococcum (A), [2] Azospirillum lipoferum (B), [3] Bacillus circulans (C), [4] A + B, [5] A + C, [6] B + C, [7] A + B + C and [8] control (without fertilizer application). The present results have shown that the highest dry weight of plant, herb fresh yield, herb dry yield and essential oil yield were obtained after applying each three bacteria (A + B + C). The maximum plant height was obtained by using two bacteria (A + B). Generally, the maximum herb dry yield and essential oil yield were obtained with the integrated application of each three bacteria.

Key Words: Basil, Azotobacter, Azospirillum, Bacillus, Yield.

INTRODUCTION

Applying plant growth promoter bacteria such as nitrogen fixing bacteria and phosphate solubilizing microorganisms in a sustainable agrosystem has led to a increase in quality agricultural products specially medicinal plants (Sharma, 2002). Free-living nitrogen fixing bacteria such as; Azotobacter chroococcum and Azospirillum lipoferum, were found to have not only the ability to fix nitrogen but also the ability to release phytohormones similar to gibberellic acid and indole acetic acid, which could stimulate plant growth, absorption of nutrients, and photosynthesis (El Ghadban et al., 2006; Mahfouz and Sharaf Eldin, 2007). Phosphate solubilizing microorganisms such as; bacteria and fungi, are effective in releasing P from inorganic and organic pools of total soil P through solubilization and mineralization (Chen et al., 2006). Also, By using biofertilizers, quantity and quality of active substances of medicinal plants can be improved (Rashmi et al., 2008; Azzaz et al., 2009). Basil plant (Ocimum basilicum) is one of the most important aromatic plants which used to flavor foods and in traditional medicines. It is an annual and herbaceous plant, belonging to the Lamiaceae family. Its essential oils are synthesized and stored in glandular hairs and are used as flavorings in foods and beverages, as fragrances, as toiletry products such

Corresponding Author E-mail: mtdarzi@gmail.com

as mouth washes and dental creams, as fungicides, or insecticides in pharmaceutical and industrial products (; Mondello et al. 2002; Khalid et al., 2006; Ziaei et al., 2012). Some studies have reported that plant growth promoter bacteria such as Azotobacter chroococcum, Azospirillum lipoferum, Bacillus sp and Pseudomonas sp could cause increased growth and yield of medicinal plants such as rosemary (Abdel-Aziz et al.,2007), fennel (Mahfouz and Sharaf Eldin, 2007; Azzaz et al., 2009; Moradi et al., 2011), turmeric (Velmurugan et al., 2008), mint (Abdel-Hadi Nadia et al., 2009), hyssop (Koocheki et al., 2009), geranium (Leithy et al., 2009), marjoram (Gharib et al., 2008; El-Ghandour et al. ,2009; Al-Fraihat et al., 2011), davana (Kumar et al., 2009), dragonhead (Rahimzadeh et al., 2011) black cumin (Valadabadi and Farahani (2011), dill (Darzi et al., 2012), thyme (Yadegari et al., 2012) and basil (Makkizadeh et al., 2011; Jahan et al., 2013).Therefore, the main objective of the present experiment was to investigate the effects of plant growth promoter bacteria on biomass and yield of basil (Ocimum basilicum L.).

MATERIALS AND METHODS

Field Experiment

A field experiment, arranged in a randomized complete blocks design with three replications, was conducted in the Experimental field of the Agriculture Company of Ran, Firouzkuh, Iran during the growing season of 2012. The geographical location of the experimental station was 35º 45´ N and 52º 44´ E with the altitude of 1930 m. The eight treatments of experiment contain: [1] Azotobacter chroococcum (A), [2] Azospirillum lipoferum (B), [3] Bacillus circulans (C), [4] A + B, [5] A + C, [6] B + C, [7] A + B + C and [8] control (without fertilizer application). Inoculation was carried out by dipping the basil seeds in the cells suspension of 10^8 CFU/ml for 15 min. Several Soil samples (0–30 cm depth) were taken for the nutrient and trace element analysis prior to land preparation. Chemical and physical properties of the experimental soil is presented in Table1. Each experimental plot was 3 m long and 2.4 m wide with the spacing of 10 cm between the plants and 40 cm between the rows. There was a space of one meter between the plots and 2 meters between replications. Basil seeds were directly sown by hand. There was no incidence of pest or disease on basil during the experiment. Weeding was done manually and the plots were irrigated weekly (as trickle irrigation system). All necessary cultural practices and plant protection measures were followed uniformly for all the plots during the entire period of experimentation. In this study, traits of plant height, dry weight of plant, herb fresh yield, herb dry yield and essential oil yield were evaluated. At the beginning of flowering, the plant height, from plant base to the tip of plant, was measured for each plot using a ruler (±0.1 cm) (Darzi et al., 2007; Azizi et al., 2008). Fresh weight of plant was calculated using a digital balance (Sartorius B310S; ±0.01 g). For evaluating the dry weight of plant at the harvest time (full blooming), plants were put in the oven at 75º C for 48 h and dry weight was calculated using a digital balance (Sartorius B310S; ±0.01 g) (Migahed et al., 2004; Badran and Safwat, 2004). Fifteen plants also were used at the harvest time to determination of herb fresh yield and herb dry yield.

Extraction of Essential oil

In order to determine the essential oil content (%), a sample of 100 g of basil dried herb from the each plot were mixed with 500 ml distilled water and then were subjected to hydro-distillation for 3 h using a Clevenger-type apparatus (Sajjadi, 2006; Darzi et al., 2012). Essential oil yield also was calculated with by using essential oil content and herb dry yield.

Table 1. Some Traits of Physical and Chemical of soil in experiment site

Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	P (mg/kg)	N (%)	O.C (%)	EC (ds/m)	pH	Texture
1.2	8	720	48	0.127	1.86	1.55	7.6	Clay-Loamy

Statistical Analysis

All the data were subjected to statistical analysis (one-way ANOVA) using SAS software (SAS Institute, version 8, 2001). Differences between the treatments were performed by Duncan's Multiple Range Test (DMRT) at 5% confidence interval. Transformations were applied to the data to assure that the residuals had normal distribution (Zar, 1996).

RESULTS AND DISCUSSION

Plant height

The present results have indicated that plant height was significantly affected by the application of different treatments of plant growth promoter bacteria (Table 2). The highest plant height (46.3 cm) was obtained by applying two bacteria (azotobacter + azospirillum) and the lowest plant height (22.6 cm) was indicated by control treatment (Figure 1). According to the present analysis, Nitrogen fixing bacteria have increased plant height by enhancing the nitrogen content and the rate of photosynthesis (Migahed et al., 2004). The present result were derived from the improvement of nitrogen fixing bacteria' activities in soil, which is in agreement with the previous studies carried out on the rosemary, fennel, turmeric, marjoram, hyssop, geranium (Abdel-Aziz et al.,2007; Mahfouz and Sharaf Eldin, 2007; Velmurugan et al., 2008; Gharib et al., 2008; Koocheki et al., 2009; Leithy et al., 2009; Al-Fraihat et al., 2011).

Dry weight of plant

The results presented in Table 2 have demonstrated that dry weight of plant was influenced by the application of different treatments of growth promoter bacteria, significantly. Among various treatments, treatment of the application of azotobacter plus azosprillum plus bacillus (A + B + C)(31.55 g) have indicated maximum increase in dry weight of plant (Figure 2). Integrated application of nitrogen fixing bacteria and phosphate solubilizing bacteria, through the increased nitrogen and phosphorus uptake (Rashmi et al., 2008; Azzaz et al., 2009), caused higher biomass production contain plant height and fresh weight of plant which leads to improvement of dry weight of plant. The result of present work are in agreement with the reports of Mahfouz and Sharaf Eldin (2007) on Foeniculum vulgare, Abdel-Aziz et al. (2007) on Rosmarinus officinalis, Kumar et al. (2009) on Artemisia pallens, Valadabadi and Farahani (2011) on Nigella sativa, Al-Fraihat et al. (2011) on Majorana hortensis and Yadegari et al. (2012) on Thymus vulgaris.

Herb fresh yield

The results presented in Table 2 have revealed that studied various treatments had significant effects on the herb fresh yield. The maximum herb fresh yield (8675 kg/ha) was obtained by using integrated application of each three bacteria and the minimum herb fresh yield (3813 kg/ha) was indicated in control

treatment (Figure 3). Improved Biomass and eventually herb fresh yield by bacteria has been attributed both to production of plant hormones, especially growth promoters and by supplying nitrogen phosphorus. The present result is in agreement with previous studies on medicinal plants such as Abdel-Aziz et al. (2007) on rosemary, Leithy et al. (2009) on geranium, Abdel-Hadi Nadia et al. (2009) on mint, Gharib et al. (2008), El-Ghandour et al. (2009) and Al-Fraihat et al. (2011) on marjoram.

Herb dry yield

The results presented in Table 2 have showed that plant growth promoter bacteria had significant effects on the herb dry yield. The highest herb dry yield (694.2 kg/ha) was obtained by integrated applying of bacteria (azotobacter + azospirillum + bacillus) and the minimum herb dry yield (524.9 kg/ha) was showed in control treatment (Figure 4). Increased herb dry yield in mentioned treatment can be owing to the improvement of yield components such as; plant height, fresh weight and dry weight of plant. The present result is in agreement with the report of Abdel-Hadi Nadia et al. (2009) on Mentha piperita, El-Ghandour et al. (2009) and Al-Fraihat et al. (2011) on Majorana hortensis, Makkizadeh et al. (2011) and Jahan et al. (2013) on Ocimum basilicum and Rahimzadeh et al. (2011) on Dracocephalum moldavica.

Essential oil yield

The present results have indicated that essential oil yield was significantly affected by the application of different treatments of growth promoter bacteria (Table 2). The maximum essential oil yield (1573.3 g) was obtained by using integration of three bacteria of Azotobacter chroococcum, Azospirillum lipoferum and Bacillus circulans and the minimum essential oil yield (537.0 g) was showed in control treatment (Figure 5). Integrated application of Plant growth promoter bacteria contain nitrogen fixing bacteria and phosphate solubilizing bacteria through the improvement of essential oil yield components such as essential oil content and herb dry yield caused more essential oil yield. This finding is in accordance with the observations of Abdel-Aziz et al. (2007) on Rosmarinus officinalis, Gharib et al. (2008), El-Ghandour et al. (2009) and Al-Fraihat et al. (2011) on Majorana hortensis, Koocheki et al. (2009) on Hyssopus officinalis, Makkizadeh et al. (2011) on Ocimum basilicum, Yadegari et al. (2012) on Thymus vulgaris and Darzi et al. (2012) on Anethum graveolens.

Table 2. Analysis of variance of studied traits

S. O. V	df	MS				
		Plant height	Dry weight of plant	Herb fresh yield	Herb dry yield	Essential oil yield
Replication	2	152.541*	10.0358^{ns}	5034870.5^{ns}	4850.84^{ns}	7176.54^{ns}
Treatments	7	174.952**	15.1845**	6669831.1*	7360.97**	311524.2**
Error	14	35.8273	3.16436	2057717.3	1533.10	50553.06

* and **: Significant at the 5 and 1% levels of probability, respectively. ns: Non-significant.

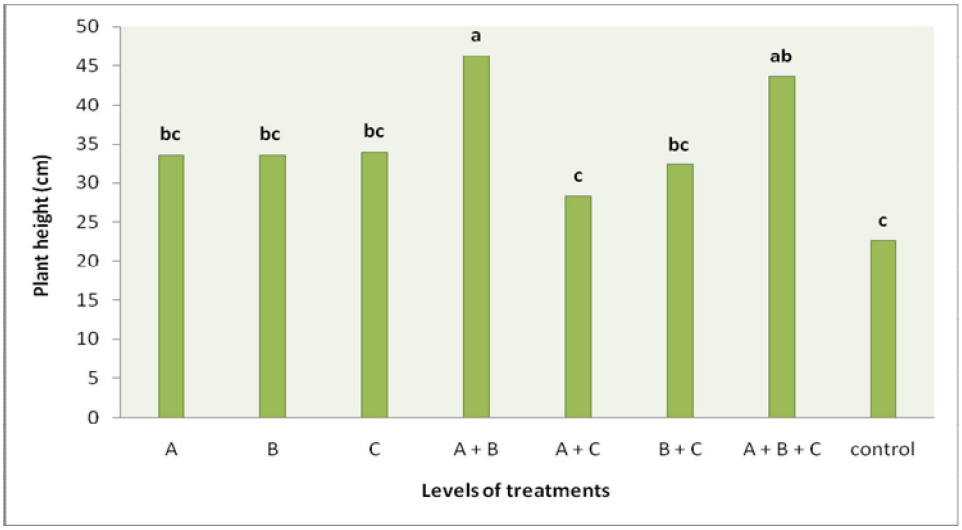

Figure 1. Mean comparison for plant height in different levels of plant growth promoter bacteria treatments

A, B, C, A + B, A + C, B + C, A + B + C and control represent azotobacter, azospirillum, bacillus, azotobacter + azospirillum, azotobacter + bacillus, azospirillum + bacillus, azotobacter + azospirillum + bacillus and without fertilizer application, respectively.

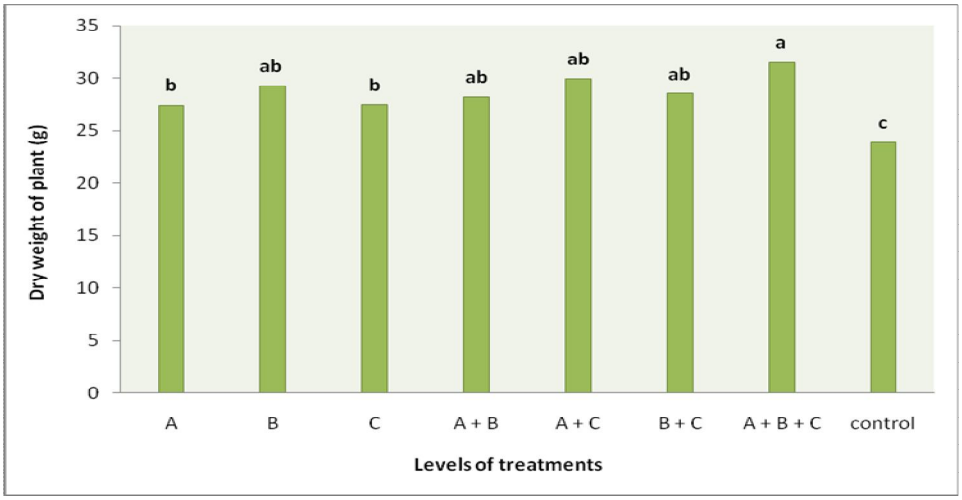

Figure 2. Mean comparison for dry weight of plant in different levels of plant growth promoter bacteria treatments

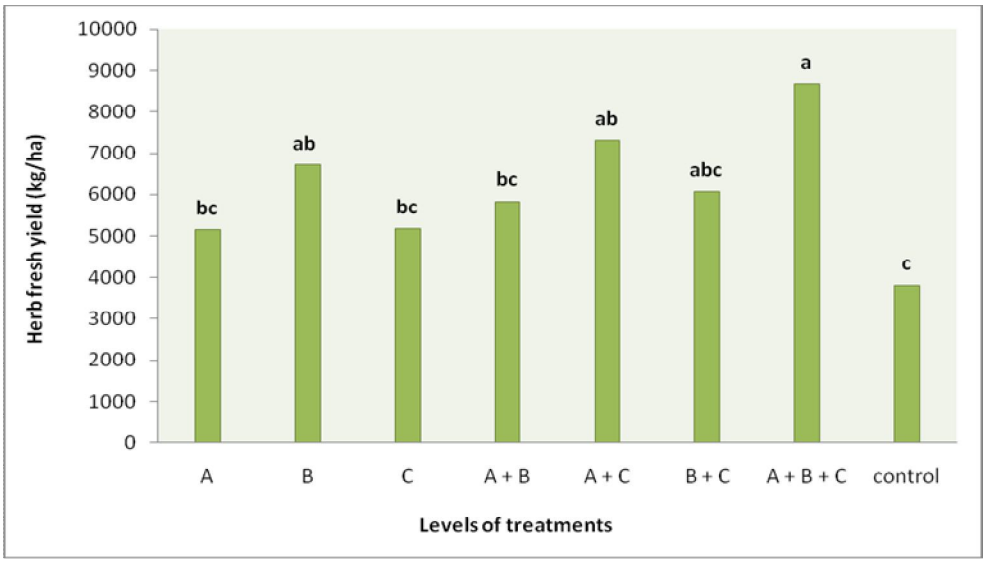

Figure 3. Mean comparison for herb fresh yield in different levels of plant growth promoter bacteria treatments

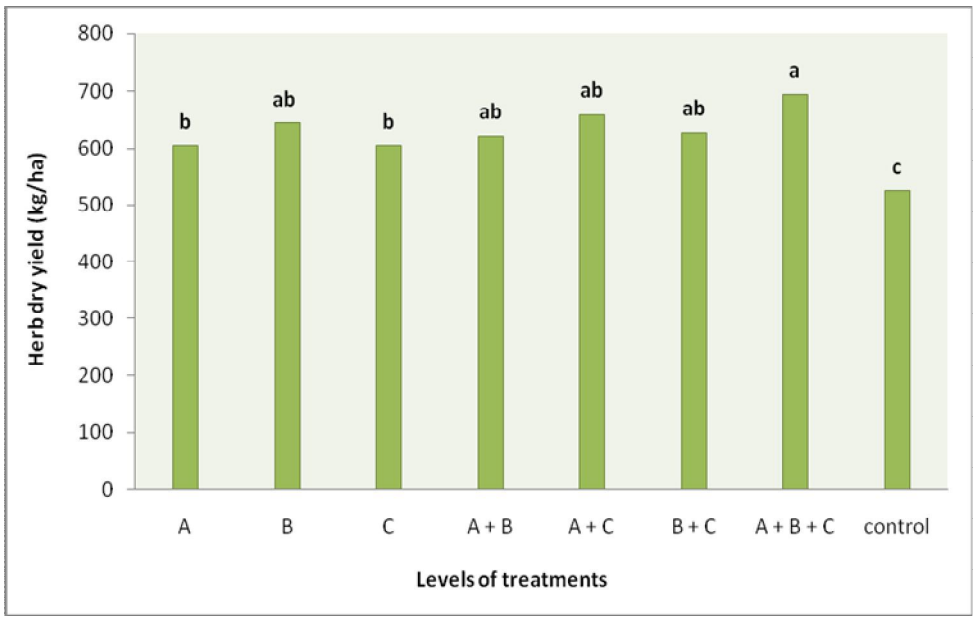

Figure 4. Mean comparison for herb dry yield in different levels of plant growth promoter bacteria treatments

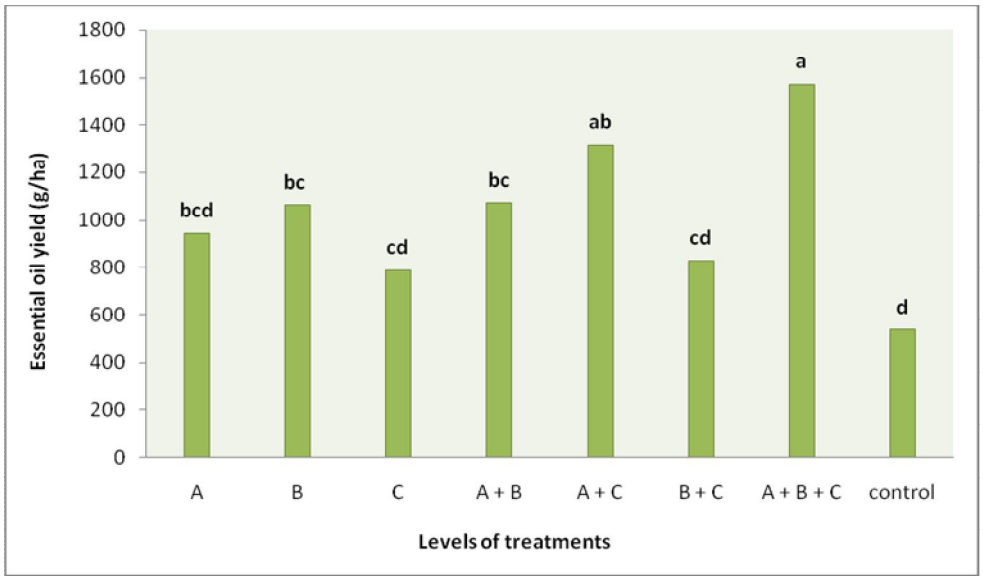

Figure 5. Mean comparison for essential oil yield in different levels of plant growth promoter bacteria treatments

CONCLUSION

It is clear from the present study that, Integrated application of plant growth promoter bacteria positively influenced on biomass and yield of basil, as the highest herb dry yield and essential oil yield were obtained by using each three bacteria (azotobacter + azospirillum + bacillus).

REFERENCES

Abdel-Aziz M, Pokluda R, Abdel-Wahab M (2007). Influence of compost, microorganisms and NPK fertilizer upon growth, chemical composition and essential oil production of Rosmarinus officinalis L. Not. Bot. Hort. Agrobot. Cluj. 35(1): 86-90.

Abdel-Hadi Nadia IM, Aboel-Ala HK, Abdel-Azim WM (2009). Response Of Some Mentha Species To Plant Growth Promoting Bacteria (PGPB) Isolated From Soil Rhizosphere. Australian Journal of Basic and Applied Sciences. 3(4): 4437-4448.

Al-Fraihat AH, Al-dalain SYA, Al-Rawashdeh ZB, Abu-Darwish MS, Al-Tabbal JA (2011). Effect of organic and biofertilizers on growth, herb yield and volatile oil of marjoram plant grown in Ajloun region, Jordan. Journal of Medicinal Plants Research. 5(13): 2822-2833.

Azizi MF, Rezwanee MH, Khayat A, Lackzian H, Neamati (2008). The effect of different levels of vermicompost and irrigation on morphological properties and essential oil content of German chamomile (Matricaria recutita) C.V. Goral. Iranian Journal of Medicinal and Aromatic Plants. 24(1): 82-93.

Azzaz NA, Hassan EA, Hamad EH (2009). The chemical constituent and vegetative and yielding characteristics of fennel plants treated with organic and bio-fertilizer instead of mineral fertilizer. Australian J. Basic and Applied Sci. 3(2): 579-587.

Badran FS, Safwat MS (2004). Response of fennel plants to organic manure and bio-fertilizers in replacement of chemical fertilization. Egyptian J. Agric. Res., 82(2): 247-256.

Chen YP, Rekha PD, Arun AB, Shen FT (2006). Phosphate solubilizing bacteria from subtropical soil and their tricalcium phosphate solubilizing abilities. Appl. Soil. Ecol., 34: 33-41.

Darzi MT, Ghalavand A, Rejali F, Sephidkon F (2007). Effects of Biofertilizers Application on yield and yield components in fennel (Foeniculum vulgare Mill.). Iran. J. Med. Aroma. Plants., 22(4): 276-292.

- Darzi MT, Haj Seyed Hadi MR, Rejali F (2012). Effects of the application of vermicompost and nitrogen fixing bacteria on quantity and quality of the essential oil in dill (Anethum graveolens). J. Medicinal Plants Res., 6(21): 3793-3799.

El Ghadban EAE, Shalan MN, Abdel Latif TAT. 2006. Influence of biofertilizers on growth, volatile oil yieldand constituents of fennel (Foeniculum vulgare Mill.). Egyptian J. Agric. Res., 84(3): 977-992.

El-Ghandour IA, Desouky EM, Galal YGM, Arafa RA, Abou Seer AMM (2009). Effect of biofertilizers and organic phosphorus amendments on growth and essential oil of marjoram (Majorana hortensis L.). Egypt. Acad. J. biolog. Sci. 1(1): 29-36

Gharib FA, Moussa LA, Massoud ON (2008). Effect of Compost and Bio-fertilizers on Growth, Yield and Essential Oil of Sweet Marjoram (Majorana hortensis) Plant. International Journal of Agriculture & Biology. 10(4): 381-387.

Jahan M, Amiri MB, Dehghanipoor F, Tahami MK (2013). Effects of Biofertilizers and Winter Cover Crops on essential oil production and some agroecological characteristics of basil (Ocimum basilicum L.) in a organic agrosystem. Journal of Iranian Agronomy Researches. 10(4): 751-763.

Khalid KHA, Hendawy SF, El-Gezawy E (2006). Ocimum basilicum L. Production under Organic Farming. Research Journal of Agriculture and Biological Sciecnes. 2(1): 25-32.

Koocheki A, Tabrizi L, Ghorbani R (2009). Effect of biofertilizers on agronomic and quality criteria of Hyssop (Hyssopus officinalis). Iranian J. Agron. Res., 6(1): 127-137.

Kumar TS, Swaminathan V, Kumar S (2009). Influence of nitrogen, phosphorus and biofertilizers on growth, yield and essential oil constituents in ratoon crop of davana (Artemisia pallens Wall.). Electronic J. Environ. Agric. Food Chemistry., 8(2): 86-95.

Leithy S, Gaballah MS, Gomaa AM (2009). Associative impact of bio- and organic fertilizers on geranium plants grown under saline conditions. International Journal of Academic Research. 1(1): 17-23.

Mahfouz SA, Sharaf Eldin MA (2007). Effect of mineral vs. biofertilizer on growth, yield, and essential oil content of fennel (Foeniculum vulgare Mill). International Agrophisics., 21(4): 361-366.

Makkizadeh M, Nasrollahzadeh S, Zehtab Salmasi S, Chaichi M, Khavazi K (2011). The Effect of Organic, Biologic and Chemical Fertilizers on Quantitative and Qualitative Characteristics of Sweet Basil (Ocimum basilicum L.). Journal of Agriculture Science and Sustainable Production. 22(1): 1-12.

Migahed HA, Ahmed AE, Abdel Ghany BF (2004). Effect of different bacterial strains as biofertilizer agents on growth, production and oil of Apium graveolens under calcareous soil. Arab Universities J. Agric. Sci., 12(2): 511-525.

Mondello L, Zappia G, Cotroneo A, Bonaccorsi I, Chowdhury JU, Yusuf M, Dugo G. (2002) Studies on the essential oil-bearing plants of Bangladesh. Part VIII. Composition of some Ocimum oils O. basilicum L. var. purpurascens; O. sanctum L. green; O.sanctum L. purple; O. americanum L., citral type; O. americanum L., camphor type. Flavour Fragr J 17:335–340.

Moradi R, Nasiri Mahallati M, Rezvani Moghaddam P, Lakzian A, Nejad Ali, A (2011). The effect of application of organic and biological fertilizers on quantity and quality of essential oil in fennel (Foeniculum vulgare). J. Hortic. Sci., 25(1): 25-33.

Rahimzadeh S, Sohrabi Y, Heidari GR, Eivazi AR, Hoseini T (2011). Effect of bio and chemical fertilizers on yield and quality of dragonhead (Dracocephalum moldavica L.). Iranian Journal of Medicinal and Aromatic Plants. 27(1): 81-96.

Rashmi KR, Earanna N, Vasundhara M (2008). Influence of biofertilizers on growth, biomass and biochemical constituents of Ocimum gratissimum. L. Biomed., 3(2): 123-130.

Sajjadi SE (2006). Analysis of the essential oils of two cultivated basil (Ocimum basilicum L.) from Iran. Daru. 14(3): 128-130.

SAS Ins (2001). SAS Institute, 2001. SAS Procedures Guide, Version 8. SAS Institute, Cary NC, USA.

Sharma AK (2002). Biofertilizers for sustainable agriculture. Agrobios, India, 407 p.

Valadabadi SA, Farahani HA (2011). Investigation of biofertilizers influence on quantity and quality characteristics in Nigella sativa L. J. Hortic. Forestry., 3(3): 88-92.

- Velmurugan M, Chezhiyan N, Jawaharlal M (2008). Influence of organic manures and inorganic fertilizers on cured rhizome yield and quality of turmeric (Curcuma longa L.) cv. BSR-2. International J. Agric. Sci., 4(1): 142-145.

Yadegari M, Farahani GHN, and Mosadeghzad Z (2012). Biofertilizers effects on quantitative and qualitative yield of Thyme (Thymus vulgaris). African Journal of Agricultural Research. 7(34): 4716-4723.

Zar JH (1996). Biostatistical Analysis. Prentice-Hall, Upper Saddle River, New Jersey.

Ziaei M, Sharifi M, Behmanesh M, Razavi K (2012). Gene expression and activity of phenyl alanine amonialyase and essential oil composition of Ocimum basilicum L. at different growth stages. Iranian Journal of Biotechnology. 10(1): 32-39.