International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2013 IJFAS Journal-2013-2-S/1277-1283
ISSN 2322-4134 ©2013 IJFAS

Effects of Vermicomost and Azotobacter and Azospirillum bacteria on quantity and quality of essential oil of coriander (Coriandrum sativum L.)

Mohammad Taghi Darzi[1]*, Mahnaz Shirkhodaei[1], Mohammadreza Haj Seyed Hadi[1]

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

Corresponding author: Mohammad Taghi Darzi

ABSTRACT: The main objective of this study was to determine the effects of vermicompost and azotobacter and azospirillum bacteria on quantity and quality of essential oil in the coriander essential oil content, essential oil yield, linalool percent, alpha pinene percent and cymene percent in essential oil. The experiment was carried out as factorial experiment in the base of 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 factors were Vermicompost in four levels (0, 3, 6 and 9 ton/ha) and biofertilizer, mixture of Azotobacter chroococcum and Azospirillum lipoferum in two levels (non-inoculated and inoculated seeds). The present results have shown that vermicompost had significant effects on evaluated traits except linalool percent in essential oil, as the highest essential oil content, essential oil yield and alpha pinene percent in essential were obtained after applying 6 ton/ha vermicompost. The minimum cymene percent in essential oil were obtained after applying 6 ton/ha vermicompost. Biofertilizer also showed significant effects on essential oil yield only. The highest essential oil yield were obtained by using the biofertilizer (inoculated seeds).

***Keywords*:** Coriander, Vermicompost, Azotobacter, Azospirillum, Essential oil

INTRODUCTION

At present, using organic manures and biofertilizers such as vermicompost and nitrogen fixing bacteria contain azotobacter and azospirillum has led to a decrease in the application of chemical fertilizers and has provided high quality agricultural products (Migahed et al., 2004; Mahfouz and Sharaf Eldin, 2007). By using correct nutritional sources through organic manures and biofertilizers, quantity and quality of active substances of medicinal plants can be maximized (Anwar et al., 2005; Singh et al., 2009). Coriander (Coriandrum sativum L.) is a native to the Mediterranean and Middle Eastern region. The aroma and flavour of coriander are due to essential oil present in oil glands in the mericarp. The seeds (fruits) contain an essential oil (up to 1%) and the monoterpenoid, linalool, is the main component. The coriander fruits have a pleasant flavour owing to the particular composition of the essential oil. The fruits are used not only in the preparation of fish and meat, but also for baking. The extracted essential oil is used in the flavouring of a number of food products and in soap manufacturing. It is principally used as a flavouring agent in the liquor, cocoa and chocolate industries. Like the fruits, it is also employed in medicine as a carminative or as a flavouring agent (Diederichsen, 1996; Msaada et al., 2009; Burdock and Carabin, 2009; Matasyoh et al., 2009).

Some studies have reported that vermicompost can increase the quantity and quality of essential oil in a few medicinal plants such as basil (Singh and Ramesh, 2002; Anwar et al.,2005; Geetha et al., 2009), coriander (Singh et al., 2009), fennel (Darzi et al., 2009; Moradi et al., 2011), chamomile (Haj Seyedhadi et al., 2011), cumin (Saeid Nejad and Rezvani Moghaddam, 2011), dill (Darzi et al., 2012) and anise (Darzi et al., 2013).

Several other studies have reported that biofertilizer such as nitrogen fixing bacteria (Azotobacter chroococcum and Azospirillum lipoferum) could cause increased quantity and quality of essential oil of some medicinal plants such as fennel (Abdou et al., 2004; Mahfouz and Sharaf Eldin, 2007; Azzaz et al., 2009; Moradi et al., 2011), lemon balm (Harshavardhan et al., 2007), turmeric (Velmurugan et al., 2008), hyssop (Koocheki et al., 2009), cumin (Saeid Nejad and Rezvani Moghaddam, 2010), black cumin (Valadabadi and Farahani, 2011) and dill (Darzi et al., 2012).

Therefore, the main objective of the present field experiment was to investigate the effects of vermicomost and azotobacter and azospirillum bacteria on quantity and quality of essential oil of coriander (Coriandrum sativum L.).

MATERIALS AND METHODS

Field Experiment

A 4×2 factorial experiment, arranged in a randomized complete blocks designed 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 treatments consisted of different levels of vermicompost (0, 3, 6 and 9 ton/ha) and biostimulant, different inoculation conditions of mixture of Azotobacter chroococcum and Azospirillum lipoferum bacteria (non-inoculated and seed inoculated). Inoculation was carried out by dipping the coriander seeds in the cells suspension of 10^8 CFU/ml for 15 min. The vermicompost was prepared from animal manure by employing epigeic species of Eisenia foetida. The required quantities of vermicompost were applied and incorporated to the top 5 cm layer of soil in the experimental beds before the plantation of coriander seeds. 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 and vermicompost are presented in Tables1 and 2.

Each experimental plot was 3 m long and 2 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. Coriander seeds were directly sown by hand. There was no incidence of pest or disease on coriander 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.

Twenty plants were randomly selected from each plot and the observations were recorded. In this study, quantitative and qualitative traits of corinder essential oil consisted of essential oil content, essential oil yield and linalool percent, alpha pinene percent and cymene percent in essential oil were evaluated.

Extraction of Essential oil

In order to determine the essential oil content (%), a sample of 100 g of coriander seeds from the each plot were crushed in electric grinder and were mixed with 500 ml distilled water and then were subjected to hydro-distillation for 3 h using a Clevenger-type apparatus (Kapoor et al., 2004; Darzi et al., 2012). Essential oil yield also was calculated with by using essential oil content and seed yield.

Identification of Essential oil Components

For identifying the essential oil components, essential oil fraction was collected and subjected to GC and GC/MS (gas chromatography and gas chromatography-mass spectrometry) analysis. For GC analysis from a Younglin Acm600, equipped with HP-5 MS capillary column (30m X 0.25 µm) and for GC/MS analysis from an Agilent 6890 GC and Agilent 5973 MS, equipped with HP-5 MS capillary column (30m X 0.25 µm) was used.

Authentic reference substance of linalool, alpha pinene and cymene were used to establish the retention times (Sephidkon, 2002; Kapoor et al., 2004).

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

Table 2. Some Characteristics of Chemical of used Vermicompost

K	P	N	O.C	O.M	EC	pH
(%)					(ds/m)	
3.9	0.67	11.3	26.1	45	1.8	8.5

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

Essential oil content

The present results have indicated that essential oil content was significantly affected by the application of vermicompost (Figure 1). The most significant essential oil content (0.536%) was obtained by applying 6 ton vermicompost per hectare. vermicompost application through increase of the mineral uptake such as; nitrogen and phosphorus (Arancon et al., 2006; Zaller, 2007), has a positive effect on proper biomass production and subsequently the enhanced essential oil content. Improved essential oil content of medicinal plants have previously been reported in the presence of optimal amounts of vermicompost (Anwar et al., 2005; Darzi et al., 2009; Geetha et al., 2009; Singh et al., 2009; Haj Seyed Hadi et al., 2011; Darzi et al., 2012).
Biofertilizer did not show significant effect on essential oil content (Table 3).

Essential oil yield

The results presented in Figure 2 have demonstrated that essential oil yield was influenced by the application of vermicompost, significantly. Among various levels, the application of 6 ton vermicompost per hectare has indicated maximum increase in essential oil yield (17.6 kg/ha). Increased essential oil yield in vermicompost treatments can be owing to the improvement of yield components such as; essential oil content and seed yield. Our findings are in accordance with the observations of (Singh and Ramesh ,2002, Pandey ,2005), (Anwar et al., 2005), Saeid Nejad and Rezvani Moghaddam ,2011), (Moradi et al. ,2011) and (Darzi et al., 2012).

Biofertilizer showed significant effect on essential oil yield (Table 3), as the highest essential oil yield (13.8 kg/ha) was obtained in the second treatment level of biofertilizer (inoculated seeds with azotobacter + azospirillum). Biofertilizer, promoted essential oil yield through the enhancement of yield attributes . These result are in agreement with the investigation of (Abdou et al., 2004 and Mahfouz ; Sharaf Eldin, 2007 on (Foeniculum vulgare, Swaminathan et al., 2008 and Kumar et al. , 2009) on(Artemisia pallens, Koocheki et al., 2009) on Hyssopus officinalis, Saeid Nejad and Rezvani Moghaddam (2010) on Cuminum cyminum, (Valadabadi and Farahani ,2011) on (Nigella sativa and Darzi et al., 2012) on Anethum graveolens.

Linalool percent in essential oil

The results indicated that linalool content in essential oil was not affected by vermicompost and biofertilizer (Figure 3 and table 3).

Alpha pinene percent in essential oil

The results presented in Figure 4 have revealed that various levels of vermicompost had significant effects on the alpha pinene percent in essential oil. The maximum alpha pinene percent (5.40%) was obtained by using 6 ton vermicompost per hectare. Vermicompost application through the improvement of biological activities of soil and mineral element absorption (Jat and Ahlawat, 2006; Zaller, 2007), caused more biomass production and subsequently seed ripening which leads to improvement of the essential oil quality (alpha pinene percent). These

findings are in accordance with the observations of (Anwar et al .,2005) on (Ocimum basilicum, Darzi et al., 2009) and (Moradi et al., 2011) on (Foeniculum vulgare and Darzi et al., 2012) on Anethum graveolens. Biofertilizer did not show significant effect on alpha pinene percent in essential oil (table 3). The present results show that the interaction of vermicompost and biofertilizer was significant. The maximum alpha pinene percent in essential oil (5.90%) was obtained after the integrated application of 6 ton/ha vermicompost and applying of biofertilizer (mixture of Azotobacter chroococcum and Azospirillum lipoferum). Many studies have reported that the interaction between organic manures and biofertilizers caused an increase in essential oil quality (Harshavardhan et al., 2007; Padmapriya and Chezhyian, 2009; Darzi et al., 2012).

Cymene percent in essential oil

The present results have indicated that cymene percent in essential oil was significantly affected by the application of vermicompost (Figure 5). The minimum significant cymene percent (4.21%) was obtained by applying 6 ton vermicompost per hectare. Applying proper amount of vermicompost, through increase of the alpha pinene percent in essential oil, has a negative effect on other components of essential oil such as; cymene percent and subsequently have decreased cymene percent in essential oil. The present result is in agreement with the report of (Anwar et al., 2005) on (Ocimum basilicum, Darzi et al., 2009 and Moradi et al. ,2011) on (Foeniculum vulgare and Darzi et al., 2012) on Anethum graveolens.

Biofertilizer did not show significant effect on cymene percent in essential oil (Table 3).

Table 3. Mean comparison of the qualitative characteristics of coriander at various levels of biofertilizer

Treatments	Essential oil content (%)	Essential oil yield (kg/ha)	Linalool percent in essential oil (%)	Alpha pinene percent in essential oil (%)	Cymene percent in essential oil (%)
Biofertilizer					
b1	0.444 a	11.42 b	76.29 a	4.76 a	4.58 a
b2	0.481 a	13.84 a	75.43 a	4.87 a	4.70 a

Means, in each column for each factor followed by at least on letter in common, are not significantly different at 5% probability level using Duncans' Multiple Range Test

b1 and b2 represent non-inoculated and inoculated seeds by azotobacter + azospirillum, respectively

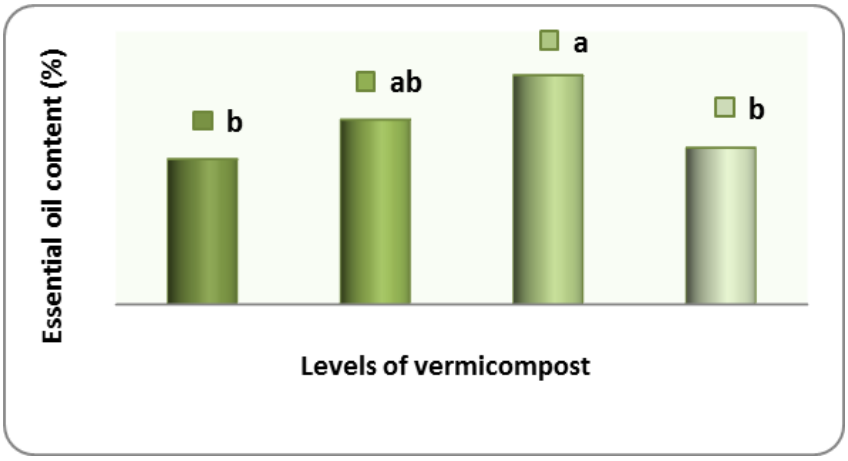

Figure 1. Mean comparison for essential oil content in different levels of vermicompost

v1, v2, v3 and v4 represent 0, 3, 6 and 9 ton vermicompost per hectare, respectively

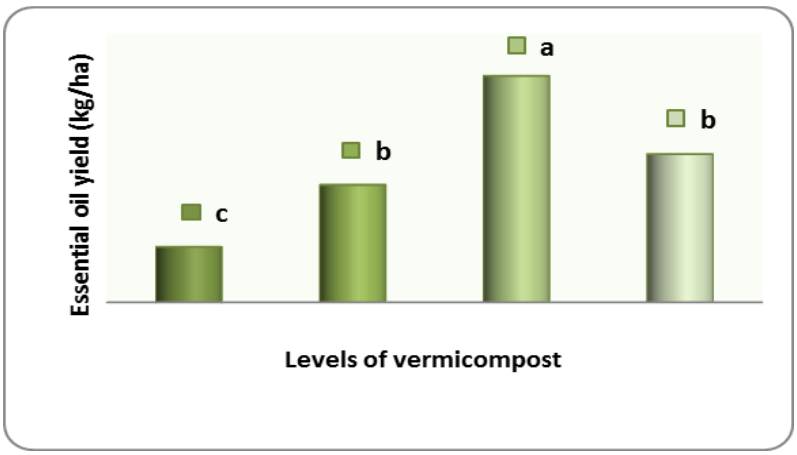

Figure 2. Mean comparison for essential oil yield in different levels of vermicompost

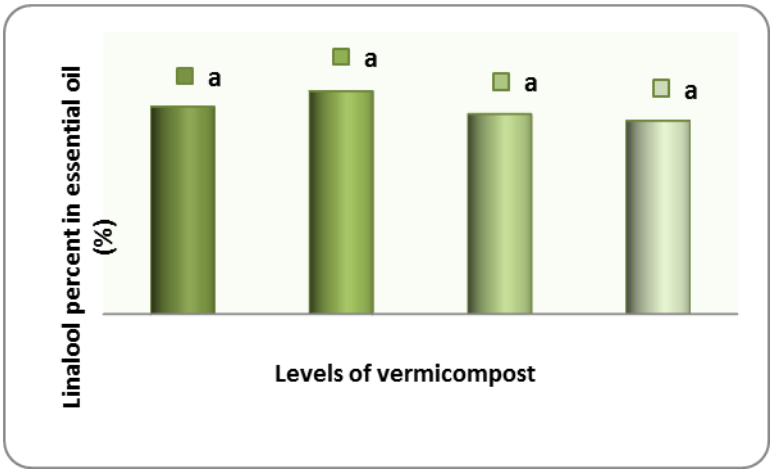

Figure 3. Mean comparison for linalool percent in essential oil in different levels of vermicompost

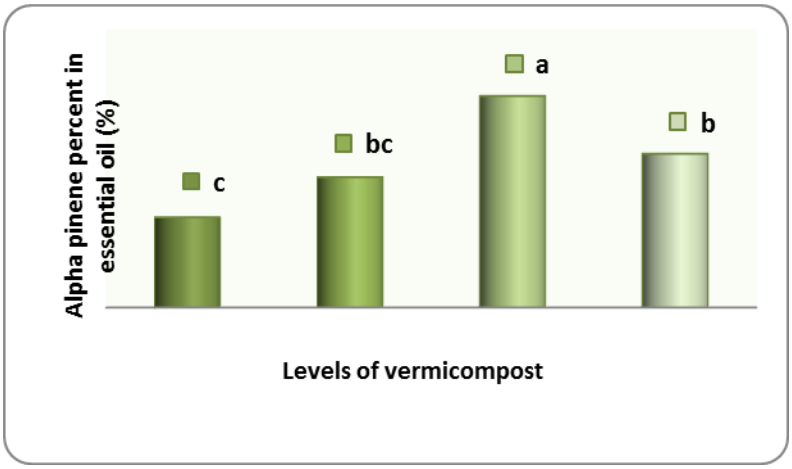

Figure 4. Mean comparison for alpha pinene percent in essential oil in different levels of vermicompost

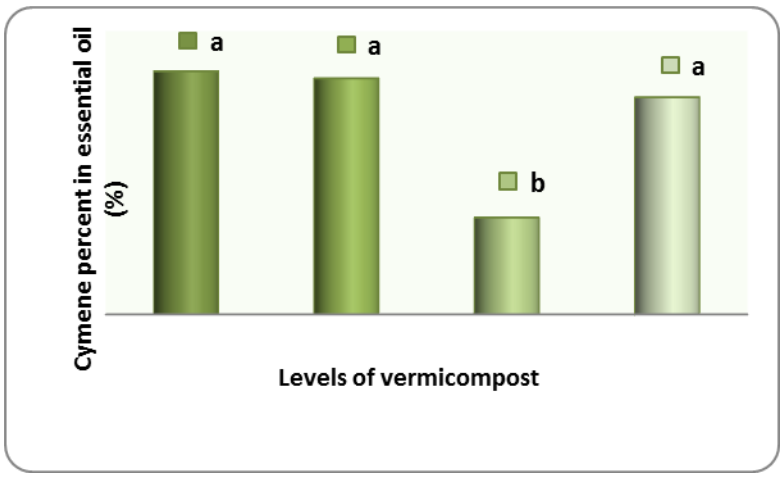

Figure 5. Mean comparison for cymene percent in essential oil in different levels of vermicompost

ACKNOWLEDGMENT

The authors wish to thank from Agriculture Company of Ran, Firouzkuh Branch becaused of assistance for this study.

CONCLUSION

Conclusively, the results of current experiment show that vermicompost and biofertilizer (azotobacter and azospirillum bacteria) have stimulatory effects on the quantity and quality of the Essential oil in coriander and thus have considerable potential for providing nutritional elements in essential oil production of coriander, especially for the sustainable production systems.

REFERENCES

Abdou MAH, El Sayed AA, Badran FS, El Deen RMS. 2004. Effect of planting density and chemical and biofertilization on vegetative growth, yield and chemical composition of fennel (Foeniculum vulgare Miller): I - Effect of planting density and some chemical (Nofatrein) and biochemical (Biogen) fertilizers. Ann. Agric. Sci. Moshtohor., 42(4): 1907-1922.

Anwar M, Patra DD, Chand S, Alpesh K, Naqvi AA, Khanuja SPS. 2005. Effect of organic manures and inorganic fertilizer on growth, herb and oil yield, nutrient accumulation, and oil quality of French basil. Communications in Soil Science and Plant. Analys., 36 (13-14): 1737-1746.

Arancon NQ, Edwards CA, Lee S, Byrne R. 2006. Effects of humic acids from vermicomposts on plant growth. European J. Soil Biology. 42: s65-s69.

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.

Burdock GA, Carabin IG. 2009. Safety assessment of coriander (Coriandrum sativum L.) essential oil as a food ingredient. Food and Chemical Toxicology, 47:22-34.

Darzi MT, Ghalavand A, Sephidkon F, Rejali F. 2009. Effects of Mycorrhiza, Vermicompost and Phosphatic Biofertilizer Application on Quantity and Quality of Essential Oil in Fennel (Foeniculum vulgare Mill.). Iran. J. Med. Aroma. Plants., 24(4): 396-413.

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.

Darzi MT, Hadj Seyed Hadi MR, Rejali F. 2013. Effects of Vermicompost and Phosphatic Biofertilizer Application on Quantity and Quality of Essential Oil in Anise. Iranian Journal of Medicinal and Aromatic Plants, 29(3): 583-594.

Diederichsen A .1996. Coriander: promoting the conservation and use of underutilized and neglected crops. International Plant Genetic Resources Institute, Rome, Italy.

Geetha A, Rao PV, Reddy DV, Mohammad S. 2009. Effect of organic and inorganic fertilizers on macro and micro nutrient uptake, oil content, quality and herbage yield in sweet basil (Ocimum basilicum). Research on Crops., 10(3): 740-742.

Haj Seyed Hadi MR, Darzi MT, Ghandehari Z, Riazi GH. 2011. Effects of vermicompost and amino acids on the flower yield and essential oil production from Matricaria chamomile L. J. Medicinal Plants Res., 5(23): 5611-5617.

Harshavardhan PG, Vasundhara M, Shetty GR, Nataraja A, Sreeramu BS, Gowda MC, Sreenivasappa KN. 2007. Influence of spacing and integrated nutrient management on yield and quality of essential oil in lemon balm (Mellisa officinalis L). Biomed., 2(3): 288-292.

Jat RS, Ahlawat IPS. 2006. Direct and residual effect of vermicompost, biofertilizers and phosphorus on soil nutrient dynamics and productivity of chickpea-fodder maize sequence. J. Sustainable Agric. 28, 41-54.

Kapoor R, Giri B, Mukerji KG. 2004. Improved growth and essential oil yield and quality in Foeniculum vulgare Mill on mycorrhizal inoculation supplemented with P-fertilizer. Bioresource Technol., 93: 307-311.
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.
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.
Matasyoh JC, Maiyo ZC, Ngure RM, Chepkorir R. 2009. Chemical composition and antimicrobial activity of the essential oil of Coriandrum sativum. Food Chemistry, 113:526-529.
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.
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.
Msaada K, Ben Taarit M, Hosni K, Hammami,M, Marzouk B. 2009. Regional and maturational effects on essential oils yields and composition of coriander (Coriandrum sativum L.) fruits. Scientia Horticulturae, 122:116-124.
Padmapriya S, Chezhiyan N. 2009. Effect of shade, organic, inorganic and biofertilizers on morphology, yield and quality of turmeric. Indian J. Hortic., 66(3): 333-339.
Pandey R. 2005. Mangement of Meloidogyne incognita in Artemisia pallens with bio-organics. Phytoparasitica., 33(3): 304-308.
Saeid Nejad AH, Rezvani Moghaddam P. 2010. Evaluation of biofertilizer and chemical fertilizer application on morphological traits, yield, yield components and essential oil percent in cumin (Cuminum cyminum). J. Hortic. Sci., 24(1): 38-44.
Saeid Nejad AH, Rezvani Moghaddam P. 2011. Evaluation of compost, vermicompost and cattle manure application on yield, yield components and essential oil percent in cumin (Cuminum cyminum). J. Hortic. Sci., 24(2): 142-148.
SAS Ins. 2001. SAS Institute. 2001. SAS Procedures Guide, Version 8. SAS Institute, Cary NC, USA.
Sephidkon F. 2002. Evaluation of Quantitative and Qualitative of fennel (Foeniculum vulgare) essential oil in different growth stages. Iran. J. Med. Aroma. Plants., 7: 85-104
Singh M, Ramesh S. 2002. Response of sweet basil (Ocimum basilicum) to organic and inorganic fertilizer in semi-arid tropical conditions. J. Medicinal and Aromatic Plant Sci., 24(4): 947-950.
Singh B, Singh B, Masih MR, Choudhari RL. 2009. Evaluation of P and S enriched organic manures and their effect on seed yield and quality of coriander (Coriandrum sativum). International J. Agric. Sci., 5(1): 18-20.
Swaminathan V, Kumar TS, Sadasakthi A, Balasubramanian R. 2008. Effect of nitrogen and phosphorus along with biofertilizers on growth, yield and physiological characteristics of Davana (Artemisia pallens Wall.). Advances in Plant Sci. 21(2): 693-695.
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.
Zaller JG. 2007. Vermicompost as a substitute for peat in potting media: Effects on germination, biomass allocation, yields and fruit quality of three tomato varieties. Scientica Hortic., 112: 191-199.
Zar JH. 1996. Biostatistical Analysis. Prentice-Hall, Upper Saddle River, New Jersey.

.