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Effect of Integrated Nutrient Management on Essential Oil (Volatile Oil) of Coriander (*Coriandrum sativum* L.)

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ABSTRACT

Aim: The experiment was intended to find out the effect of Integrated Nutrient Management on Essential oil (Volatile oil) of Coriander (*Coriandrum sativum* L.).

Methodology: The experiment was laid out in a randomized block design with 8 treatments using chemical fertilizers (NPK), vermicompost and biofertilizers (*Azotobacter* and *Phosphate Solubilizing Bacteria sp. Pseudomonas strata*) in different combinations including one control treatment.

Results: The results indicated that volatile oil percentage and percentage of different compounds i.e. Linalool, Geraniol, a-*pinene* and *B* - pinene in volatile oil of *Coriandrum sativum* L. was recorded significantly higher in T7 treatment compared to control treatment at different growth stages.

Conclusion: From the analysis of results it can be concluded that integrated use of biofertilizers, chemical fertilizers and vermicompost is the best combination for the Coriander (*Coriandrum sativum* L.) crop.

Key Words: Biofertilizers, Chemical Fertilizers, Vermicompost, Integrated Nutrient Management, Volatile oil, *Coriandrum sativum*

INTRODUCTION

India is known all over the world as "The Home of Spices". The fame of Indian spices is older than the recorded history. The term spice applies to natural plant or vegetable products or mixtures in whole or ground form, which are used for imparting flavor, aroma and piquancy to the food items. Spices are made up of many parts of a plant such as roots, bark, flowers, fruits, leaves etc. with distinct flavor and taste (www.mccormickscienceinstitute.com). Coriander (*Coriandrum sativum* L.) an annual herb of the parsley family (*Apiaceae*), is native to the Mediterranean region and is extensively grown in Bangladesh, India, Russia, central Europe and Morocco and has been cultivated since human antiquity (Small,1997 and Bhuiyan *et al*., 2009). The plant is grown widely all over the world for seed, as a spice, or for essential oil production (Lawrence, 1993). All part of the plants is edible but the fresh leaves and the dried seeds are the most common parts used in cooking. Coriander contains an essential oil (0.03-2.6%). The essential oil of coriander is also called volatile oil. It has strong effects on the nervous system and is therefore widely used by aroma therapists and herbologists as a sedative, spasmolytic and local anaesthetic. It is also used against many skin complaints, mostly in the form of tea tree oil. The different parts of this plant contain monoterpenes, limpnene, a-pinene, g-terpinene, p-cymene, citronellol, borneol, camphor, coriandrin, geraniol, dihydrocoriandrin, coriandrons A-E, flavonoids and essential oils (Farooq Anwar *et al*., 2011 and Nadeem *et al,* 2013). Various parts of this plant such as seed, leaves, flower and fruit, possess antioxidant activity, anti-diabetic activity, anti-mutagenic activity, anthelmintic activity, sedative - hypnotic activity, anticonvulsant activity, diuretic activity, cholesterol lowering activity, protective role against lead toxicity, antifungal

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activity, anti-feeding activity, anticancer activity, anxiolytic activity, hepatoprotective activity, anti-protozoal activity, anti-ulcer activity, post-coital anti-fertility activity, heavy metal detoxification (Momin *et al*., 2012). According to Polo and De Bravo (2006) Geraniol has anti-tumor activity against human hepatocarcinoma cell line Hep G2, human pancreatic cancer cells (Jin *et al*., 2013) and anti-proliferative effects on human colon cancer cells (Carnesecchi *et al*., 2002). Chen *et al*., (2015) found that liver cancer cell growth was inhibited by the use of α - pinene. Silva *et al*., (2012) found that α and β - pinene has antimicrobial activities against bacterial and fungal cells. All parts of the plant contain essential oils that give the green plant a characteristic smell, which is similar to that of bugs. This smell is caused by different aldehydic components of the essential oil present in the green plant.

MATERIAL AND METHODS

The field experiment was conducted in farmer's field at village Raghogarh, Distt. Guna, Madhya Pradesh. The experiment was conducted in a randomized block design (RDB) with 8 treatments and three replicas of each, using vermicompost, chemical fertilizers (NPK) and biofertilizers (*Azotobacter* and *Phosphate Solubilizing Bacteria*) in different combinations including one control treatment. The treatments were T_1 - Biofertilizers (250g *Azotobacter* + 250g *PSB* ha^{-1}), T_2 - Vermicompost 5t ha^{-1}, T_3 – Chemical Fertilizers (60:30:30 kg NPK ha^{-1}), T_4 - Biofertilizers + Vermicompost (125g *Azotobacter* + 125g *PSB* + 5t Vermicompost ha^{-1}), T_5 - Vermicompost + Chemical Fertilizers [5t Vermicompost ha^{-1} + 50% NPK ha^{-1} (RDF)], T_6 - Chemical Fertilizers + Biofertilizers [50% NPK (RDF as 30:15:15 kg per ha^{-1}) + 125g *Azotobacter* + 125g *PSB* ha^{-1}], T_7 - Biofertilizers + Vermicompost + Chemical Fertilizers [125g *Azotobacter* + 125g *PSB* ha^{-1} + 5t Vermicompost ha^{-1} + 50% NPK (RDF as 30:15:15 kg ha^{-1})], T_8 – Control (No Treatment).

Estimation of Essential oil (volatile oil)

Estimation of essential oil of *Coriandrum sativum* was performed on vegetative parts and on harvested dried seeds. The extraction of volatile oil was done by hydrodistilation for 4 hour, using Clevenger's apparatus to know the percentage of volatile oil and analysis of volatile oil was done by using GC – MS (Gas Chromatography - Mass spectrometry) to know the composition and to know the quantity of each component in volatile oil as described by Masada, 1976.

The oil dried over anhydrous sulphate solution, and stored at 4°C up to analysis by GC-MS.

Analysis of essential oil

Analysis of essential oil was done by using Gas Chromatography with Mass Spectrometer as described by James and Martin (1951) to know the composition of oil and the quantity of each composition. Analysis of essential oil for chemical composition was carried out using an Agilent – Technologies 6890 N network gas Chromatographic (GC) system equipped with 5975 inert XL mass selective detector and 7683 B series auto injector Agilent – Technologies. A sample volume of 1.0 µl was injected, applying split mode (split ratio 100:1), into HP-5 MS capillary column (30m × 0.25 mm), film thickness 0.25 µm.

The initial column temperature was set at 80^{0}C and raised to 220^{0}C by the rate of 4^{0}C/ min. The initial and final column temperatures were held for 3 and 10 min, respectively. The operating temperatures for detector and injector were 220^{0}C and 290^{0}C, respectively. The mobile phase used was helium at a flow rate of 1.5 ml/min. An electron ionization (EI) system, with ionization energy (70 $_e$V) was used for GC-MS detection. Mass scanning range was varied over 50 to 550 m/z. the injector and MS transfer line temperature were 220^{0}C and 290^{0}C, respectively. The essential oil compounds were identified on the basis of matching their retention indices in relation to n-alkenes (C_9 – C_{24}) and moreover with those of authentic compounds or published data (Minica *et al*., 2004, Vagionas *et al*., 2007). Beside the comparison of MS spectral data of the compounds with those from NIST mass spectral library was also applied to authenticate the compounds (Adams, 2001).

RESULTS

Various nutrient schedules influenced the essential oil % and % of different compounds in essential oil (volatile oil) of coriander at different growth stages. (Table and Fig. 1, 2, 3)

The combined application of BF 250g/ha + VC @ 5t/ha + 50% NPK RDF as 30:15:15 kg/ha (T_7) was found to be superior when compared to control, in registering the maximum essential oil (%) in vegetative parts of the plant at different growth stages, while in dried seeds after harvest, it was also superior over control, when compared to other treatments it was found non-significant.

The amount of different compounds (α-pinene, β-pinene, Linalool and Geraniol) within the essential oil were also recorded higher in combined application of BF @ 250g + VC @ 5t/ha + 50% NPK RDF as 30:15:15 kg/ha (T_7) when compared to control (T_8) at different growth intervals.

DISCUSSION

The essential oil % and % of different compounds in essential oil (volatile oil) of Coriander was found maximum in T_7 treatment with the application of BF + VC + CF. The better essential oil (%) in plants might be due to increased

Table 1: Effect of biofertilizers, vermicompost and chemical fertilizers on volatile oil % and % of different compounds in volatile oil of *C. sativum* at vegetative stage

Plot No.	Treatments		Volatile oil %	% of different compounds in volatile oil			
				α-pinene	β – pinene	Linalool	Geraniol
T_1	BF		0.12	0.78	0.24	7.39	25.65
T_2	VC		0.10	1.32	0.46	8.12	16.26
T_3	CF		0.12	0.24	0.33	7.00	22.54
T_4	BF+VC		0.14	0.94	0.21	10.16	23.81
T_5	VC+CF		0.12	0.76	0.23	6.38	22.18
T_6	CF+BF		0.12	0.89	0.19	5.7	28.37
T_7	BF+VC+CF		0.17	1.46	0.62	11.45	23.43
T_8	NT		0.07	0.3	0.15	4.14	15.45
SA	Mean		.1200	.8362	.3038	7.5425	22.2113
SA	Variance		.001	.184	.026	5.585	19.291
SA	SD		.02878	.42908	.16035	2.36323	4.39216
SA	SE_m		.01018	.15170	.05669	.83553	1.55286
SA	95% confidence Interval of the difference	Lower	.0959	.4775	.1697	5.5668	18.5393
		Upper	.1441	1.1950	.4378	9.5182	25.8832

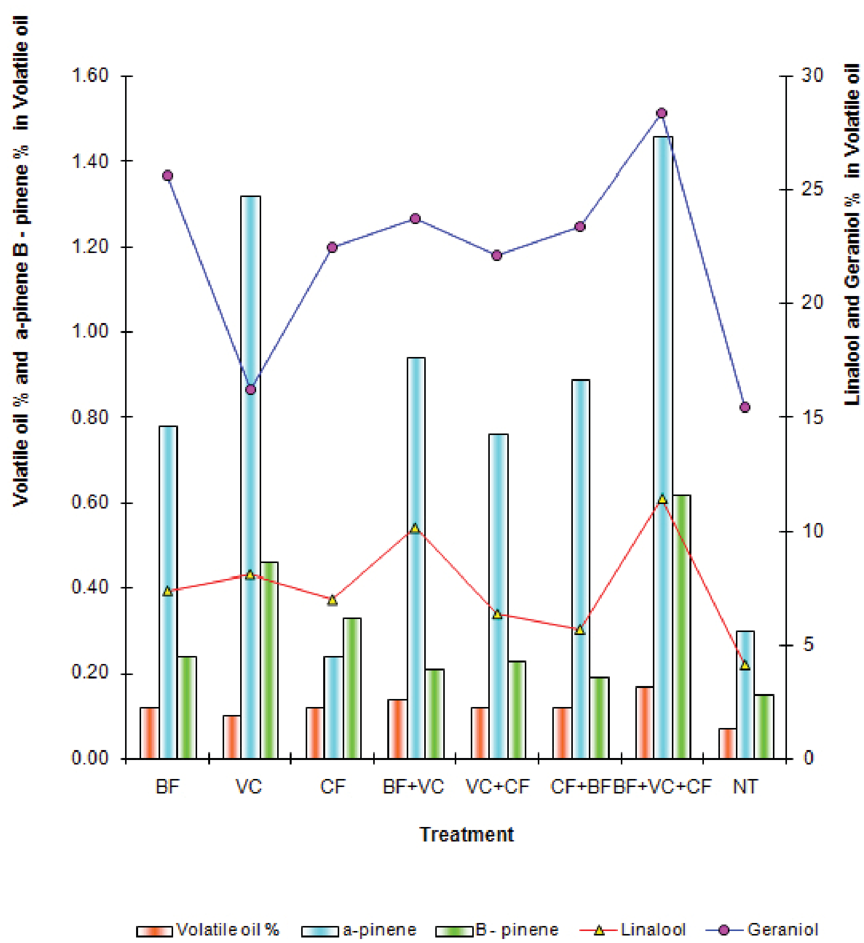

Figure 1: Effect of biofertilizers, vermicompost and chemical fertilizers on volatile oil % and % of different compounds in volatile oil of C. sativum at vegetative stage.

Table 2: Effect of biofertilizers, vermicompost and chemical fertilizers on volatile oil % and % of different compounds in volatile oil of *C. sativum* at harvest stage

Plot No.	Treatments		Volatile oil %	% of different compounds in volatile oil			
				α-pinene	β - pinene	Linalool	Geraniol
T_1	BF		0.12	1.62	0.20	22.01	11.43
T_2	VC		0.12	1.56	0.17	20.55	11.23
T_3	CF		0.12	1.42	0.19	20.58	13.40
T_4	BF+VC		0.10	1.59	0.17	21.76	9.26
T_5	VC+CF		0.12	1.21	0.15	31.63	8.40
T_6	CF+BF		0.10	1.48	0.14	33.30	10.75
T_7	BF+VC+CF		0.14	1.83	0.22	34.29	14.45
T_8	NT		0.10	0.82	0.12	11.95	8.05
SA	Mean		.1150	1.4412	.1700	24.5088	10.8712
SA	Variance		.000	.094	.001	60.900	5.189
SA	SD		.01414	.30722	.03295	7.80384	2.27785
SA	SE_m		.00500	.10862	.01165	2.75907	.80534
SA	95% confidence Interval of the difference	Lower	.1032	1.1844	.1425	17.9846	8.9669
		Upper	.1268	1.6981	.1975	31.0329	12.7756

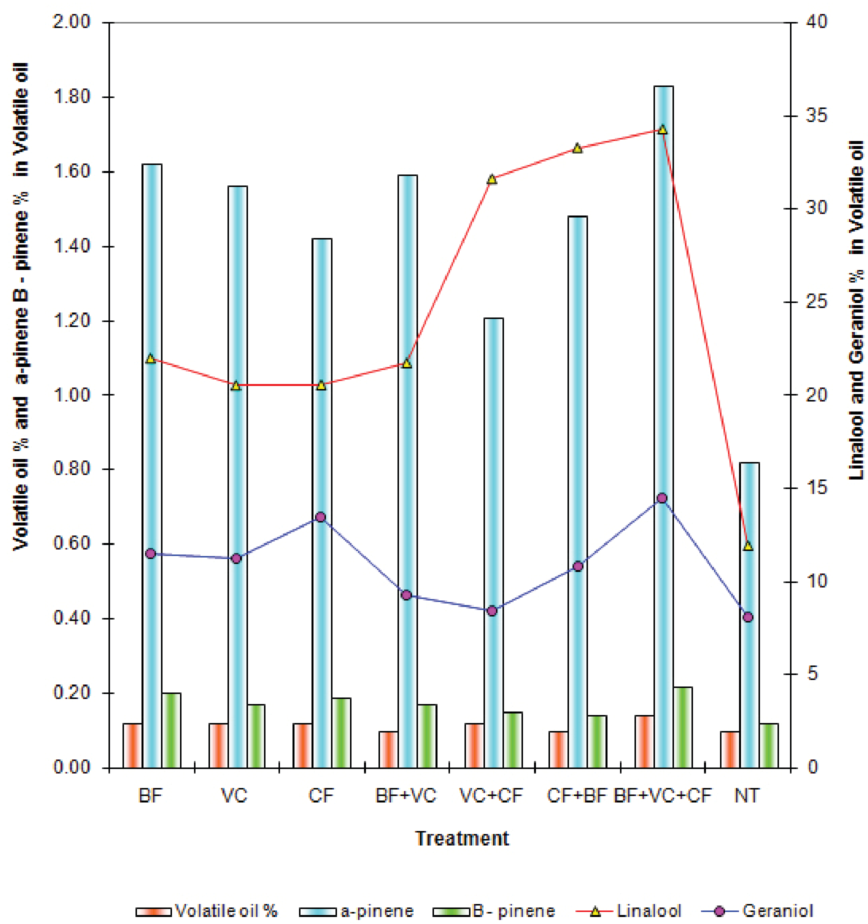

Figure 2: **Effect of biofertilizers, vermicompost and chemical fertilizers on volatile oil % and % of different compounds in volatile oil of *C. sativum* at harvest stage.**

Table 3: Effect of biofertilizers, vermicompost and chemical fertilizers on volatile oil % and % of different compounds in volatile oil of *C. sativum* (dry seeds) after harvesting

Plot No.	Treatments		Volatile oil %	% of different compounds in volatile oil			
				α-pinene	β - pinene	Linalool	Geraniol
T_1	BF		0.5	4.30	0.23	85.49	0.56
T_2	VC		0.4	4.14	0.24	85.80	0.69
T_3	CF		0.4	4.03	0.25	83.37	0.56
T_4	BF+VC		0.5	6.60	0.66	83.16	0.49
T_5	VC+CF		0.5	5.51	0.51	86.01	0.56
T_6	CF+BF		0.4	8.26	0.56	82.91	0.72
T_7	BF+VC+CF		0.5	8.76	0.71	86.36	1.00
T_8	NT		0.3	2.68	0.21	80.97	0.37
SA	Mean		.4375	5.5350	.4212	84.2588	.6188
SA	Variance		.006	4.693	.044	3.715	.036
SA	SD		.07440	2.16625	.21074	1.92746	.18879
SA	SE_m		.02631	.76588	.07451	.68146	.06675
SA	95% confidence Interval of the difference	Lower	.3753	3.7240	.2451	82.6474	.4609
		Upper	.4997	7.3460	.5974	85.8701	.7766

Abbreviations:- NT - No Treatment, BF - Biofertilizers, VC - Vermicompost, CF- Chemical Fertilizers, SD- Standard Deviation, SEm - Standard Error mean, SA - Statistical Analysis, INM - Integrated Nutrient Management, N - nitrogen, P - phosphorus, K- Potassium, PSB - phosphate solubilising bacteria.

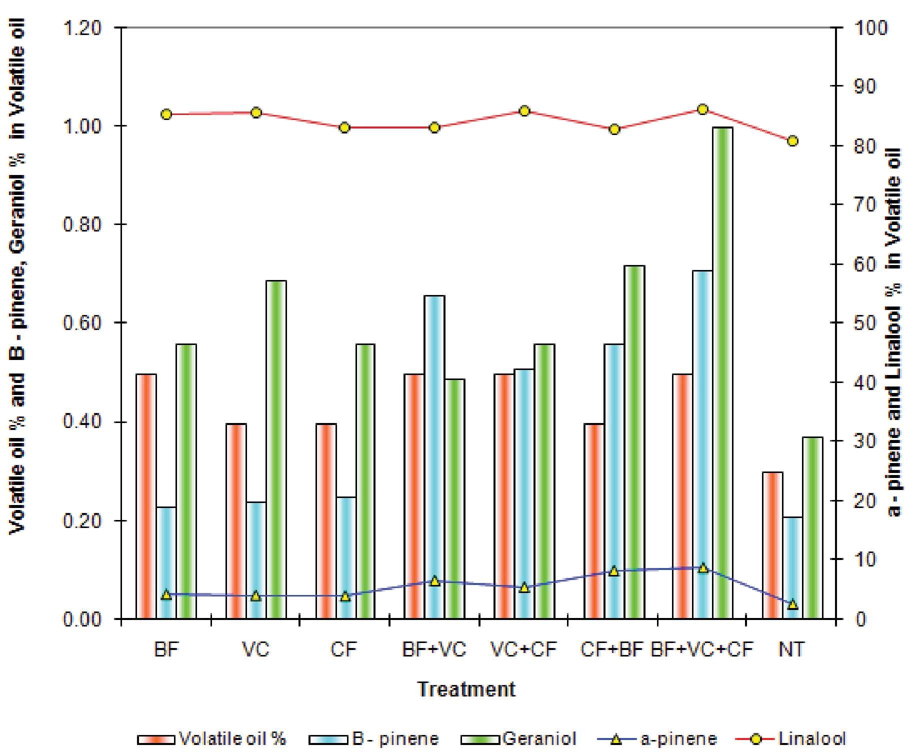

Figure 3: Effect of biofertilizers, vermicompost and chemical fertilizers on volatile oil % and % of different compounds in volatile oil (dried seeds) of *C. sativum* after harvesting.

vegetative growth due to integrated nutrient management that results in better photosynthetic activity and it results in increased volatile oil (%) in Coriander plants at different growth intervals.

The study by Kumar T. Senthil *et al.* (2009) also revealed that the combined application of nitrogen and phosphorus along with biofertilizers increased the essential oil yield in Devana (*Artimisia pallens* Wall). The results are in conformity with Srinivasan *et al*. (2005) in black pepper, Garg (2007) in fennel (*Foeniculum vulgare* Mill.), Gharib *et al*. (2008) in Sweet Marjoram (*Majorana hortensis*).

CONCLUSION

The findings revealed that the application of BF 250g/ha + VC @ 5t/ha + 50% NPK RDF was effective and it significantly improved the essential (volatile) oil (%) and percent of different compounds in essential oil of Coriander. Therefore, the nutrient needs can best be met through integrated nutrient management (INM). The concept of INM aims to increase the efficiency of use of all nutrient sources, the soil resources, mineral fertilizers, organic manures and recyclable wastes or biofertilizers. It can be concluded by these findings that biofertilizers and vermicompost along with chemical fertilizers (RDF) should be applied to Coriander for better quality crop, as already reported by Darzi and Hadi (2012) in coriander (*Coriandrum sativum* L.).

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