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Effects of Vermicompost (VC) and Farmyard Manure (FYM) on the germination percentage growth biochemical and nutrient content of Coriander (*Coriandrum sativum* L.)

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Abstract

The main objective of this study was to determine the effects of vermicompost (VC) and Farmyard manure (FYM) on the growth, biochemical and nutrient content of coriander (*Coriandrum sativum* L.). It was found that the VC was rich in nutrients like OC, N, P, K, Ca, Mg, Fe, Zn, Cu, Mn and Br were compared to FYM. The research experiment was laid out with plastic pots each pot contains 4 kg of both samples. The concentrations of FYM 50% and (VC) 50% were prepared. The concentrations of VC and FYM were prepared (50%=2000g VC + 2000 g soil) and (50%=2000 FYM + 1500g soil). Soil without FYM and compost was treated as control. The germination percentage, root and shoot length, fresh and dry weight, total chlorophyll, carotinoid and protein content and the nutrient composition such as Nitrogen (N), Phosphrous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Zinc (Zn), Iron (Fe) and Manganese (Mn) were estimated in the shoot portions of 90 DAS of coriander (*Coriandrum sativum* L.) plants. The VC application increased the all the Morphological, pigment, protein and nutrient content of coriander plants. The research work also showed distinct differences between VC and FYM in terms of their nutrient content and their effect on coriander plants.

Keywords: Vermicopost (VC), Farmyard manure (FYM), chlorophyll, protein and nutrient content, *Coriander sativum* L

Introduction

In recent years, numerous advances have been achieved towards enhancement on the quality and quantity in agriculture. Soil is a natural dynamic body on the surface of earth in which plants grow and is composed of minerals, organic matter, air, water, soil micro flora and fauna. The clean discarding of organic wastes by composting is an environmentally sound and economically viable technology resulting in the production of organic fertilizer which is a basic and valuable input in organic farming. In India, about 350 million tonns of agricultural wastes are generated annually is in major portion (Sharma, 2011).

Vermicomposting (VC) is a simple and effective technique to reprocess of agricultural waste, city garbage and kitchen waste along with bioconversion of organic waste materials into nutritious compost by earthworm action. VC technology involves the bio-conversion of organic waste into vermicasts, vermiwash utilizing earthworms (Jadia & Fulekar, 2008). These earthworms feed on the waste and their gut act as the bioreactor where the vermicasts are produced (Ansari and Sukhraj 2010). These vermicasts are also termed VC and are rich in NPK and micronutrients (Palanichamy *et al.,* 2011). Consequence of these VC on plant growth is well reported but mostly it used as a main source of 'N' and 'P' is a significant nutrient as a part of some key plant structural components and worked as catalysis in the change of numerous key of biochemical reactions in plants.

The VC application is one of the useful methods to renew the depleted soil fertility and augment the available pool of nutrients and conserve more water, maintain soil quality and conserve additional biological resources. As reported by a number of researchers, VC is an appropriate technology for residue and waste management like *viz.*, horticultural residues (Edwards 1998), sericulture wastes (Gunathilagraj and Ravignanam 1996), agricultural residues (Bansal and Kapoor 2000), cattle dung (Gunadi *et al.*, 2002), domestic kitchen wastes (Sinha *et al.*, 2002) and weeds (Gajalakshmi *et al.*, 2001). VC has also been found to have positive effects on some aromatic and medicinal plants (Anwar *et al.,* 2005; Prabha *et al.*, 2007). Could all be converted into good quality of VC with reasonable values of N, P, K.

VC has much larger microbial biodiversity and act than conventional thermophilic composts. Microbes present in gut wall of earthworm responsible for the biochemical degradation of organic matter and transformed it VC (Aira *et al.,* 2007). VC contains plant growth regulators and other plant growth influencing materials created by microorganisms (Tomati *et al.,* 1990) as well as humates (Atiyeh *et al.,* 2000), cytokinins and auxins (Krishnamoorthy and Vajrabhiah, 1986). The physico-chemical and biological property of soil of compost improves soil physical properties by declining bulk density and increasing the soil water holding capacity (Weber 2007). Besides, in assessment with mineral fertilizers, compost produces considerably better increases in soil Organic Carbon (OC) and some plant nutrients (Nardi 2004; Weber 2007). VC has incredibly 'high porosity', 'aeration', 'drainage' and 'water holding capacity'. They have an enormous surface area, providing strong absorbability and maintenance of nutrients. They become visible to retain more nutrients for longer period of time.

VC contains enzymes like amylase, lipase, cellulase and chitinase, which maintain to break down organic matter in the soil to liberate the nutrients and make it accessible to the plant roots. They also increase the levels of soil enzymes like dehydrogenase, acid and alkaline phosphatases and urease. VC biotechnology will bring in 'economic prosperity' for the farmers, 'ecological security' for the farms and 'food security' for the people.

Coriander (*Coriandrum sativum* L.) which belongs to the family *Apiaceae* (Umbelliferae) is mostly cultivated from its seeds throughout the year. India is the major producer, consumer and exporter of coriander in the world with an annual production of approximately (3 lakh tones). In India coriander growing states are Rajasthan, Andhra Pradesh, Madhya Pradesh, Tamilnadu, Bihar, Karnataka and Uttar Pradesh. It is an annual, herbaceous plant which originated from the Mediterranean and Middle Eastern regions and known as medicinal plants.

This plant is very much aromatic and has several uses in food and in other industries. Plants have played a major role in maintaining human health and civilizing the value of human life for thousands of years (Dhankar *et al.*, 2011). It is also used to perfume sausages. All parts of plant are edible, fresh leaves can be used for garnishing and are common ingredient in many foods like chutneys and salads. The green herb is also engaged for the preparation of either steam-distilled essential oil or the solvent extracted oleoresin (Mhemdi *et al.,* 2011). Fresh juice of coriander is tremendously beneficial in therapeutic many deficiencies correlated to vitamins and iron. Fresh leaves can be eaten as such because a variety of health benefits however, if it is not harvested freshly seeds mature and ripen in late summer developing delicate aroma which are then used as dried spice. Dried coriander fruit is an important ingredient in pickle making. It is sometimes used to mask odd flavors (Parthasarathy *et al.,* 2008). Its fruits contain vegetable oil with a high concentration of monounsaturated fatty acids, especially of petroselinic acid. So the present investigation was undertaken to assess the nutrient analysis of VC and FYM their impact on growth, biochemical and nutrient content of Coriander (*Coriandrum sativum* L.).

Materials and Methods

In the present investigation the soil samples was taken from Botanical garden, Department of Botany, Annamalai University. The FYM was collected from locally framers at Annamalainagar, the vermicompost (VC) were collected at Dept. of microbiology, Tamilnadu Agriculture University (TNAU), Coimbatore. Both the samples were dried and processed for the analysis.

The experiment was laid out with each pot contains 3 kg of sample. The concentrations of FYM (50%) and VC (50%) were prepared. The concentrations of FYM and VC were prepared (50%=1500 FYM + 1500g soil) and (50%=1500g VC + 1500g soil). Soil without FYM and compost was treated as control. Twenty coriander seeds were sown in each pot and irrigated on alternate days. All the concentrations were maintained in replicated. The VC, FYM and Soil were analyzed by using methods (Trivedi and Goel 1997)

Plant materials

Total nitrogen (Jackson, 1958 quoted by Yoshida et al., 1972)

Two hundred mg of dried plant (root, stem and leaf) materials were taken in a 100 mL Kjeldahl flask. About 200 mg of salt mixture (potassium sulphate, cupric sulphate and selenium powder mixed in the ratio of 50:10:1) and 3 mL of concentrated sulphuric acid were added. After digestion, 10 mL of distilled water was added and cooled. The diluted sample was decanted into the microkjeldahl distillation flask. To that, 10 mL of 40 per cent sodium hydroxide was added and distilled. The distillate was collected in a conical flask containing 10 mL of 4 per cent. Boric acid and 3 drops of mixed indicator (0.3 g bromoceral green and 0.2 g methyl red in 400 mL of 90% ethanol). This solution was titrated against 0.05 N HCl. Nitrogen content was estimated using the following formula,

$$\text{Nitrogen (\%)} = \frac{(\text{Sample titrate} - \text{blank litre}) \times \text{N of HCl} \times 14 \times 100}{\text{Sample weight} \times 1000}$$

Phosphorus (Black, 1965 quoted by Yoshida et al., 1972)

One gram of dried powdered plant material was digested with 10 mL of acid mixture (nitric acid 750 mL; sulphuric acid 150 mL and perchloric acid 300 mL). The digest was cooled and made up to 50 mL and filtered. One mL of the digest was mixed with 2 mL of 2 N nitric acid and diluted to 8 mL. One mL of molybdovanadate reagent (25 g of ammonium molybdate in 500 mL of water, 1.25 g of ammonium vanadate in 500 mL of 1 N nitric acid, both were mixed in equal volume) was added, shaken and the absorbance was measured at 420 nm in a UV-spectrophotometer after 20 min of standing. Calibration curve was prepared using potassium dihydrogen phosphate as standard.

Potassium (Williams and Twine, 1960)

Dried and ground tissue of 0.5 g was digested in 100 mL Kjeldahl flask using 10 mL of concentrated nitric acid, 0.5 mL of 60 per cent perchloric acid and 0.5 mL of sulphuric acid. The inorganic residue was cooled and diluted with 15 mL of distilled water and filtered through Whatmann No. 42 filter paper. The filtrate was made up to 50 mL with distilled water. The filtrate was used for potassium estimation by flame photometer and standards were prepared with potassium chloride.

Calcium and magnesium (Yoshida et al., 1972)

Two mL of the filtrate was mixed with 2 mL of 5 per cent lanthanum chloride solution and diluted with 10 mL of 1 N hydrochloric acid. The solution was fed into an Atomic Absorption Spectrophotometer at 211.9 nm for calcium and 285.4 nm for magnesium. Standard curve was prepared by using calcium chloride/magnesium chloride.

Zinc, copper, iron and manganese (De Vries & Tiller, 1980)

One mL of sulphuric acid and 15 mL of double distilled water were added to a Kjeldahl flask containing 0.5 g of dried and powdered material was incubated at 80 C for overnight. After that, 5 mL of acid mixture (nitric acid and perchloric acid in the ratio of 3:1) was added and then digested. The digested material was cooled, made up to 50 mL and filtered through Whatmann No. 42 filter paper. The sample was aspirated into an Atomic Absorption Spectrophotometer with air/acetylene flame for the estimation of zinc (214 nm), copper (324.6 nm), iron (568 nm) and manganese (530 nm) and the readings were taken and recorded. The Pigment and protein content analyzed in following methods Chlorophyll (Arnon, 1949), Carotenoid (Kirk and Allen, 1965), protein (Lowry *et al.*, 1951).

Results and Discussion

The nutrient content analysis of VC, FYM and soil, vary depending on the raw materials that are being used for compost preparation. If the raw materials are heterogeneous one, there will be wide range of nutrients available in the compost. If the raw materials are homogenous one, there will be only positive nutrients are available (Table. 1).

VC is a simple biotechnological process of composting in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. It is a finely divided, peat-like material, with high porosity, aeration, drainage, water holding capacity and microbial activity, which make it an excellent soil conditioner

(Atiyeh *et al.,* 2001). The most nutrients such as nitrates, phosphates, exchangeable, calcium and soluble potassium available forms are in soil, FYM and VC (Singh *et al.*, 2008).

Table.1 Nutrient analysis of VC, FYM, Soil

Nutrient contents	VC	FYM	Soil
pH	6.7	6.9	7.1
EC (mmhos/cm)	3.6	3.1	3.5
Organic carbon (%)	13.6	11.8	11
N (%)	2.63	1.03	0.72
P (%)	9.17	6.59	5.09
K (%)	2.95	1.55	0.98
Ca (%)	7.8	4.5	3.1
Mg (%)	2.44	1.19	0.85
Fe (ppm)	182	132.8	102
Zn (ppm)	22.8	16.2	13.2
Cu (ppm)	4.8	3.12	1.8
Mn (ppm)	84.9	65.3	48.4
Boron (ppm)	33.7	35	31.2

The results of several long-term studies have shown that the addition of VC improves soil physical properties by decreasing bulk density and increasing the soil water holding capacity Furthermore, in comparison with mineral fertilizers, compost produces significantly better increases in soil organic carbon N, P, K and some plant nutrients (Tognetti *et al.*, 2005; Weber *et al.*, 2007).

The experimental result, higher germination percentage (94%), root length (8.4cm), shoot length (24.8cm), plant fresh weight (16.7 g), Plant dry weight (7.8g) total chlorophyll (6.8 mg.fr.wt), carotenoids (2.25 mg.fr.wt) and protein (23.32 mg.fr.wt) was recorded in VC application at 90 DAS of coriander plant. the minimum germination (81%), root length (6.2 cm), shoot length (19.5cm), plant fresh weight (12.3 g), plant dry weight (4.22g) total chlorophyll (3.14 mg. fr. wt), carotenoids (1.22 mg.fr.wt) and protein (16.48 mg.fr.wt) was recorded in control at 90 DAS of coriander plants (Table 2).

Table. 2 Effects of different ratio of FYM and VC on the growth of coriander (*Coriandrum sativum* L.)

Treatments	G (%)	R. L (cm)	S. L (cm)	F.W (g)	D. W (g)	T Chl, (mg.fr.w)	Carotenoids, (mg.fr.wt)	Protein, (mg.fr.wt)
C	81 ± 4.05	6.2 ± 0.31	19.5 ± 0.975	12.3 ± 0.615	4.22 ± 0.211	3.14 ± 0.157	1.22 ± 0.061	16.48 ± 0.824
FYM	86 ± 4.3	7.1 ±0.355	21.4 ± 1.07	13.8 ± 0.69	5.18 ± 0.259	4.2 ± 0.21	1.98 ± 0.099	18.26 ± 0.913
VC	94 ± 4.7	8.4 ± 0.42	24.8 ± 1.24	16.7 ± 0.835	7.8 ± 0.39	6.28 ± 0.314	2.25 ± 0.1125	23.32 ± 1.166

G (%) = Germination percentage, R. L (cm) = Root Length, S.L = Shoot length, F.W = Fresh Weight, D.W = Dry Weight, T. Chl = Total Chlorophyll
± Standard deviation

Seed germination and growth are necessary importance for continuation of plant life. Seed germination is distinct as the resumption of metabolic activities. The growth of an embryo starts with the break of the seed coat and the emergence of the young seedlings. The effect of the environment on germination is quite complex because of external and internal factors that modify germination patterns (Rout *et al.*, 2000). Enhancement of growth might be attributed to the role of (VC) in greater the nutrient availability, and increase in beneficial enzymatic activities, increased population of beneficial microorganisms or the presence of biologically active plant growth influencing substances such as plant growth regulators or plant hormones in the VC and humic acids (Arancon *et al.*, 2006).

Canellas *et al.*, (2002) reported that the humic substances extracted from earthworm compost were capable of inducing lateral root growth in maize plants by stimulation of the plasma membrane H+ **-**ATPase activity, thus producing similar effects such as the exogenous application of indole-3-acetic acid (IAA). Stimulation of root growth (initiation and proliferation of root hair), increased root biomass, enhanced plant growth and development have been reported with the application of VC, because of the presence of humic acids (Chen and Aviad, 1990). Besides, the positive influences of humic acids on plant growth and productivity, which give the impression to be concentration specific, could be mainly due to hormone like activities of humic acids through their involvement in cell respiration, photosynthesis, oxidative phosphorylation, protein synthesis and various enzymatic reactions (Zandonadi *et al.*, 2006).

The enhancement of plant growth by VC may not only be nutritional, but due to its content of biologically active plant growth-influencing substances (Warman and Anglopez, 2010). The presence of plant growth regulators such as auxins, gibberellins, cytokinins of microbial origin and humic acids (Tomati *et al.*, 1988 and Atiyeh *et al.*, 2002) has been reported in VC. Chlorophyll is one of the important pigment content which is used as an index of plant production capacity. The pigment content is an indication of photosynthetic and metabolic activity. The chlorophyll is an integral component of plant pigments and plays a main role in the process of photosynthesis. It is the molecule that absorbs sunlight and uses its energy to synthesis carbohydrates from CO_2 and water. It also plays an important role in ATP synthesis (Kochot *et al.*, 1998). The increased chlorophyll content to the compost application was recorded in various plants such as lettuce (Ali *et al.*, 2007), common bean (Luqueno *et al.*, 2010), *Cyamopsis tetragonoloba* and *Trigonalla foenum-graecum* (Suthar, 2010), citrus (Wu and Xia, 2006) and ginger (Ahmad *et al.*, 2009). The increasing chlorophyll content was due to the presence of microorganisms in the VC and FYM that colonize in the rhizosphere and stimulate the plant growth and biochemical contents. The important increasing in protein content respectively when compared to the control is due to the increase the percentage of 'N' and 'P' in plants (Vazquez *et al.*, 2002). Increased chlorophyll may be attributed to the increased biological nitro-fixation, better organic nitrogen utilization, better development of root system and the possible synthesis of plant growth regulators like IAA, GA_3 and cytokinins (Martinez *et al.*, 2001). And increase in chlorophyll may be related to general role of VC in stimulating nutrient uptake especially nitrogen which has role in the assimilation of several amino acids that are subsequently included in proteins and nucleic acid, which provides frame work for chloroplast, mitochondria and other structure in which the most of the biochemical reactions occurs (Awasthi *et al.*, 1998).

It was found in VC that organic acid of soils increased the plant uptake of P form a water soluble and also the release of organic acids both sequester cations and acidity. Nutrients such as N, P, K, Mg, Fe and Cu, which are readily available through VC, are used in the formation of chlorophyll which is required for light harvesting and subsequent conversion into chemical energy via photo-assimilation (Tanaka *et al.*, 1998).

The higher plant nutrient content such as nitrogen, phosphorus, potassium, calcium, magnesium, sodium, zinc and iron content of coriander plants (29, 384, 423, 31.2, 523, 192, 3.1 and 30.01 mg g^{-1} dr. wt.) was recorded in VC application at 90 DAS. The minimum nitrogen, phosphorus, potassium, calcium, magnesium, sodium, zinc and iron content (19, 230, 308, 20.8, 452, 158, 1.3 and 21.8 mg g-1 dry wt.) was recorded in control, at 90 DAS of coriander plants (Table 3).

Table. 3 Effects of different ratio of FYM and VC on the nutrient content of coriander (*Coriandrum sativum* L.)

Treatments	Nitrogen (mg. dr. wt)	Phosphorus (mg. dr. wt)	Potassium (mg. dr. wt)	Calcium (mg. dr. wt)	magnesium (mg. dr. wt)	Sodium (mg. dr.wt)	Zinc (mg. dr. wt)	Iron (mg.dr.wt)
C	19 ± 0.95	230 ± 11.5	308 ± 15.4	20.8 ± 1.04	452 ± 22.6	158 ± 7.9	1.3 ± 0.06	21.8 ± 1.09
FYM	22 ± 1.1	275 ± 13.75	342 ± 17.1	24.02 ± 1.20	497 ± 24.9	174 ± 8.7	2 ± 0.1	26.1 ± 1.31
VC	29 ± 1.45	384 ± 19.2	423 ± 21.15	31.2 ± 1.56	523 ± 26.2	192 ± 9.6	3.1 ± 0.16	30.01 ± 1.6

C- Control, FYM – Farmyard Manure , VC- Vermicompost,
± Standard deviation

Nitrogen from leaf tissue might have been translocated and utilized for formation of flowers and pods. This might be the reason for observed descend in nitrogen content at these stages. Hormone application causes increase in physiological and metabolic activities of plant as a result of which there might be more uptakes of plant nutrients from soil (Umamaheswari and Vijayalakshmi. 2003).

The pattern of potassium uptake by plants under different treatments was similar to nitrogen assimilation. The lowest potassium uptake was detected in plants grown without any application. Individual VC application increased the potassium content uptake when compared with the control. The micronutrient such as Mn, Zn, Fe. This probably related to phosphorus element in the VC and also other important nutrients are found such as Ca, Mg and K and N (Gutierrez-Miceli *et al.,* 2007; Basu *et al.*, 2008; Wang *et al.*, 2010 and Lazcano *et al.,* 2011). Humic substances prolonged bioavailability of phosphorus and others micro nutrients have reported increased tissue levels of zinc and iron (Chen *et al.,* 2004; Mackowiak *et al.,* 2001), and manganese (Liu *et al*., 1998).

The effects of VC and FYM were applied in experiment crop of coriander to investigation its importance in plant growth, nutrient content and productivity. Organic leafy vegetable production is proscribed by essential macro and micronutrients and other growth promoting substances present in the VC. Thus utilization of VC is the most excellent means of reduction the environmental pollution, soil degradation and removal in discriminate use of chemical fertilizers. The data clearly indicates that VC may be a well-organized plant growth media for sustainable plant production, if applied without some combinations of inorganic fertilizer.

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