Influence of Vermifertilizer on Soil Quality, Yield and Quality of Chilli, *Capsicum annuum*

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Abstract

Field experiments were conducted during 2012 – 2013 on clay loam soil at Vallampadugai, Chidambaram, Cuddalore district, Tamil Nadu, India, to evaluate the efficacy of vermifertilizer (VF) on the soil quality characteristics, and on the yield and quality characteristics of chilli – *Capsicum annuum* L., in comparision to inorganic fertilizers (NPK). VF (5 tons/ha) and VF supplemented with recommended dose of inorganic fertilizer (RDCF) (120:60:30 kg.ha) (w/w) had significantly (P<0.05) increased the pore space, water holding capacity, cation exchange capacity, organic carbon, available N, P, K, other micro-macro nutrients – Ca, Mg, Na, Fe, Mn, Zn, Cu and microbial population - activity and humic acid content, reduced particle and bulk density, pH, EC in the field soil. Also the yield (both fresh and dry fruit weight) and quality (vitamin A, Vitamin C and Capsaicin content) of chilli was enhanced in the soil. On the contrary, the application of NPK alone has resulted in reduced porosity, compaction of soil, organic carbon, microbial population, microbial activity and humic acid content. In over all investigations, the obtained results specified that the combined application of VF and RDCF show promising results in the cultivation of chilli and better for obtaining the higher quality chilli and further the VF reduce 50% RDCF to the chilli crop and also enhances soil quality, yield and quality characteristics of chilli than 100% application of RDCF on chilli.

KEYWORDS: Vermifertilizer, Inorganic fertilizers, *Capsicum annuum*, Soil quality, Yield, Vitamin A, Vitamin C, Capsaicin.

INTRODUCTION

In India, the area of productive agricultural land is about 143 million hectares, of which 83 million hectares suffer from various degrees of soil degradation. Hence conservation of soil health, fertility, plant productivity and wise use of soil are very essential today. It has been proved that indiscriminate use of inorganic fertilizers results in decrease in soil fertility and increase in soil acidity with depletion of organic humus content in addition to poor crop quality. Use of organic manures to meet the nutrient requirements of crop would be an inevitable practice in the years to come sustainable agriculture since organic manures not only improve the soil physical, chemical and biological properties (Heitkamp *et al.*, 2011) but also improves the moisture holding capacity of soil, thus resulting in enhanced crop productivity along with better quality of crop produce (Premsekhar and Rajashree, 2009). Manure and biologically active preparations of animal and plant origin are most commonly used for sustainable agricultural production due to their beneficial effects on nutrient uptake and retention, pest control and productivity (Barrios – Masias *et al.*, 2011).

Among such preparations, vermicompost has been recognized as having considerable potential for soil amendments (Wei *et al.*, 2012). The practice of organic farming through vermicomposting in agriculture is an essential step. Vermcompost promotes soil porosity, aeration, drainage, granulation, water holding capacity, soil organic matter and aggregation and root penetration (Edwards *et al.*, 2011). Albiach *et al.* (2000), Manivannan *et al.* (2009) and Parthasarathi (2010) reported significant increase in soil nutrient uptake, microbial – enzymatic activities with vermicompost application. Vasanthi and Kumarasamy (1999), Parthasarathi *et al.*, (2008), Parthasarathi (2010) and Najar and Khan (2013) found that application of vermicompost has not only enhanced soil fertility but also risen productivity. The increased growth and yield components of paddy, wheat, maize, tomato, rose, citrus, curry leaf, turmeric, ornamental plants, cash crops, oil seeds, spices, vegetable fruits and sorghum have been reported by many investigators (Kulkarni *et al.*, 1996; Edwards and Bohlen, 1996; Garg and Bharadwaj, 2000; Parthasarathi, 2010; Najar and Khan, 2013) and the application of vermifertilizer from a particular unutilized solid organic wastes using indigenous earthworm on clay loam soil and analysis of soil quality, yield and quality of a particular crop under field are scanty.

Of late soil condition has deteriorated due to huge application of inorganic fertilizers and pesticides in order to increase the yield and protect the crop varieties. Application of chemical fertilizer has boomaranged on man, soil organisms and environment. The production and use of vermicomposts in agriculture is economical with regard to food production and more eco-friendly with regard to environment and soil protection (Haynes *et al*, 1999). The unique advantage of using vermicompost is that it helps to build and sustain soil condition and fertility which is necessary for prolonged agricultural activities. Secondly vermicomposting reduces bad odours and prevents pollution of soil, air and water. Vermicompost has been shown to have higher level of organic matter, organic carbon, total and available N, P, K and micro-nutrients, microbial - enzyme activities and growth regulators (Mulongoy and Bedoret, 1989; Tomati and Galli, 1995; Edwards and Bohlen, 1996; Parthasarathi and Ranganathan, 1999, 2000). Use of vermicompost/ vermifertilizer in agriculture can solve the management and disposal problem associated with solid organic wastes and also resolves the deficiency of organic matter in such soils in addition to nutrient depletion (Nagar and Khan, 2013). We already managed enormously availably unutilized solid organic wastes – cashew leaf letter admixed with different animal dungs in various proportions through vermicomposting practices (using indigenous earthworm, *Perionyx excavatus*; Parthasarathi and Jayanthi, 2013) and produced agronomic quality vermifertilizer (C:N ratio is below 15; Jordening and Winter, 2008) and from this study observation, 2:2 ratio a cashew leaf litter and cowdung could be recommended for vermiculture and quality vermifertilizer production for sustainable agricultural activity. Hence the objective of the present study was to evaluate the response of this vermifertilizer (VF) in alone and in supplemented with chemical fertilizers (NPK) on soil quality, yield and quality of chilli, *Capsicum annuum* L. under field condition.

MATERIALS AND METHODS

Preparation of vermifertilizer from solid organic wastes

Dried cashew leaf litters (CLL) were collected from Mutlur cashew Farm, Cuddalore district, Tamil Nadu, India and CLL were chopped in to 12-18 cm size. The cowdung (CD) were obtained from agricultural Farm of Annamalai University, Annamalainagar, Tamil Nadu, India. To 10 kg of 2:2 mixture of CLL: CD were taken in a cement tank (35 x 40 x 30 cm) and to this 250 g of earthworms, *Perionyx excavatus* (Perrier) were introduced and maintained for 50 days, maintaining 65-67% moisture in the mixture at 30 ± 2°C and 65-70% RH. After 50 days, fresh VF were collected by hand from the surface and used for experiments.

Experimental site and design

A microplot (2 m^2) field experiment was conducted for two consecutive years (2012 – 2013) at Vallampadugai village, Chidambaram, Tamil Nadu. Experiment was laid out in randomized block design with factorial concept having three replications. Altogether these were 12 plots, four replicate in each. The soil of experimental site was clay loam in nature (course sand – 6.28%, fine sand – 14.25%, silt – 27.50% and clay – 51.97%; Parthasarathi *et al.*, 2013) with well fertile and free from weeds. Chilli (*Capsicum annuum* L. CVKI) was used as test crop. Seeds were collected from Regional Vegetable Research Station, Palur, Cuddalore District, Tamil Nadu. Seeds with uniform size were chosen for the experiments. Treatments consisted of T_1 – control (without application of inorganic NPK fertilizer or VF), T_2 – 100% recommended dose of NPK (RDCF) (120:60:30 kg/ha), T_3 – 100% recommended dose of VF (RDVF) (5 t/ha) and T_4 – 50% RDVF supplemented with 50% RDCF (w/w). Inorganic NPK fertilizer was applied through urea, single super phosphate and muriate of potash. Inorganic NPK fertilizer and VF were applied to the field soil by basal application at the time of sowing of seeds.

Soil quality analysis

Soil samples were collected from each plot from 0-15 cm depth in two different periods: initial (I) – 0 day (before application of NPK and VF and chilli seed sowing) and final (F) – 120 days (after harvesting of chilli). Soil physical properties like porosity, particle density and bulk density were determined by specific gravity bottle method of Kanwar and Chopra (1980), water holding capacity (WHC) was determined by the procedure of Baruah and Barthakur (1999) and cation exchange capacity (CEC) was estimated by ammonium saturation method of Jackson (1973). Chemical parameters like pH and electrical conductivity (EC) were determined by ISI Bulletin (1982) by using digital pH and conductivity meters, organic carbon (OC) was estimated by following the procedure of Walkley and Black (1934), available nitrogen, phosphorus and potassium were estimated respectively by alkaline potassium permanganate method of Subbiah and Asija (1956), Olsen *et al.* (1954) and neutral normal ammonium acetate method of Standford and English (1949). Total microbial population was estimated according to the method of Baron *et al.* (1994) and expressed as CFU x 10^6 g^{-1} and microbial activity in terms of dehydrogenase activity was estimated adopting the procedure of Stevenson (1959) and expressed as µlH/5g substrate.

Yield and quality characteristics of chilli

The fruit yield obtained from each picking from the net plot area at 60, 90, 120 days after transplanting and at harvest was weighed immediately for fresh fruit weight, the total fresh weight yield per hectare was computed and express in kg.ha and the fruits were sun dried till they attained constant weight, the total dry weight yield per hectare was computed and expressed in kg/ha. The harvested fruits of chilli (at 90 days for fresh fruit and after 120 of fully sun dried for dry fruit) were analysed for vitamin A by the procedure of Sawhney and Singh (2011), for vitamin C using the procedure of Sadasivam and Manickam (1992) and Capsaicin content by the method of Sadasivam and Manickam (2003).

Statistical analysis

The results were statistically analysed at $P<0.05$ level using analysis of variance (ANOVA – NPRC Statistical package; Version 8/98).

RESULTS AND DISCUSSION

The effect of application of NPK, VF and VF supplemented with NPK on the soil quality parameters, before sowing (initial soil) and post harvest of chilli, yield and quality characters of chilli *C. annuum* are given in the Table 1. Long-term application of inorganic fertilizers like high doses of ammonium sulfate and sulfer coated urea has led to soil acidification (Ma *et al.*, 1990), decrease in soil aggregate stability (Estevez *et al.*, 1996), decrease in soil respiration (Sharma, 2003), pollution of underground water and decrease in earthworm populations (Edwards and Bohlen, 1996). Vermicompost has been shown to have high levels of total and available micro-macro nutrients, microbial-enzyme activities and growth regulators (Kale *et al.*, 1992; Edwards and Bohlen, 1996; Parthasarathi, 2010) and continuous and adequate use with proper management can increase soil organic carbon, soil water retention and transmission and improvement in other physical properties of soil like bulk density, penetration resistance and aggregation (Zebarth *et al.*, 1999) as well as beneficial effect on the growth and yield of a variety of plants (Atiyeh *et al.*, 2002). Long-term application of inorganic fertilizers without organic supplements damages the soil's physical properties (Goyal *et al.*, 1999). The porosity depends upon the texture and aggregation of the soil. Application of sewage sludge compost at rates equivalent to 50 and 150 t/h manure, based on OC content, had been shown to increase the porosity of a soil at all times during two years of monitoring (Guidi *et al.*, 1983). The increased porosity in VF and VF supplemented with RDCF treated plots in the present study is probably due to aggregation of the soil particles by the action of microorganism in the VF which produce polysaccharides providing a cementing action between the soil particles (Six *et al.*, 1998) and possibly also by fungal mycelia (Edwards and Bohlen, 1996). These results are in confirmation with the reports of Parthasarathi *et al.*, (2008), Mannivannan *et al.*, (2009) and Parthasarathi (2010) who applied vermicompost and NPK plus vermicompost, had been shown to increased porosity of different soils like clay loam, sandy loam and red soil. Earlier studies have shown that vermicast appears to be enriched with polysaccharides which act in the soil as cementing substances causing aggregate stability, contributing to create and maintain the soil structure and causing better aeration, water retention, drainage and aerobic conditions, very useful for root development and nutrient availability to plants (Tomati and Galli, 1995). Edwards and Bohlen (1996) reported that earthworm cast contains more water stable aggregate than the surrounding soil.

In the present study, the particle density and bulk density were significantly reduced in all the treatments (T3 and T4 plots) compared to the initial non-cultivable control soils and NPK alone treated soils. This could be mainly due to the enhanced microbial population and activity that resulted in the formation of aggregates and increased porosity. Similar observations were made by Vasanthi and Kumarasamy (1999), Parthasarathi *et al.*, (2008), Manivannan *et al.*, (2009) and Parthasarathi (2010) who found a significant reduction in the particle and bulk density of soil treated with vermicompost and vermicompsot supplemented with NPK. The least

Table 1. Effect of vermifertilizer and NPK on soil quality, yield and quality of chilli (n=6) ($p<0.05$)

Parameters		T_1	T_2	T_3	T_4	F – value	CD value
Pore space (%)		34.32	31.16 (-9.2)^x	43.66 (+21.4)^x(+28.6)^y	38.61 (+11.1)^x(+19.3)^y(-11.6)^z	32.0	5.65
Particle density (Mgm^{-3})		1.82	1.73 (-4.9)^x	1.26 (-30.7)^x(-27.2)^y	1.51 (-17.0)^x(-12.7)^y(+16.6)^z	3.58	0.82
Bulk density (Mgm^{-3})		1.26	1.34 (+5.9)^x	0.89 (+29.4)^x(-33.6)^y	1.03 (-18.3)^x(-23.1)^y(+13.6)^z	2.17	0.90
Water holding capacity (%)		86.18	82.31 (-4.5)^x	96.13 (+10.4)^x(+14.4)^y	91.61 (+5.9)^x(+10.2)^y(-4.7)^z	3.49	17.69
Cation exchange capacity(emol (p^{-1}) kg^{-1})		26.42	28.12 (+6.1)^x	34.16 (+22.7)^x(+12.7)^y	30.72 (+14.0)^x(+8.5)^y(-10.1)^z	6.45	6.70
pH		7.11	7.22 (1.5)^x	7.02 (-1.3)^x(-2.8)^y	7.09 (-0.28)^x(-1.8)^y(+0.98)^z	16.05	2.38
EC (dsm^{-1})		0.84	0.98 (+14.3)^x	0.66 (-21.4)^x(-32.7)^y	0.75 (-10.7)^x(-23.5)^y(+12.0)^z	45.38	0.03
OC (%)		0.26	0.19 (-26.9)^x	3.32 (+92.2)^x(+94.3)^y	1.86 (+86.0)^x(+89.8)^y(-44.0)^z	2.29	0.89
Available N (kg ha^{-1})		116	163 (+28.8)^x	225 (+48.4)^x(+27.6)^y	207 (+44.0)^x(+21.3)^y(-8.0)^z	0.23	65.59
Available P (kg ha^{-1})		10.30	15.13 (+31.9)^x	20.17 (+48.9)^x(+25.0)^y	17.41 (+48.8)^x(+13.1)^y(-13.7)^z	10.37	3.41
Available K (kg ha^{-1})		103	146 (+29.5)^x	189 (+45.5)^x(+22.6)^y	165 (+37.6)^x(+11.5)^y(-12.7)^z	3.12	69.55
Ca (%)		1.62	1.68 (+3.6)^x	3.15 (+48.6)^x(+46.7)^y	2.42 (+33.1)^x(+30.6)^y(-23.2)^z	27.0	1.15
Mg (%)		0.59	0.54 (-8.5)^x	0.92 (+35.9)^x(+41.3)^y	0.73 (+19.2)^x(+26.0)^y(-20.7)^z	1.19	1.13
Na (%)		0.09	0.07 (-22.2)^x	0.16 (+43.8)^x(+56.3)^y	0.10 (+10.0)^x(+30.0)^y(-37.5)^z	0.85	0.46
Fe (ppm)		12.13	11.86 (-2.2)^x	56.18 (+78.4)^x(+78.9)^y	38.11 (+68.2)^x(+68.9)^y(-32.2)^z	13.36	3.83
Mn (ppm)		11.33	10.69 (-5.6)^x	77.61 (+85.4)^x(+86.2)^y	41.16 (+72.5)^x(+74.0)^y(-47.0)^z	21.23	4.12
Zn (ppm)		1.35	1.16 (-14.1)^x	42.31 (+96.8)^x(+97.3)^y	29.05 (+95.4)^x(+95.0)^y(-31.3)^z	9.11	5.14
Cu (ppm)		1.96	2.13 (+8.0)^x	19.5 (+90.0)^x(+89.1)^y	13.15 (+85.6)^x(+83.8)^y(-32.6)^z	7.11	4.02
Total microbial population (CFU x 10^6 g^{-1})		40.4	36.7 (-9.2)^x	62.6 (+35.5)^x(+41.4)^y	50.5 (+20.0)^x(+27.3)^y(-19.3)^z	6.98	7.18
Microbial activity (µl H / 5g soil substrate)		3.9	3.5 (-10.3)^x	5.8 (+32.8)^x(+39.7)^y	4.6 (+15.2)^x(+23.9)^y(-20.7)^z	22.09	1.91
Humic acid content (%)		0.88	0.79 (-11.4)^x	2.82 (+68.8)^x(+71.9)^y	2.35 (+62.6)^x(+66.4)^y(-16.7)^z	3.12	1.14
Yield (kg.ha^{-1})	a	1819	1946 (+6.5)^x	2267 (+19.8)^x(+14.2)^y	2412 (+24.6)^x(+19.3)^y(+6.0)^z	10.60	7.05
	b	618	686 (+9.9)^x	785 (+21.3)^x(+12.6)^y	813 (+23.9)^x(+15.6)^y(+3.4)^z	11.68	4.39
Vitamin A (µg / g)	a	55.6	63.2 (+12.0)^x	76.8 (+27.6)^x(+17.7)^y	81.5 (+31.8)^x(+22.5)^y(+5.8)^z	0.86	8.94
	b	17.9	20.4 (+12.3)^x	24.6 (+27.2)^x(+17.1)^y	26.3 (+31.9)^x(+22.4)^y(+6.5)^z	16.33	3.46
Vitamin C(mg/ 100 g)	a	62.3	76.6 (+18.7)^x	88.5 (+29.6)^x(+13.5)^y	94.7 (+34.2)^x(+19.1)^y(+6.6)^z	8.56	3.54
	b	14.5	17.4 (+16.7)^x	20.2 (+28.2)^x(+13.9)^y	21.3 (+39.9)^x(+18.3)^y(+5.2)^z	18.77	3.00
Capsacinin (%)	a	2.69	3.10 (+13.2)^x	3.83 (+29.8)^x(+19.1)^y	4.14 (+14.5)^x(+25.1)^y(+7.5)^z	13.36	1.91
	b	1.20	1.49 (+19.5)^x	1.72 (+30.2)^x(+13.4)^y	1.88 (+36.2)^x(+2.07)^y(+8.5)^z	4.85	0.0007

T_1 – Control(without application of inorganic fertilizer/vermifertilizer); T_2 – Recommended dose of NPK (120:60:30 kg ha^{-1}); T_3 – Recommended dose of vermifertilizer (5 tons ha^{-1}); T_4 – 50% vermifertilizer supplemented with 50% NPK (w/w); a–Fresh(green) fruit; b – Dry fruit; CD value – Critical difference value; x - The figures in parentheses (+/-) indicates the percent increase / decrease over T_1; y - The figures in parentheses (+/-) indicates the percent increase / decrease over T_2; z - The figures in parentheses (+/-) indicates the percent increase / decrease over T_3.

reduction in particle and bulk density among the four treatments were found in soils treated with NPK alone.

Aggregation of soil and its water use efficiency improved with increasing dose of vermicompost upto a particular level (Bhattacharjee *et al.*, 2001). A comparison between a raw, composted, and a worm-worked mixture of primary and secondary kraft paper mill sludge found that the composted and worm-worked sludges increased the available soil moisture from 10.5% to 54.4 and 31.6%, respectively. WHC was reported to be greater in soils with large amount of organic matter (or) clay particles (Einspahr and Fiscus, 1984). The increased WHC in VF and VF plus RDCF treated plots, in the present study, was due to increased porosity and decreased bulk density of the soil due to VF application and these inturn provide greater aeration and better drainage. Vasanthi and Kumaraswamy (1999), Parthasarathi *et al.* (2008), Manivannan *et al.* (2009) and Parthasarathi (2010) also reported that there was a significant increase in WHC of the soil treated with vermicompost and vermicompost supplemented with NPK.

CEC is greater in soils with greater amount of organic matter and clay. Our present study reveled that CEC has been significantly increased in the soil treated with VF and VF supplemented with RDCF. Such increased CEC in the T3 and T4 treated plots in the present study was mainly due to higher amount of organic matter and humic substances in the VF. This finding falls in line with Vasanthi and Kumaraswamy (1999), Parthasarathi *et al.* (2008), Manivannan *et al.*, (2009) and Parthasarathi (2010) who found significant increase in CEC of the soil treated with vermicompost and vermicompost plus NPK. In addition to the presence of higher amount of humic substances and organic matter in the VF, presence of clay particle in the soil have helped in boosting the CEC.

pH range between 6-7 seems to promote the availability of nutrients to the plants (Brady, 1988; Edwards and Bohlen, 1996). In the present study, irrespective of the treatments, the pH of the soil had not decreased significantly. Application of NPK / RDCF alone treated soil had increased the pH. However, the very slightly decrease in pH observed in the present study in the T_3 and T_4 treated soils could be due to the acidifying effect of urea and organic acids produced during the course of decomposition of organic amendments. Similarly, decreased pH was observed in the soils treated with enriched compost of industrial wastes, after harvest of ragi and cowpea (Srikanth *et al.*, 2000) and with pressmud-trash-bagase vermicompost of sugar industrial wastes, after harvest of blackgram (Parthasarathi *et al.* 2008) and beans (Manivannan *et al.* 2009).

Application of VF and VF plus RDCF in the present study revealed that, EC was decreased in the T_3 and T_4 treated soil; however it was increased in the NPK alone treated soil (T2). Such decreased EC, in the present study, could be due to the increased permeability and leaching of salts. Similarly, low EC was observed in the soils treated with enriched compost, FYM and vermicompost where ragi and cowpea were grown (Srikanth *et al.*, 2000) and pressmud – trash – bagase vermicompost where blackgram and beans were grown (Parthasarathi *et al.* 2008) and Manivannan *et al.*, 2009).

The deficiency in OC reduces the storage capacity of soil nutrients and reduction in soil fertility (Kale *et al.*, 1992). OC had been enhanced in soils treated with VF (T_3) and VF plus NPK (T_4) and was sustained after harvest. On the contrary in fields where only NPK was applied, the percentage of OC content was lower than control fields. Our results are in line with the observation made by Vasanthi and Kumarasamy (1999), Srikanth *et al.* (2000) and Parthasarathi *et al.* (2008), Manivannan *et al.* (2009) and Parthasarathi (2010) where the incorporation of various enriched compost, FYM, vermicompost and pressmud-trase-bagase vermicompost have been shown to have increased OC content in the soil. Hervas *et al.* (1989) reported that the organic fraction of vermicompost is upto over 50% of the total weight. So it can be concluded that increased OC content in the soil, in the present study, is mainly due to higher amount of OC content in the vermifertilizer.

Also available N, P, K, total Ca, Mg, Na, Zn, Fe, Cu and Mn, in the present study, were significantly increased in soil treated with VF (T_3) and VF plus NPK (T_4). Bhattacharjee *et al.* (2001) reported that application of vermicompost reduces the loss of nutrients through leaching from the soil by changing the soils physico-chemical properties. Increased available NPK in the soils was observed where the soil were treated, respectively, with enriched compost from different organic wastes, FYM, vermicompost and vermicompost plus NPK after the harvest of rice, rage and cowpea (Vasanthi and Kumaraswamy, 1999; Srikanth *et al.* 2000; Chaoui *et al.* 2003). This present observations was supported by Parthasarathi *et al.* (2008), Manivannan *et al.* (2009) and Parthasarathi (2010) who found significantly enhanced available NPK total Ca, Mg, Na, Zn, Fe, Cu and Mn in soil treated with only vermicompost from sugar industrial waste and vermicompost plus NPK, after the harvest of blackgram and beans.

Manure application is known to stimulate and improve stable soil structure, microbial population and biological activity (Chaoui *et al.*, 2003). Compared to control, in the present study, the total microbial population and activity and humic acid content had been significantly enhanced in the soils treated with VF (T_3) and VF plus NPK (T_4). A very striking feature of the application of NPK (T_2) to soil is the reduction in total microbial population – activity and humic acid content and the reduction was even lesser than the values of observed in the control field where neither organic or inorganic fertilizer was applied. This study was supported by Parthasarathi *et al.* (2008), Manivannan *et al.* (2009) and Parthasarathi (2010) who found enhanced microbial population – activity and humic acid content in the soil treated with vermicompost and vermicompost plus NPK after the harvest of blackgram and beans. Organic residues were found to increase the size, biodiversity and activity of the microbial population and humic acid content in soil (Albiach *et al.*, 2000). Zink and Allen (1998) found that the application of the composts enhances the microbial population and activity in the soil. Further, Goyal *et al.* (1999) observed that soil organic matter level, soil microbial biomass and activities and humic acid content were increased with the use of organic fertilizers. In the present study, total microbial population - activity and humic acid content had been significantly enhanced in soil where VF (T_3) and VF plus NPK (T_4) were applied. This is due to the more availability of nutrients, HWC, microbial population – activity and humic and content in the VF. The greater pore volume in vermicompost amended soils increased the availability of both water and nutrients to microorganisms in soils (Scott *et al.* 1996). On the contrary, in the present study, application of NPK alone had resulted in the reduction of microbial population, activity and humic acid content in T_2 plots which is due to reduction of OC content in the soil, compaction, reduced porosity, WHC and micro nutrients.

Vermicompsot could serve as a naturally produced, slow release source of plant nutrients and their amendment has been shown to modify and maintain sustainable soil health and fertility, increase plant dry weight, plant N uptake, yield and quality (Tomati *et al.*, 1990; Kale *et al.*, 1992; Edwards and Bohlen, 1996; Parthasarathi, 2010). The combined application of organic and inorganics for crop production provides an ideal nutrition. Chilli is one of the important solanaceous vegetable and most valuable commercial spice crops grown for its fruit in India. In the present study, the treatment with VF and VF plus RDCF recorded significantly higher chilli fruit yield (both fresh and dry) than NPK and control plots. The reasons for increased fruit yield in chilli was attributed to the increased solubilization effect and availability of nutrients (growth hormones, vitamins, microbes, enzymes and micro and macro elements) by the addition of VF (Tomati and Galli, 1995; Edwards and Bohlen, 1996; Parthasarathi and Ranganthan, 2002; Parthasarathi, 2010) and increased physiological activity leading to the build up of sufficient food reserves for the developing sinks and better portioning towards the developing fruits and thus higher fruit yield. Similar results were also reported by Subbaiah *et al.* (1982), Amirthalingam (1988), Balaraj (1999), Shashidhara (2000) and Kodalli (2006) in chilli.

Application of organics is more friendly to environment and better for quality crop productivity. Vitamin A and C are more abundant in capsicum fruit, and are the main nutrient ingredients of capsicum, while capsaicin is responsible for the hot taste. Thus the vitamin A and C and capsaicin content of capsicum fruit are useful indicators of quality. The increase in yield and quality components – vitamin A and C and capsaicin in the present study (T_3 and T_4 plots) may be due to the fact that VF are known to enhance microbial population – activity and humic acid content which might have helped and improved availability of nutrients through mineralization (Parthasarathi and Ranganathan, 1999; 2000; Parthasarathi *et al.*, 2007; Parthasarathi, 2010) and eventually leading to better canopy coverage, higher photosynthesis and translocation of photosynthates from source of sink Kodalli (2006) / accumulation of substances and availability of nutrients for longer period and reduced loss of nutrients through leaching (Sekar *et al.*, 2013) / the increased microbial population and activity improves the availability of soil N and P (Parthasarathi, 2010) and also due to better development of fruits and its quality / increased uptake of N and P in plants leading to enhanced chlorophyll content, carbohydrate, protein, vitamin and capsaicin synthesis / higher accumulation of photosynthates and their distribution to the developing ovules. These results are in accordance with the research findings of Chavan *et al.* (1997), Shashidhara (2000), Sutagundi (2000) and Kodalli (2006) in chilli. And also these results are in line with the observations of Vasanthi and Kannarasamy (1999), Sailajakumari and Ushakumari (2002), Parthasarathi *et al.*, (2008) and Manivannan *et al.* (2009) who found increased rice yield after treatment with vermicompost plus NPK, enhanced nutrient uptake and yield by cowpea after application of vermicompost enriched with rock phosphate increased black gram yield and better quality (protein and sugar) after treatment with vermicompost plus NPK and higher yield by beans and quality (protein and sugar) after application of vermicompost plus NPK. In the present study, RDVF alone and RDVF supplemented with RDCF application improved the soil porosity, WHC and CEC and reduced bulk density which support better aeration to plant root, drainage of water, facilitation of cations N^+, P^+ and K^+ exchange and thereby the uptake by the plants has resulted the better growth, yield and quality of chilli.

Finally, based on the field experiment in the present study, the results clearly indicate that the vermifertilizer exhibited a beneficial effect on chilli crop as a plant nutrients and the VF alone and VF supplemented RDCF have shown a greater influence on various soil quality parameters, yield and quality characters of chilli. Application of RDCF along with VF from solid organic wastes was found to be useful for maintaining sustainable soil quality and obtaining higher fruit yield coupled with better fruit quality in chilli. From the overall investigations, the results indicated that the combined application of VF with RDCF influences positively on soil quality, yield and quality characters of chilli. Further, the VF reduces 50% of the RDCF to the crop and enhances the soil quality yield and quality of chilli than individual application RDCF. Thus, 2:2 cashew leaf litter – cowdung vermifertilizer is an eco-friendly, low cost efficient quality yielder and economy enhancer for healthy and sustainable agricultural activity and productivity.

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