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Effect of organic and inorganic amendments to soil on the microflora of tea [*Camellia sinensis* L. (O) Kuntze] agroecosystem

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A study of organic (*Eichhornia crassipes*, *Cymbopogon* spp, *Tripsicum laxum*, *Ipomea carnea*, compost, pruning litter, tea waste and vermicompost) and inorganic (NPK) amendments to tea soil and their effect on soil microflora was carried out. Higher bacterial, actinomycetes and fungal population was observed in the soils amended with vermicompost, compost, tea waste, *Ipomea carnea*, pruning litter while comparatively less population was observed in the soils amended with *Cymbopogon* spp, *Tripsicum laxum*, *Eichhornia crassipes* and NPK. Fungal diversity was also found to be highest in the soils amended with vermicompost, compost followed by pruning litter , *Tripsicum laxum*, tea waste, *Ipomea carnea* etc. It was observed that some organic and inorganic amendments to soil increased microbial population and diversity of the tea soil that may contribute to the health and productivity of tea at large through higher nutrient availability and protection from the soil borne tea pathogens.

Key words: *Camellia sinensis* L(O) Kuntze, compost, fertilizer (N,P and K), green manure, vermicompost

INTRODUCTION

Organic and bio-dynamic farming emphasise management practices involving use of organic manure, organic pest management practices and so on. Extensive use of chemical fertilizer and resultant adverse soil condition has encouraged the use of organic amendments for soil nutrient improvement which is getting importance these days for sustainable productivity and soil nutrient management .Chemical fertilizers can be substituted by the organic amendments for greater stability and sustainability of the crop production. Composting and vermicomposting are two alternative approaches through which we can get good quality organic manure from the organic residues. The disadvantages of composting is that it takes 6-8 months to complete the process, whereas vermicomposting takes only 1-2 months (FAO,1980) Vermicopost has a much finer structure than composts and it contains nutrient in the forms that are readily available for plant uptake (Edwards and Burrows, 1988). There are reports on the presence of plant growth regulators in vermicompost (Krishnamoorthy and Vajrabhiah,1986;Tomati and Galli,1995). It has the potential to improve plant growth when added in greenhouse condition or in soil and in some cases it is superior to compost (Atiyeh *et al.*,2000).Study suggests that vermicompost along with supplemental dose of inorganic fertilizer results significant increase in pepper plant growth and marketable yields (Arancon *et al.*, 2003).Organic amendment to soil contributes to substantial residual effect on succeeding crops besides supplying nutrients to the target crops (Nambiar and Abrol,1989).It helps to improve soil physical properties and increases the absorption capacity of soil for cations and anions leading to higher yield. The present study focuses on the effect of organic and inorganic amendments on soil microflora in tea agroecosystem. Microbes are involved in organic matter decomposition, nitrogen fixation, solubilization and immobilization of several major and minor nutrients (Alexander,1971). They also play an important role in soil structure maintenance, soil borne disease control and plant growth promotion through secretion of hormones/antibiotics. During the last 50 years, many beneficial effects of microbes in soil have been discovered (Alexander, 1971; Subha Rao and Gaur, 2000) and microorganisms are used for improving productivity in agriculture, industry and pharmaceuticals. Therefore, the present study has been conducted to understand the effect of organic and inorganic amendments to soil, on the

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microflora around the root/collar region of tea plants that may contribute to the health and productivity of tea at large by increasing nutrient availability and protection from root pathogens etc.

MATERIALS AND METHOD

Organic and inorganic amendments to soil

Citronella (*Cymbopogon* spp.), Guatemala (*Tripsicum laxum*), *Ipomea carnea*, water hyacinth (*Eichhornia crassipes*) and pruning litter were chopped into small pieces. 20 Kg of each chopped material, compost, tea waste and vermicompost were applied per plot containing 60 tea bushes in RBD design at Rosekandy Tea Estate. 0.66 Kg of 60 Kg NPK, 1.32 Kg of 120 Kg NPK and 2 Kg of 180 Kg NPK were also applied per plot containing 60 tea bushes.

Microbial analysis

Soil dilution plate method

For bacterial, fungal and actinomycetes population estimation, soil samples were collected bimonthly across the soil depths (0-15, and 15-30 cm) using a sterilized corer. The samples were brought to the laboratory in sealed containers and microbial populations were placed for culture within 24 hr of sampling. A modified soil dilution plate method (Timonin, 1940) followed the culture media preparation using Rose Bengal agar media (Tsao, 1964) for fungi, Starch Casein agar media (Kuster and Williams, 1964) for actinomycetes and nutrient agar media for bacteria. The inoculated plates were incubated for 5-7 days at 25±1°C for fungi and actinomycetes, where as plates for bacteria were incubated 30±1°C for 24 hr. The colonies were counted subsequently.

Identification of the fungal species

Fungal species were identified with the help of standard literature (i.e Manual of the genus Aspergillus by K.B. Raper and D.I. Fennel, the Penicillia by K.B.Raper and C. Thom, Soil fungi by Gilman, Imperfect fungi by H.L.Barnet and B.B Hunter, Trichoderma by A.Nagamani,C. Manoharachary and D.K. Agarwal and P.N.Chowdhry).

Study of soil dehydrogenase activity

Dehydrogenase activity was determined using 2, 3,5 triphenyl tetrazolium chloride (TTC) reduction technique (Casida, 1977). 5 g of soil was placed in a test tube followed by 0.1 g of $CaCO_3$ and 1.5 ml of distilled water. After mixing the contents 1ml of 1% freshly prepared TTC solution was added and the tubes were incubated at 30± 2°C for 24 hr. After incubation, triphenyl formazon (TPF) was extracted using methanol and subsequently filtering it through Whatman filter paper No. 1. Finally the volume was made 50 ml by methanol. The optical density of the pink colour extract was read out with the help of spectrophotometer at 485 nanometer using methanol as control (without soil).

Statistical analysis of variance were done as per Tukey's test (one-way ANOVA).

RESULT AND DISCUSSION

The fungal population of compost, vermicompost amended soil was found to be highly significant ($p<0.001$) compared to control in all the observations taken from July 2008 to May 2009 (Table 1).Tea waste, pruning litter, guatemala, water hyacinth,180 kg NPK and 120 kg NPK treated soil showed significant increase of microbial population at $p<0.001$, $p<0.01$ levels in some of the observations. *Ipomea carnea* , 60 kg NPK amended soil showed significant increase of microflora at $p<0.05$ level . A total of 41 fungal species were isolated from the amended soil samples. Among the fungal species, *A. fumigatus, A. fischeri, A. niger, M. hiemalis, P. citrinum, P. purpurogenum* showed luxuriant growth in amended soil followed *by A. tamari, A. flavus, C. geniculata, P.frequentans, P. expensum, T. citrinoviride and T. viride*. (Table 4). Compost, vermicompost, pruning litter, tea waste amended soil showed highest population of actinomycetes with significant increase at $p<0.001$ level in all the observations made from July 2008 to May 2009 (Table 2). *Ipomea carnea*, citronella, guatemala, water hyacinth, 180 kg NPK, 120 kg NPK, 60 kg NPK amended soil also showed significant increase at $p<0.001$, $p<0.01$ and $p<0.05$ levels in some of the observations. Effect of soil amendments on the total bacterial population in case of compost, vermicompost and pruning litter amended soil showed highly significant increase at $p<0.001$ in all the observations made from July 2008 to May 2009 (Table 3). tea waste, *Ipomea carnea*, citronella, guatemalla, water hyacinth, 180 kg NPK, 120 kg NPK, 60 kg NPK amended soil also

Table 1: Effect of organic and inorganic amendments to soil on the myco-flora (1×10⁴) of tea agroecosystem

Treatment	Observations–Total population(Mean±S.E)					
	1st (1.7.08)	2nd (1.9.08)	3rd (1.11.08)	4th (1.1.09)	5th (1.3.09)	6th (1.5.09)
Control topsoil	4.67±0.3	5±.052	8±0.52	6.33±0.3	9.67±0.3	9.67±0.59
Control subsoil	4±0.52	4.33±.03	6±0.52	4.67±0.3	7±0.52	7.33±0.3
60 kg NPK topsoil	5±.052	5.67±.059	8.33±0.3	7.67±0.3	10.33±0.59*	10.33±0.3
60 kg NPK subsoil	4.67±0.3	5±.052	5.67±0.3*	5±0.52	6.67±0.3	7.67±0.3
120 kg NPK topsoil	9.67±0.3***	8±.052*	10±0.52	8±0.52	10.67±0.59	10.67±0.3
120 kg NPK subsoil	5.67±0.3	6.33±.03	7.33±0.3	5±0.52	7±0.52	7.67±0.3
180 kg NPK topsoil	9.67±0.3***	8.67±.079**	11±0.52**	11.33±0.3***	13.67±0.59**	14.67±0.3***
180 kg NPK subsoil	7.67±.059***	8.33±0.3**	8.33±0.3	8±0.52**	10±0.52	11.67±0.59***
Water hyacinth topsoil	6±0.52	8.33±.03**	12.67±0.3***	11.67±0.3***	11.67±0.3	12.33±0.3*
Water hyacinth subsoil	5±.052	6.33±.03	9.33±.79**	9±0.52***	8.67±0.59	8.33±0.3
Guatemala grass topsoil	5.67±.03	7±.052	10±0.52	10.67±0.3***	13±0.52**	13.67±0.3***
Guatemala grass subsoil	5.33±.03	6.67±0.59	8.67±0.3	7.33±0.3**	10.67±0.3**	11.33±0.79***
Citronella topsoil	6.67±0.59	7.33±.03	8.67±0.3	8±0.52	11.33±0.59	11.67±0.3
Citronella subsoil	6±.052	7±0.52	6.33±0.3	6.33±0.3	8±0.52	8.67±0.3
Pruning litter topsoil	7±.052	7.67±0.79	12±.0.52**	11.67±0.79***	13.67±0.3***	14.33±0.3***
Pruning litter subsoil	6.33±.079	7.33±0.59	9±0.52	9±0.52***	10.67±0.3***	11.33±0.3***
Ipomea carnea topsoil	7.33±.059	8.67±0.79*	9.67±0.3	8.67±0.3	10.33±0.3	11±0.52
Ipomea carnea subsoil	7±.052	8.33±0.79	7.33±0.3	6.33±0.59	7.33±0.59	7.67±0.3
Tea waste topsoil	9.67±.079**	10.33±0.59**	14±0.52***	11.67±0.3***	13±0.52**	13.67±0.59***
Tea waste subsoil	6.67±.059	8.33±0.79	10.67±0.59***	8.33±0.3*8	8.33±0.3	11±0.52**
Compost topsoil	10.67±.079***	11.67±0.79***	16±0.52***	14±0.52***	21.67±0.3***	24±0.52***
Compost subsoil	6.33±.03	9±0.52**	12±0.52***	10±0.52***	17±0.52***	20.33±0.79***
Vermicompost topsoil	12.33±.03***	13.67±0.79***	16.67±0.3***	13.33±0.3***	19.67±0.59***	24.33±0.3***
Vermicompost subsoil	8.33±0.3***	10.67±0.79***	12.67±0.59***	10.67±0.3***	15.33±0.3***	21±0.52***

*P<0.05 significantly different from the control. **P<0.01 significantly different from the control. ***P<0.001 significantly different from the control.

showed significant increase at $p<0.001$, $p<0.01$ and $p<0.05$ levels when compared to the control. Although observation was done on the population of bacteria, actinomycetes and fungi; but identification of fungi only were done as our main objective was to see the increase or decrease of fungal population because fungi are comparatively easy to identify. Dehydrogenase activity was found to be highest in vermicompost and compost amended soil compared to other inorganic and other organic amended soil (Fig. 1). Higher Dehydrogenase activity was also shown by tea waste, pruning litter, guatemala, water hyacinth amended soil and less

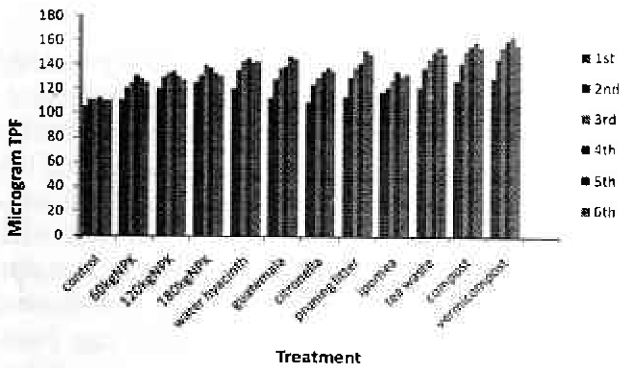

Fig. 1: Dehydrogenase activity of soil amended with inorganic and organic manure/material 1-6th= No. of bimonthly observations

Table 2: Effect of organic and inorganic amendments to soil on the actinomycetes population (1×10^6) of tea agro-ecosystem

Treatment	Observations–Total population (mean± S.E)					
	1st (1.7.08)	2nd (1.9.08)	3rd (1.11.08)	4th (1.1.09)	5th (1.3.09)	6th (1.5.09)
Control topsoil	1.37±0.01	1.38±0.02	1.17±0.02	1.26±0.01	1.45±0.01	1.55±0.00
Control subsoil	1.34±0.01	1.35±0.02	1.07±0.02	1.16±0.01	1.32±0.01	1.41±0.01***
60 kg NPK topsoil	1.44±0.01	1.46±0.01	1.27±0.01*	1.35±0.01***	2.03±0.01***	2.25±0.01***
60 kg NPK subsoil	1.43±0.01	1.43±0.02	1.15±0.01	1.28±0.01***	1.89±0.01***	2.07±0.00***
120 kg NPK topsoil	1.57±0.01**	1.57±0.01***	1.51±0.01***	1.45±0.01***	1.99±0.01***	2.14±0.01***
120 kg NPK subsoil	1.52±0.01	1.5±0.01**	1.35±0.02***	1.33±0.01***	1.68±0.01***	1.93±0.01***
180 kg NPK topsoil	1.53±0.04*	1.54±0.01***	1.49±0.01***	1.49±0.01***	2.09±0.01***	2.19±0.01***
180 kg NPK ubsoil	1.43±0.06	1.47±0.01**	1.38±0.02***	1.37±0.01***	1.97±0.01***	2.04±0.01***
Water Hyacinth topsoil	1.57±0.01***	1.59±0.01***	1.79±0.02***	1.51±0.01***	1.59±0.01***	1.65±0.01**
Water Hyacinth subsoil	1.45±0.02**	1.49±0.01**	1.63±0.02***	1.41±0.01***	1.45±0.01***	1.49±0.01
Guatemala Grass topsoil	1.78±0.01***	1.74±0.03***	1.69±0.01***	1.63±0.01***	1.71±0.01***	1.81±0.01***
Guatemala Grass subsoil	1.46±0.01**	1.53±0.02***	1.55±0.02***	1.49±0.01***	1.52±0.01***	1.65±0.01***
Citronella topsoil	1.62±0.01***	1.63±0.02***	1.77±0.02***	1.72±0.01***	2.21±0.01***	2.44±0.03***
Citronella subsoil	1.41±0.01	1.46±0.02	1.51±0.02***	1.54±0.01***	2.05±0.01***	2.21±0.01***
Pruning litter topsoil	1.87±0.01***	1.88±0.02***	1.88±0.01***	1.77±0.01***	2.28±0.01***	2.4±0.01***
Pruning litter subsoil	1.53±0.01***	1.53±0.01***	1.69±0.01***	1.57±0.01***	2.13±0.01***	2.25±0.01***
Ipomea topsoil	1.9±0.03***	1.91±0.01***	1.81±0.01***	1.53±0.01***	1.48±0.01	1.57±0.01
Ipomea subsoil	1.83±0.01***	1.84±0.01***	1.61±0.01***	1.39±0.01***	1.37±0.01	1.47±0.01
Tea Waste topsoil	2.1±0.01***	2.09±0.01***	2.08±0.01***	1.89±0.01***	1.77±0.01***	1.84±0.01***
Tea Waste subsoil	1.84±0.04***	1.85±0.03***	1.76±0.02***	1.71±0.01***	1.64±0.01***	1.75±0.01***
Compost topsoil	1.88±0.02***	1.93±0.01***	1.95±0.01***	2.03±0.01***	2.17±0.01***	2.29±0.01***
Compost subsoil	1.79±0.01***	1.77±0.02***	1.77±0.01***	1.91±0.01***	2.04±0.01***	2.19±0.01***
Vermicompost topsoil	1.89±0.01***	2.1±0.01***	2.1±0.01***	2.08±0.01***	2.19±0.01***	2.32±0.01***
Vermicompost subsoil	1.85±0.01***	1.87±0.02***	1.96±0.01***	1.93±0.01***	2.07±0.01***	2.23±0.01***

*P<0.05 significantly different from the control. **P<0.01 significantly different from the control. ***P<0.001 significantly different from the control

activity was observed in citronella and *Ipomea carnea* amended soil

Application of organic amendment had significantly influenced the soil microflora. The organic amendment to soil is known to be metabolized by bacteria, actinomycetes, fungi and protozoa . Among the various groups of microorganisms, fungi are considered to be the most important decomposers because they can degrade, which usually remains unattacked by other organisms in soil. The diverse microbial population such as *Aspergillus* spp, *Penicillium* spp and *Trichoderma* spp are found frequently in organic amended soil. These organisms are known to decompose complex organic materials into simple inorganic forms that can be utilized by plants and microbes in soil. These decomposition of complex organic materials may provide favourable conditions for the growth of fungi, actinomycetes, bacteria etc and thus higher population of fungi, actinomycetes and bacteria found in organic amended soil should contribute to the nutrient availability to the tea plantation at large. It was reported by Dutta and Isaac (1978) that organic amendments (i.e chitin, cellulose and green manure) induce qualitative and quantitative changes in the soil and rhizosphere microflora of antirrhinum plants. Dutta and Deb (1986) also re-

Table 3 : Effect of Organic and inorganic amendments to soil on the bacterial population (1x 10^6) of tea agroecosystem

Treatment	Observation–Total population(Mean±S.E)					
	11st (1.7.08)	2nd (1.9.08)	3rd (1.11.08)	4th (1.1.09)	5th (1.3.09)	6th (1.5.09)
Control topsoil	2.2±0.02	2.21±0.03	2.05±0.03	2.06±0.01	2.23±0.01	2.41±0.01
Control subsoil	2±0.01	2.01±0.01	1.76±0.02	1.93±0.01	2.15±0.01	2.25±0.01
60 kg NPK topsoil	2.31±0.01	2.33±0.03	2.11±0.02	2.18±0.01***	2.43±0.01***	2.77±0.01***
60 kg NPK subsoil	2.12±0.01	2.13±0.02	1.92±0.01	2.05±0.01***	2.08±0.01	2.2± 0.01
120 kg NPK topsoil	2.25±0.02	2.27±0.01	2.45±0.02***	2.42±0.01***	2.69±0.02***	2.85±0.01***
120 kg NPK subsoil	2.16±0.05*	2.17±0.01	2.09±0.04***	2.23±0.01***	2.27±0.01**	2.38±0.01***
180 kg NPK topsoil	2.39±0.02**	2.41±0.02**	2.4±0.01***	2.87±0.01***	2.82±0.01***	3.08±0.02***
180 kg NPK subsoil	2.06±0.02	2.07±0.03	2.29±0.01***	2.72±0.01***	2.59±0.01	2.85±0.01***
Water hyacinth topsoil	2.62±0.07***	2.63±0.02***	2.76±0.01***	2.84±0.01***	2.81±0.01***	2.83±0.01***
Water hyacinth subsoil	2.31±0.01***	2.32±0.02***	2.49±0.01***	2.21±0.01***	2.2±0.02	2.28±0.01***
Guatemala grass topsoil	2.76±0.04***	2.77±0.05***	2.68±0.02***	3.04±0.01***	3.09±0.01***	3.17±0.01***
Guatemala grass subsoil	2.67±0.03***	2.68±0.01***	2.48±±0.02***	2.64±0.01***	2.67±0.01***	2.74±0.01***
Citronella topsoil	2.67±0.01***	2.680.04***	2.74±0.01***	3.17±0.01***	3.19±0.01***	3.33±0.01***
Citronella subsoil	2.07±0.01	2.09±0.01	2.37±0.01***	2.95±0.01***	2.93±0.02***	2.97±0.01***
Pruning litter topsoil	3.04±0.02***	3.02±0.03***	3.05±0.02***	3.18±0.01***	3.28±0.02***	3.38±0.02***
Pruning litter subsoil	2.57±0.02***	2.58±0.01***	2.77±0.01***	3±0.01***	2.85±0.0***	2.87±0.02***
Ipomea topsoil	3.21±0.04***	3.2±0.02***	3±0.01***	2.41±0.01***	2.5±0.02***	2.8±0.01***
Ipomea subsoil	3.03±0.01***	3.02±0.04***	2.8±0.01***	2.18±0.02***	2.2±0.01	2.41±0.02***
Tea Waste topsoil	2.76±0.04***	2.77±0.03***	3.12±0.02***	3.14±0.02***	3.16±0.01***	3.19±0.01***
Tea Waste subsoil	2.07±0.03	2.11±0.03	2.8±0.03***	2.97±0.03***	2.71±0.02***	2.86±0.02***
Compost topsoil	3.1±0.04***	3.12±0.04***	3.37±0.01***	3.27±0.01***	3.36±0.01***	3.49±0.02***
Compost subsoil	2.94±0.03***	2.94±0.01***	3.01±0.01***	3.04±0.02***	3.01±0.02***	3.09±0.01***
Vermicompost topsoil	3.17±0.03***	3.19±0.01***	3.41±0.01***	3.37±0.02***	3.43±0.02***	3.53±0.01***
Vermicompost subsoil	2.9±0.01***	2.93±0.01***	3.06±0.01***	3.06±0.01***	2.75±0.02***	3.19±0.01***

*P<0.05 significantly different from the control. **P<0.01 significantly different from the control. ***P<0.001 significantly different from the control

ported that organic (*Eupatorium adenophorum*) and inorganic amendments (i.e urea) to soil increased the soil and rhizosphere population of bacteria and actinomycetes, while urea and zinc reduced the fungal and actinomycetes population in soil and soyabean rhizosphere. Dehydrogenase activity was also found to be highest in organic amended soil as higher population of bacteria, actinomycetes and fungi were found in these amended soil ie dehydrogenase activity and microbial population are positively correlated. It is known that organic matter introduced to soil stimulates soil microbial populations and soil biological activity (Parkinson and Paul,1982). Compost used as a soil amendment may improve the microbial diversity of the soil. Compost depending on the degree of maturity, provides rich medium supporting high microbial activity (Chen *et al.*,1988) and may also cause diverse microbial population. The addition of compost to soil has been reported to increase the incidence of bacteria in tomato rhizosphre (Alvarez *et al.*,1995). The number of colony forming units of bacteria and fungi increased when pig manure compost was added to the soil (Weon *et al.*,1999). Increase in soil biological activity and microbiological growth were also reported when vermicompost sewage sludge was added (Dar,1996; Marinari *et al.*,2000). Various agricultural management practices such as cropping systems, fertilizer applications, cultivation practices, soil

Table 4 : Dominance and occurrence of soil Fungal species in the inorganic/organic amended soil

Fungal species	Observations*					
	11st (1.7.08)	2nd (1.9.08)	3rd (1.11.08)	4th (1.1.09)	5th (1.3.09)	6th (1.5.09)
Aspcergillus candidus Link	–	–	+	+	+	+
Aspergillus ellipticus sp.nov.	+	+	+	+	+	+
Aspergillus fischeri Wehmer	+++	+++	+++	++	++	++
Aspergillus flavus Link	++	++	++	++	++	+
Aspergillus fumigatus Fresenius	+++	+++	+++	++	++	
Aspergillus gracilis Bainier	+	+	+	–	–	–
Aspergillus melleus Yukawa	+	+	+	+	+	+
Aspergillus nidulans (Eidam) Wint.	+	+	–	+	+	+
Aspergillus niger Van Tieghem	+	+++	+++	++	++	++
Aspergillus ochraceous Wilhelm	+	+	+	+	+	+
Aspergillus oryzae (Ahlburg) Cohn	+	+	–	+	+	–
Aspergillus parasiticus Speare	+	–	+	+	+	+
Aspergillus spinulosus Warcup sp.nov	–	–	–	+	+	–
Aspergillus sydowi (Bainier and Sartory) Thom and Church	+	+	+	+	+	+
Aspergillus tamarii Kita	++	++	+	+	++	++
Aspergillus terreus Thom	–	–	+	+	+	+
Aspergillus ustus (Bainier) Thom and Church	+	+	+	+	+	+
Aspergillus versicolor	+	+				
Tiraboschi	–	+	+	–	+	–
Cladosporium herbarum (Persoon) Link	+	+	–	–	–	–
Curvularia geniculata (Tracy and Earle) Boedijn	+	+	++	+	+	+
Curvularia interseminata Berkeley and Ravenel	+	+	+	+	+	+
Curvularia lunata (Walker) Boedijn	–	+	+	+	+	+
Mucor hiemalis Wehmer	+	++	+++	+++	+++	+++
Nigrospora sphaerica (Saccardo) Mason	–	–	–	+	–	–
Penicillium chrysogenum Thom	+	+	+	+	+	++
Penicillium citrinum Thom	++	+++	+++	+	+	+++
Penicillium expensum (Link) Thom	++	+	+	+	++	+
Penicillium frequentans Westling	+	++	+	+	+	++
Penicillium janthinellum Biourge	+	+	–	–	+	++
Penicillium martensii Biourge	+	+	+	+	+	–
Penicillium purpurogenum Stoll	+++	+++	++	+++	+++	++
Penicillium rubrum Stoll	+	+	+	++	+	–
Rhizopus nigricans Ehrenberg	–	+	+	+	+	–
Humicola sp.	–	+	–	+	–	–
Fungal species						
Trichoderma atroviride Karsten	–	+	++	++	++	+
Trichoderma citrinoviride Bisset	++	++	+	+	+	–
Trichoderma flavofuscum (J.Miller, Giddens and Foster) Bisse	t+	–	–	+	–	–
Trichoderma glaucum Abbott	+	+	–	–	+	+
Trichoderma harzianum Rifai	–	+	–	+	+	+
Trichoderma virens (Miller, Giddens and Foster) Von Arx	+	+	+	+	+	+
Trichoderma viride Pers.ex.S.F.Gray	++	+	+	++	+	+

(–) = Nil, (+) = Rare, (++) = Moderate and (+++) = Luxuriant, organic matter amendments and pesticides are known to alter the microbial dynamics of agroecosystems. Addition of compost and other partially degraded materials improves the soil organic matter content and thereby increases the stability of soil structure. Incorporation of organic fertilizers in the form of plant compost enhances the organic carbon level of the soil which has direct and indirect effect on soil physical properties and processes. Dick and Crist (1995) reported that adding organic wastes to the soil can increase total N, organic matter, microbial population, enzyme activity, moisture retention, pH buffering capacity and crop yield. The increase of microbial population in the organic amended tea soil suggests that a some of the fungal organisms observed in the present work (i.e *Aspergillus* spp, *Penicillium* spp.) are known to be good decomposers. They should contribute to the faster decomposition process of the litter as well as organic amendments to soil and should contribute to the higher nutrient availability, which should reflect on the productivity in the tea agroecosystem at large. The results on these aspects of the study will be communicated in due course of time.

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REFERENCES

Alexander, M. 1971. *Microbial Ecology*, John Wiley &Sons, Inc.,

Alvarez, M.A., Gagne, S. and Antoun, H. 1995. Effect of compost on rhizosphere microflora of the tomato and on the incidence of plant growth-promoting rhizobacteria. *Applied Environ. Microbio.*, **61**:194-199.

Arancon. N.Q., Edwards. C.A. Bierman, P., Metzer. J., Lee, D. and Welch, C. 2003. Effects of vermicompost on growth and marketable fruits of field-grown tomatoes,peppers and strawberries. *Pedobiologia*, **47**:731-735.

Atiyeh, R.M., Subler.S., Edwards, C.A Bachman, G., Metzger, J.D. and Shuster, W., 2000. Effects of vermicomposts and composts on plant growth in horticultural container media and soil. *Pedo. Biol.* **44**, 579-590.

Casida, L.E. Jr. 1977. Microbial metabolic activity in soil as measured by dehydrogenase determinations. *Applied Environmental Microbiology.* **34**: 630-636.

Chen, W., Hoitink, H.A.J., Schmitthenner, A.F. and Tuovinen, O.H. 1988. The role of microbial on the suppression of damping off caused by *Pythium ultimum*. *Phytopathology.* **78** : 314-322.

Dar, G.H., 1996. Effect of cadmium and sewage sludge on soil microbial biomass and enzyme activities. *Bioresour. Technol.*, **56**:141-145.

Dick, R.P. and Crist, R.A. 1995. Effect of long term waste management and nitrogen fertilization on availability and profile distribution of nitrogen. *Soil Sci.*, **159**:402-408.

Dutta, B.K. and Deb, P.R. 1986. Effect of organic and inorganic amendments on the soil and rhizosphere microflora in relation to the biology and control of *Sclerotium rolfsii* causing foot rot of soyabean. *J. of Plant Diseases and Protection*, **93**(2), 163-171.

Dutta, B.K. and Isaac, I. 1979. Effect of organic amendments to soil on the rhizosphere microflora of Antirrhinum infected with *Verticillium dahliae* Kleb. *Plant and Soil*, **53** :99-103.

Edwards, C.A. and Burrows, I. 1988. The potential of earthworm composts as plant growth media. In: Edwards, C.A., Neuhauser, E.(Eds.), *Earthworms in Waste and Environmental Management*. SPB Academic Press, The Hague, The Netherlands.pp.21-32.

FAO, 1980. *A manual of Rural Composting*. FAO/UNDP Regional project RAS/75/004. Field document 15.

Krishnamoorthy, R.V., and Vajrabhiah,S.N., 1986. Biological activity of earthworm casts: as assessment of plant growth promoter levels in casts. *Proc. Indian Acad.Sci. (Anim.Sc.)* **95**: 341-351.

Kuster, E. and Williams, S.T. 1964. Selective media for isolation of Streptomycetes. *Nature.* **202:** 928-929.

Marinari, S.,Masciandaro, G. , Ceccanti, B. and Grero, S. 2000. Influence of organic and mineral fertilizers on soil biological and physical properties. *Bioresour.Technol.* **72**:9-17

Nambiar, K.K.M., and Abrol, I.P., 1989. Long-term fertilizer in India-an overview. *Fert.News* **34**(4),11-20,26

Parkinson, D. and Paul, E.A. 1982. Microbial Biomass. In: *Methods of Soil Analysis*, Part 2. Chemical and Microbiological Properties, Page, A.L., R.H. Miler and D.R Kenney (Eds.). American Society of Agronomy, Inc. Madison, Wisconsin, pp: 821-830.

Subha Rao, N.S. and Gaur D.Y. 2000. Microbial diversity-Management and Exploitation for Sustainable Agriculture, In: extended summaries: International Conference on Managing Natural Resources for Sustainable Agricultural Production

Timonin, M.I. 1940.The interaction of higher plant and soil microorganisms I. Microbial population of seedlings of certain cultivated plants. *Can J. Resistant* **18**:307-317.

Tomati,U. and Galli,E., 1995. Earthworms , soil fertility and plant productivity. *Acta Zool. Fenn.* **196**, 11-14

Tsao, P.H. 1964. Effect of Certain Fungal Isolation Agar Media on *Thielaviopsis basicola* and on its Recovery in Soil Dilution Plates, *Phytopathology.* **54**:548-555.

Weon, H.Y., . Kwon, J.S, Suh, J.S. and Choi, W.Y. 1999. Soil microbial flora and chemical properties as influenced by the application of pig manure compost. Kor.*J. Soil. Sci.Fert.*. **32**:76-83.