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REGULAR ARTICLE

AMENDMENTS FOOD WASTE COMPOST ON SOIL ENZYMATIC ACTIVITIES IN GROUNDNUT CULTIVATED SOIL, INDIA

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SUMMARY

Soil enzymes are play an important role in organic soil. Soil microbes enhances the enzymatic activities .Which is very beneficial to solubilizing the nutrients in the soil. In the present investigation was to find out the activity of soil enzymes such as acid phosphatase, alkaline phosphatase, dehydrogenase and to find the fresh weight of groundnut pods in the addition of food waste compost.

Keywords: soil enzymes, food waste compost, organic soil, groundnut.

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1. Introduction

Most countries have traditionally utilized various kinds of organic materials to maintain or improve the tilth, fertility and productivity of their agricultural soils. However, several decades ago organic recycling practices in some countries were largely replaced with chemical fertilizers which were applied to high yielding cereal crops that responded best to high level of fertility and adequate moisture, including irrigation. Soil tillage was also intensified to improve weed control and seedbed conditions. Consequently, the importance of organic matter to crop production received less emphasis, and its proper use in soil management was sometimes neglected or even forgotten. With these changes and the failure to implement effective soil conservation practices, agricultural soils in a number of developed and developing countries have undergone serious degradation and decline in productivity because of excessive soil erosion and nutrient runoff and decreased soil organic matter levels.

Soil ecosystems are highly complex containing a tremendous amount of species. Indigenous microbial populations in soil are of fundamental importance for ecosystem functioning, through determining nutrient cycling, organic matter decomposition and energy flow [1]. Despite all attempts to measure fluxes and gross microbial pools, the soil and its microbiota still remain a black box. Most soil microorganisms and still unknown, while very few have been isolated, cultured and identified and directly related to their function in agro ecosystems. Although new culture media have been recently developed to maximize the recovery of diverse microbial

groups from soils [2, 3]. The comparison between microscopic counts and plate counts indicates that as less than 1% of agricultural soil microorganisms are culturable [4].

Since ancient times, the addition of organic matter has benefited soils and contributed to the productivity of plants. The use of solid resides for the rational production of compost has started about a century ago and ever since, many methods have been studied [5]. According [6] an accessible and low cost way to produce compost basically consists of the formation of piles of residues with periodical revolving to improve mass aeration and homogenization and accelerate the decomposition process.

2. Materials and methods

Groundnut (*Arachis hypogaea* L.) seeds were placed in multi cell flats (plug trays) filled with medium (1 kg for each cell), germinated and raised in a greenhouse. The nursery medium was purchased from Tamil Nadu Agricultural University, Coimbatore. Three weeks after planting, groundnut seedlings were transplanted to pots containing 5 kg of soil amended with mineral fertilizer, commercial compost, or food waste compost. Every two weeks after transplanting, plant growth characteristics, microbial populations and enzyme activities were analyzed. In this study, treatments were as follows: MF (Mineral fertilizer: N 15 kg, P2O5 8.85 kg, K2O 9.6 kg/10a); CC (commercial compost: 1800 kg 110a); FW 0.5 (food waste composted with MS : 900 kg 100a); FW 1.0 (food waste composted with MS : 1800 kg 110a), FW 1.5 (food waste composted with MS : 2700 kg 110a0 and CON (control). The commercial compost was purchased from Saratha Vermiculite Co. Ltd., Erode. The commercial compost was comprised of 30% animal slurry 30% plant residue, 30% sawdust and 10% vermiculite, which was composted aerobically for four months. The food waste compost was prepared in our laboratory as follows. One hundred kilograms of fresh food waste was gathered from restaurants, mixed with 0.5 kg miraculous soil microorganisms (Agricultural Microbiology Department, Tamil Nadu Agricultural University, Coimbatore) and then composted aerobically for one year. The chemical properties of nursery medium and commercial and food waste compost are shown in Table 1.

One gram of soil sample was placed in a 50 ml Erlenmeyer flask, to which 0.2 ml toluene and 4 ml modified universal buffer (MUB) solution (pH 6.5 for acid phosphatase or pH 11 for alkaline phosphatase) were added. One ml of 0.025 M P-nitrophenyl phosphate solution was added, mixed well and the flask was sealed tightly. The mixture was incubated at 37°C for 1 h. After this period, 1 ml of 0.5 M CaCl2 and 4 ml of 0.5 M NaOH were added and the solution was mixed thoroughly. The mixture was filtered through a Whatmann No.2. The yellow colour intensity of the filtrate was measured with a spectrophotometer at 410 nm (Tabatabai, 1982). For dehydrogenase activity, 20 g of air dried soil and 0.2 g of CaCO3 were mixed. Six grams of this mixture was placed in each of three test tubes. One ml of 3% aqueous solution of TTC (2, 3, 5-triphenyl tetrazolium chloride) and 2.5 ml of distilled water were added to each tube and the contents were mixed well with a glass rod. The tube was sealed tightly and incubated at 37°C for 24 h. Ten milliliters of methanol was added and shaken for 1 min. The suspension was filtered through a glass funnel plugged with absorbent cotton into 100 ml volumetric flask. The soil transferred to the funnel was washed with methanol until the reddish colour disappeared from the cotton plug. Dehydrogenase activity was determined using a spectrophotometer at 485 nm [7].

Total nitrogen content in soil was determined by sulphuric acid digestion using CuSO4 and K2SO4 as catalyst. The soil organic matter was determined by oxidation with potassium dichromate. The pH and electrical conductivity (EC) were measured in

a 1:5 (soil : water) aqueous extract. Inorganic ions were determined using ICP. Available phosphorus was determined colorimetrically by the Olsen method [8]. The soil (silty clay) used for planting was collected from the agricultural field. The soil had a pH (1:5 H2O) of 6.13, electrical conductivity (dS/m) of 0.2, organic matter of 0.9%, total N of 0.3%, available P2O5 of 21.85 μg/g soil, (EC of 9.94 cmol+/kg, Ca of 3.12 cmol+/kg, Mg of 1.85 cmol+/kg and K of 0.34 cmol+/kg.

Analysis of variance was performed using the SAS version 6.05. The least significant differences (LSD) among mean values were calculated at $p < 0.05$ confidence level.

3. Results and discussion

As shown in Table 2 to 4, the food waste compost introduced to soil significantly increased soil enzyme activities compared to CON, CC and MF treatments at 2, 4, 6 weeks. Acid phosphatase activity in FW treatments (FW 0.5, FW 1.0 and FW 1.5) was 289-355 μg p-nitrophenol g-1 soil h-1 at 2 weeks and then reduced to 190-232 μg p-nitrophenol g-1 soil h-1 at 4 weeks (Table 5). However, acid phosphatase activity in CON, CC and MF treatments was only 26-69 μg p-nitrophenol g-1 soil h-1 throughout the growing period. Alkaline phosphatase activity in FW treatments was significantly higher than that in CON, CC and MF treatments. Alkaline phosphatase activity in FW treatments was correlated with applied amounts of food waste compost at 2, 4, 6 weeks and the highest activity was shown in FW 1.5 at 4 weeks (Table 3). However, alkaline phosphatase in CON, CC and MF treatments during the growing season showed an almost constant activity of near zero. Dehydrogenase activity in the rhizosphere of all FW treatments was also significantly higher than that in CON, CC and MF treatments at 2, 4, 6 weeks (Table 4). Dehydrogenase activity in FW treatments generally increased with time.

Table 1. Chemical properties of nursery medium, commercial and food waste compost

Treatments	T-N (%)	OM (%)	C/N	K (g kg-1)	Ca (g kg-1)	Mg (g kg-1)	Na (g kg-1)
NM	0.30	29.5	56.75	6.04	14.78	9.73	3.74
FW	3.78	56.8	12.02	3.23	52.35	2.64	5.24
CC	0.67	25.4	37.56	6.95	39.64	45.47	1.19

NM : nursery medium; FW : food waste compost; CC : commercial compost

Table 2. Acid phosphatase activity in rhizosphere of groundnut in pots as affected by commercial compost (CC), mineral fertilizer (MF) and different amounts of food waste compost (FW 0.5, FW 1.0, FW 1.5). Means with the same letters are not significantly different at $p < 0.05$ when compared by LSD. Treatment means are the average of three replicates

Duration	CON	CC	MF	FW 0.5	FW 1.0	FW 1.5
Log CFU g-1soil						
2 weeks	35f	50f	50f	280bc	340ab	354a
4 weeks	34f	45f	48f	200e	210de	240de
6 weeks	37f	47f	65f	212e	254cd	290bc

Table 3. Alkaline phosphatase activity in rhizosphere of groundnut in pots as affected by commercial compost (CC), mineral fertilizer (MF) and different amounts of food waste compost (FW 0.5, FW 1.0, FW 1.5). Means with the same letters are not significantly different at $p < 0.05$ when compared by LSD. Treatment means are the average of three replicates

Duration	CON	CC	MF	FW 0.5	FW 1.0	FW 1.5
Log CFU g-1soil						
2 weeks	20g	25g	18g	100e	250c	427b
4 weeks	15g	17g	13g	80ef	225c	459a
6 weeks	10g	13g	07g	55f	150d	402b

Table 4. Dehydrogenase activity in rhizosphere of groundnut in pots as affected by commercial compost (CC), mineral fertilizer (MF) and different amounts of food waste compost (FW 0.5, FW 1.0, FW 1.5). Means with the same letters are not significantly different at $p < 0.05$ when compared by LSD. Treatment means are the average of three replicates

Duration	CON	CC	MF	FW 0.5	FW 1.0	FW 1.5
Log CFU g-1soil						
2 weeks	0.5g	1.8efg	1.3fg	5.4d	9.2b	10.5ab
4 weeks	0.9g	2.2eg	2.8e	6.4cd	10.1ab	11.0a
6 weeks	1.6efg	2.4ef	2.9e	7.3c	10.3ab	11.1a

Table 5. Fresh weight of groundnut in pots as affected by commercial compost (CC), mineral fertilizer (MF) and different amounts of food waste compost (FW 0.5, FW 1.0, FW 1.5). Means with the same letters are not significantly different at $p < 0.05$ when compared by LSD. Treatment means are the average of three replicates

Duration	CON	CC	MF	FW 0.5	FW 1.0	FW 1.5
Log CFU g-1soil						
2 weeks	10i	20hi	37gh	26gh	28gh	38gh
4 weeks	9i	24gh	74f	97e	95ef	117d
6 weeks	8i	25gh	144ef	132cd	177b	207a

Table 6. Chemical properties of soil at 6 weeks after planting

Treatments	pH (1:5 H2O)	EC (dSm-1)	T-N (%)	OM (%)	Av P2 O5 (mg kg-1)	Na (cmol kg-1)
CON	6.32	0.34	0.019	0.29	23.4	0.15
CC	5.98	0.96	0.037	0.57	59.9	0.10
MF	5.42	0.93	0.049	0.36	43.7	0.12
FW 0.5	6.39	1.12	0.056	0.47	28.1	0.28
FW 1.0	6.68	2.66	0.081	0.83	44.1	0.61
FW 1.5	7.08	3.37	0.114	1.07	65.0	0.75
LSD (5%)	0.12	0.33	0.017	0.12	6.5	0.18

Means were separated using an LSD at $p < 0.05$

There was no significant difference in the fresh weight of groundnut among CC, MF, FW 0.5 and FW 1.0 at 2 weeks. However, FW 1.5 showed significantly higher fresh weight than CON and CC treatments (Table 5). At 4 weeks, the fresh weight of groundnut was 81-119 g plant-1 in MF and FW treatments, which was about 2-3 times higher than compared to CC. At 6 weeks, the fresh weight in MF and FW treatments was also significantly higher than that in CON and CC, where the highest fresh weight was observed in FW 1.5 (Table 6).

4. Discussion

Soil is an important natural resource that needs to be preserved and it possible, its quality and productive capacity improved. Soil quality or health as the capacity to function within an ecosystem and sustain biological productivity, maintain environmental quality and promote plant, animal and human health [9]. Biochemical actions are dependent on or related to the presence of enzymes. Many reactions involving soil organic matter transformations may be catalysed by enzymes existing outside the microorganisms and plant root systems. Each soil may have a characteristics pattern of specific enzymes and described [10]. It is believed that most soil enzymes originate from soil fungi, bacteria and plant roots [11,12]. Soil enzymes produced play a significant role in mediating biochemical transformations involving organic residue decomposition and nutrient cycling in soil [13,14]. The addition of the organic matter maintained high levels of phosphatase activity in soil during a long term study [15]. The phosphatase activities increased when compost was added at rates of up to 90 t ha-1 and the phosphatase continued to show a linear increase with compost rates of up to 270 t ha-1 in a field experiment [16]. As shown in Table 5 and 6 acid and alkaline phosphatase generally increased with an increase in the rate of food waste compost application. Increased phosphatase activity could be responsible for hydrolysis of organically bound phosphate into free ions, which were taken up by plants. The plants can utilize organic P fraction from the soil by means of phosphatase activity enriched in the soil root interface [17]. The due to the reactions of phosphatase, H_2PO_4 was mode available to plants from organic substances in soils [18].

Soil dehydrogenase activity reflects the total range of oxidative activity of soil microflora and its is consequently used as an indicator of microbial activity. The a higher level of dehydrogenase activity was observed in soil treated with vermicompost and manure compared to soil treated with mineral fertilizer [19]. The application of compost caused a significant increase in dehydrogenase activity [20]. The enzyme activity in organic amendment soil increased by average 2-4 fold compared with the unmanured soil [21]. These results were similar to our finding that dehydrogenase in rhizosphere soil of FW treatments was an average 4-20 times higher than that of un amended (CON) and mineral fertilizer (MF) treatments.

It is known that a high value of EC and interfere with plant growth[22]. The value of EC in FW 1.5 was 3.37 d Sm-1 and the highest among the treatments. The highest value was mainly due to Na content in food waste, which was not so high as to disturb the growth of plants. High sodium content in food waste compost in Korea due to salt favored cooking has been considered another problem for application into soil. ESP (exchangeable sodium percentage) has been used as the parameter of estimation of Na+ accumulation in relation to that affecting plant growth. When ESP value is over 15, the soil is defined as sodic soil, which inhibits plant growth. The sodium concentration in FW 1.5 treatment at 6 weeks was 0.75 cmol+ kg1 (Table 9). This is equal to a 7.2 ESP value which is not considered sodic to inhibit the plant growth.

Food waste compost could be an alternative to chemical fertilizer to increase soil

microbial populations and enzyme activities and to promote the soil nutrient for groundnut growth.

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