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MICROBIAL RESPIRATION AND NITROGEN MINERALIZATION IN SOIL AMENDED WITH DIFFERENT PROPORTIONS OF VERMICOMPOST AND COIR DUST

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Abstract

The effect of different combinations of vermicompost and coir dust on microbial respiration and nitrogen mineralization in soil was studied under laboratory conditions. Treatment with 75% vermicompost and 25% coir dust (T_2) demonstrated the highest carbon mineralization and NH^+_4-N contents followed by treatment T_1 (100% vermicompost) and T_3 (50% vermicompost and 50% coir dust). Despite the varied NO_3-N contents at the initial stages of incubation, the NO_3-N content steadily increased for all the treatments at day 49 onwards. The highest NO_3-N content was observed in T_1 followed by that in T_2 and T_3. Such studies need be conducted under field conditions to reach a definite conclusion.

Key Words: Vermicompost, coir dust, mineralization.

Introduction

Vermicomposting means the use of earthworms for composting organic residues. Earthworms can eat as much as their own body weight per day. It is estimated that 1000 tons of moist organic manure can be converted into 300 tons of compost by earthworms (Sajnanath and Sushama, 2004).

Vermicompost could release nutrients slowly and steadily into the system and enables the plants to absorb these nutrients over time (Sharma, 2003). It does not have any adverse effect on soil, plant and environment and it improves soil aeration and texture thereby reducing soil compaction. However, 100% vermicompost would have poor porosity and aeration and high soluble salt concentrations (Atiyeh *et al.,* 2000).

Coir (coconut fibre) dust is a major by-product of coir fibre industry. It has superior structural quality, water absorption ability, CEC and dry density compared to either sphagnum or sedge peat (Cresswell, 2006). Coir dust is an excellent surface mulch in all kinds of soils. It absorbs more than eight times its weight of water. It is reported that by incorporation of 2% coir dust (by weight) into sandy soil, the water holding capacity of the soil is increased by 40% (Thampan, 1981). It is about 70 % of the weight of the coconut husk.

Despite vermicompost is a nutrient-rich natural fertilizer, its poor physical properties are a matter of concern. Coir dust, on the other hand, possesses good

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physical qualities, though it has low nutrient content. However, the soil organic matter can be maintained by application of coir dust which has a very high C: N ratio, either in mixture with the organic manure like vermicompost or coir dust alone. Therefore, the present study was undertaken to assess the effect of different combinations of vermicompost and coir dust on microbial respiration and nitrogen mineralization.

Materials and Method

Soil collection

The experiment was conducted in the laboratory of the Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka. The soil used in this study belongs to Red Yellow Podzolic great soil group and is classified as Hapludults according to the USDA soil taxonomy (Mapa *et al.*, 1999). Soil samples were collected randomly from several locations of the research farm of the Faculty of Agriculture, University of Ruhuna, Sri Lanka. After removing the surface litter, soil samples were taken from 0-15 cm depth by using an auger and mixed thoroughly to make a composite sample. Physico-chemical characteristics of the soil were determined by standard methods. The soil was pre-incubated for a week at 60 % water holding capacity prior to the treatments. Characteristically the soil was loamy sand with 6.3 pH, 0.85% organic C, 0.13% total N, 125 mg/kg borax P, 45 mg/kg exchangeable K and 12.1 cmol/kg CEC. Organic carbon and total nitrogen contents in vermicompost were 39 and 1.02%, respectively and the corresponding figures for the coir dust were 45 and 0.39%.

Treatments

Sub samples of 100 g of homogeneously mixed air dry soil were placed in glass bottles. Bottles were watered to adjust the moisture content to 50 % of the field capacity (dry basis) and maintained by daily monitoring and adding water when necessary. Bottles were then kept in dark for two weeks prior to addition of plant materials. After two-week preincubation period, the glass bottles were opened and different percentages of vermicompost and coir dust were used in making four different mixtures and mixed thoroughly with the soil. The treatments were 100% vermicompost (T_1), 75% vermicompost + 25% coir dust (T_2), 50% vermicompost + 50% coir dust (T_3), 25% vermicompost + 75% coir dust (T_4) and control (T_5). This rate of application was 5 tons per hectare on the assumption that l ha soil with 15 cm depth contains 2.13×10^9 kg soil (soil bulk density 1.42 g cm^{-3}). The treated soil samples along with the controls (free from treatments) were incubated in the dark at room temperature (25 ± 1°C). Constant moisture content of the soil was maintained throughout the incubation period.

Carbon mineralization

Soil samples were placed in gas-tight glass containers along with a vial containing 10 ml of 1 M NaOH to trap CO_2 and a vial of water to maintain humidity. Soil was incubated at room temperature (25 °C) in the dark and NaOH traps were replaced at 2, 5, 7, 14, 21, 28, 35, 42, 49, 56, 63 and 70 days after the treatment. Unreacted alkali in the NaOH traps was titrated with 0.5 M HC1 to determine CO_2 -C released from the soil (Anderson, 1982).

Nitrogen mineralization

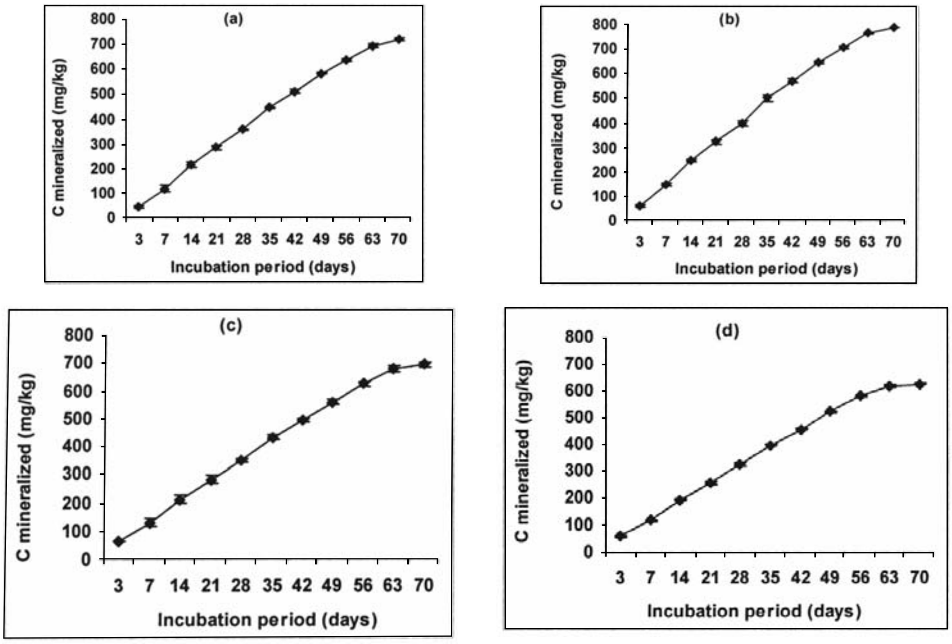
Nitrogen mineralization was determined in terms of inorganic N (NH_4^+-N and NO^{-3} -N) concentration of soil extracted at 2, 5, 7, 14, 21, 28, 35, 42, 49, 56, 63 and 70 days after incubation. Samples containing 10 g soil were extracted using 30 ml of 2 M KCI and the extracts was used to determine NH_4^+-N and NO_3^--N. The NH_4^+-N content was determined utilizing the Berthelot reaction (Searle, 1984) and the NO_3^--N by sodium salicylate yellow colour method (Bremner, 1960).

Results and Discussion

No significant ($p \leq 0.05$) variation was observed among the treatments at day 3 of the incubation. However, treatments T_1, T_2 and T_3 were significantly ($p \leq 0.05$) different from the control at day 7 and treatments T_2 and T_3 were significantly ($p \leq 0.05$) different from day 14. Since then, significant ($p \leq 0.05$) differences were no longer observed for any treatment until the end of the incubation (Fig. 1).

After 3 days of incubation, the average C mineralized of the soil were 46, 59, 64 and *56* mg/kg for the treatments T_1, T_2, T_3 and T_4, respectively, and at the end of the 70-day incubation, C mineralization had decreased to 26, 25, 15 and 7 mg/kg for the respective treatments. In contrast, T_2 (75 % vermicompost + 25 % coir dust) showed higher carbon mineralization than other treatments throughout the incubation period. Furthermore, control exhibited the lowest carbon mineralization. In addition, all treatments inhibited the carbon mineralization as incubation progressed.

The effect of different mixtures of vermicompost and coir dust on nitrogen mineralization in soil is shown in Fig. 2 and 3. Variation in soil NH_4^+-N during the first 3 days of incubation was significantly different ($p \geq 0.05$) in treatments T_1, T_2 and T_3 (Fig. 2). No distinct relationships were found after day 3 of incubation and NH_4^+-N contents were highly varied throughout the incubation. However, control (T_5) was found to be significantly different ($p \geq 0.05$) from other treatments towards the end of the incubation. Furthermore, it was observed that NH_4^+-N contents were increased at the initial stage of the incubation followed by gradual reductions. The initial increment might be due to organic N ammonification or from depression of ammonium oxidation activity. Treatment T_2 was found to exhibit the highest NH_4^+-N contents followed by treatment T_1 and T_3.



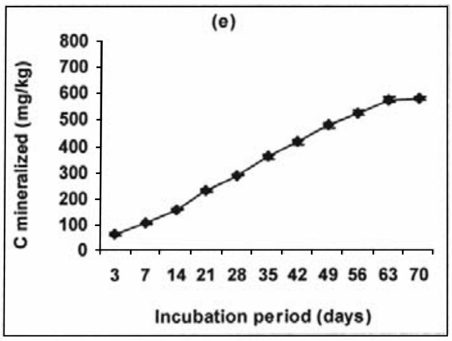
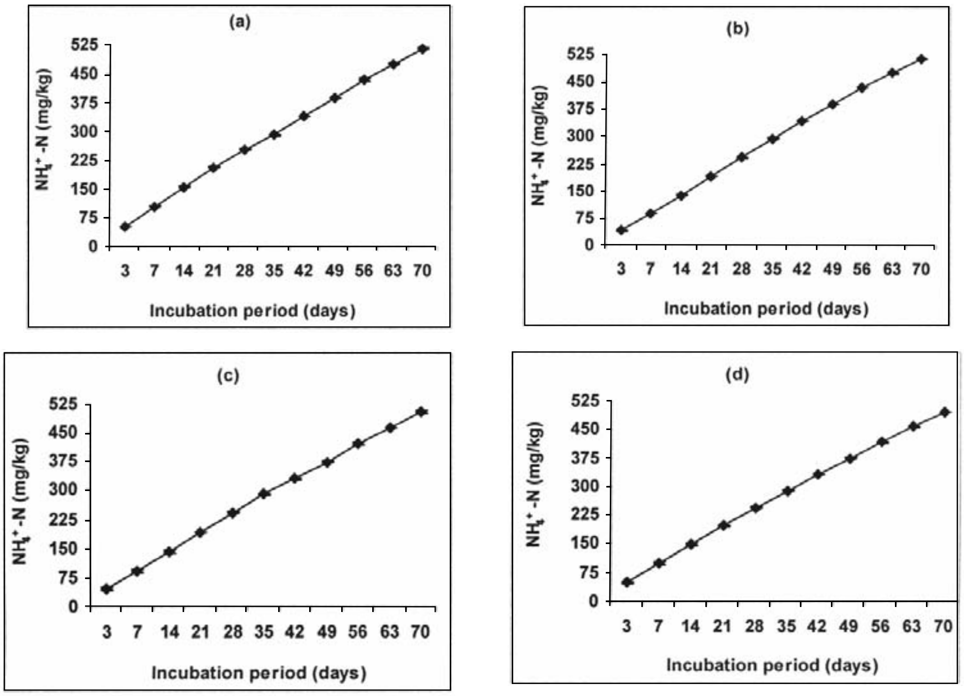


Fig. 1. Cumulative C mineralization of the soil amended with different combinations of vermicompost and coir dust. (a), (b), (c), (d) and (e) represent treatment T_1, T_2, T_3, T_4 and T_5, respectively. Values are the means of 4 replications.

Fig. 3 shows the soil NO_3-N variation during the incubation period. According to the results, NO_3-N contents were highly varied at the initial stages of incubation with no distinct relationships among the treatments. However, as incubation progressed, the NO_3-N contents were increased for all the treatments. It was also observed that the NO_3-N increment in treatment T_1 was significantly ($p \geq 0.05$) higher than those of other treatments. This might be due to enhanced mineralization of organic N. At the end of the incubation (last 2 weeks), NO_3-N contents in all the treatments were significantly different ($p \geq 0.05$) from the control. However, the values for treatments T_2, T_2 and T_3 were not significantly different ($p \geq 0.05$) from each other.



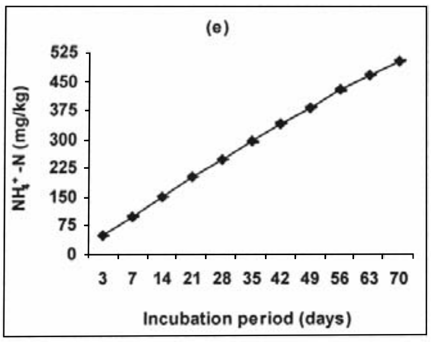
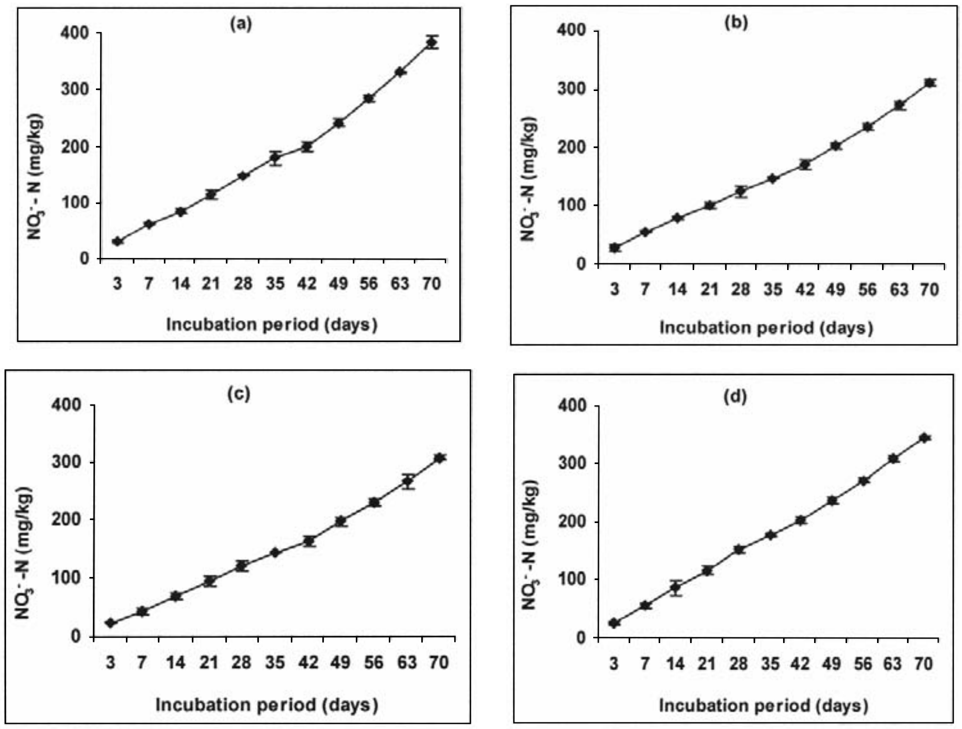


Fig. 2. Release of NH_4^+-N *from* the soils amended with different combinations of vermicompost and coir dust. (a), (b), (c), (d) and (e) represent treatment T_1, T_2, T_3, T_4 and T_5, respectively. Values are the means of 4 replications.



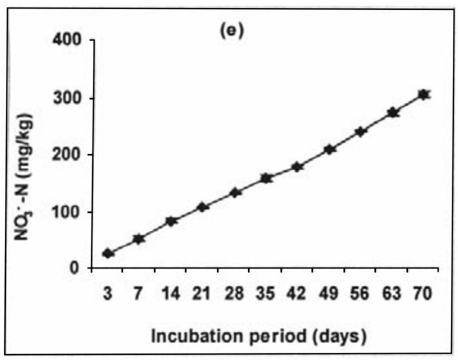


Fig. 3. Release of NO_3^--N from the soils amended with different combina-tions of vermicompost and coir dust. (a), (b), (c), (d) and (e) represent treatment T_1, T_2, T_3, T_4 and T_5. respectively. Values are the means of 4 replications.

However, previous studies have shown that 100% vermicompost can not be used as it is, due to poor porosity, aeration and high soluble salt concentrations (Atiyeh *et al.*, 2000). On the other hand, 75% coir dust also can not be used due to its low nutrient content. Such result is applicable to the present investigation that treatments T_1 and T_4 did not show positive results in terms of microbial respiration and N mineralization.

Conclusion

The combination of 75% vermicompost and 25% coir dust showed better performance in terms of carbon mineralization and thus more effectively enhanced the microbial activity compared to other treatments. The NH_4^+-N contents in all the treatments were found to be increased at the initial stage of the incubation followed by gradual reductions. Treatment T_2 showed the highest NH_4^+-N contents followed by treatment T_1 and T_3. The NO_3-N contents were highly varied at the initial stages of the incubation with no distinct relationships among the treatments. However, as incubation progressed, NO_3-N contents were increased for all the treatments with the highest increment for T_1 followed by T_2 and T_3.

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