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Original Research Article

CO_2 Evolution during Degradation Process of Leaf Residues in *Tectona grandis*

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A b s t r a c t

Organic manures or compost were the main source of replenishing soil fertility in India until the 1950's when chemical fertilizers began to gain popularity. The concept of composting is centuries old. Only the scale and complexities have gone up many folds. Composting of available organic residues is essential for better quality of organic manure not only by way of crop nutrition but also in terms of soil health. The present study demonstrated the rate of degradation process by estimation of CO_2 evolution in leaf residues in *Tectona grandis* independently or with inoculation of rock phosphate and microbials (in the form of cow slurry). Findings suggested that addition of rock phosphate more than 10% declined the biodegradation process.

K e y w o r d s

CO_2 evolution
Composting
Degradation process
Organic manures
Tectona grandis

Introduction

Modern agriculture depends upon the external application of plant nutrients to meet crops need. During growth, the plant absorbs lot of nutrients from soil and harvested, the plant takes away the absorbed nutrients with it. For example, to produce every tone of grain, a cereal crop absorbs 60-75 kg of essential nutrients. Harvested crops have been removing 9-10 million tonnes (N, P_2O_5, K) every year from soils (Tandon, 1995). Their individual amount varies from 20-25 kg N. It is clear that no single source of (plant nutrients/fertilizer/organic manure/crop residues/ fertilizers) can meet the total nutrient needs of the present day agriculture. A waste is resource, unless is toxic or harmful. The potential for waste recycling in agriculture is so large and basically ecofriendly. A waste is only waste unless it is recycled or made use of. Then it becomes a valuable resource rather a form of wealth. A sizable portion of nutrient needs of agriculture, forestry and aquaculture can be met through the appropriate recycling of wastes through conventional composting or degradation process (Tandon, 1995).

A common indicator of microbial decomposition of organic matter incubated under standard temperature and moisture condition is CO_2 evolution (Singh and Gupta, 1977).It is one of the principal metabolic products of heterotrophic microorganisms in soil. The quantity and rate of CO_2 production from soil have proved to be one of the best methods for measure the activity of soil micro-fauna. A different type of carbon and nitrogen sources also changes the CO_2 evolution. However the rate of changes depend not only on the numbers and types of organisms present but also on the nature and quantity of oxidisable carbon source added, C:N ratio and various other soil environmental factors. The present study was undertaken to estimate CO_2 evolution (rate of decomposition) during the degradation process of leaf residues of *Tectona grandis.*

Materials and methods

Leaf residues of teak plant (LT, *Tectona grandis*) were degraded independently and with the help of inoculants. Dried leaves were crushed and kept in high density, small holed (aeration required for metabolizing reactions of microorganisms) polythene bags for 90 days. Eight treatments of leaf residues of teak plant with rock phosphate and cow dung in different combinations (LT + 5% Rock Phosphate; LT + 10% Rock Phosphate; LT + 15% Rock Phosphate; LT + 20% Rock Phosphate; LT + 5% Rock Phosphate+ 10% Cow dung; LT + 10% Rock Phosphate+ 10% Cow dung; LT + 15% Rock Phosphate+ 10% Cow dung; LT + 15% Rock Phosphate+ 10% Cow dung) were studied. Various parameters were analyzed including C:N ratio, humus content, micronutrients, enzymatic activities (not discussed). The present study demonstrated the microbial activity estimated by Co2 evolution (following Pramer and Schmidt, 1984) during degradation process.

Results and discussion

Rate of decomposition of substrates was judged in terms of carbon mineralization by CO_2 evolution method. The results presented in Table 1 showed that maximum decomposition pattern was recorded between 7th and 9th day and then between 11th and 13th day of decomposition in all treatments and there is gradually declined up to 60 days. The highest cumulative CO_2 (1114.78±9.94 mg/100g of substrates) was recorded at the end of experiment in treatment where 10%RP was added along with cow dung slurry. With higher addition of rock phosphate less CO_2 was released than 3 and 10 % addition of rock phosphate.

Kretinin (1985) observed that composting leaf litter in solonetzic soil increased the rate of evolution of CO_2, and reduced catalase activity and increased invertase activity. The CO_2 evolution pattern and its intimate relationship with type of organic material were explained by Sharma et al. (1988). Malewar et al. (1999) reported significant differences in CO_2 evolution due to addition of organic, inorganic fertilizers in soil. The role of temperature, moisture in CO_2 evolution in bench scale continuously thermophilic composting of solid waste was studied by Malewar et al. (1999) over a 96 hours composting period, the cumulative amount of evolved, was maximal at 56 to 60^{o}C, and reported an aeration rate that left an CO_2 residual of 10 or 18% in the exhaust gas and a moisture content of 60% wet weight. During waste treatment mass losses of carbon were highest in the aerobic treatment and composting was lowest during anaerobic waste treatment. Following their application to soil, the amount of CO_2–C evolved from wastes was highest from anaerobically treated material, intermediate from the non-decomposed material and lowest from anaerobically treated and composted waste as observed by Kirchmann and Bernal (1997). Microbial efficiency was defined for any carbon pool undergoing decomposition as the ratio of assimilated carbon to assimilated carbon plus assimilated carbon. As important factor of the approach was the introduction of a fraction with a C: N ratio of protein that decomposed very readily for those substrates where initial N mineralization was large while CO2 evolution was small (Gilmour et al., 1985). The present study demonstrated a common index of microbial activity and carbon mineralization is the CO_2 evolution from the substrates under standard temperature and moisture condition.

Table 1. Cumulative carbon dioxide evolved (mg/10g) during biodegradation process of leaf residues of *Tectona grandis*.

Treatments	Sampling Intervals in Days										
	1	3	5	7	9	11	13	15	30	60	%
LT	58.02±4.24	65.02±6.54	83.12±6.20	94.07±5.24	214.01±8.20	325.56±6.20	540.20±8.20	580.11±9.20	638.40±7.24	698.02±8.68	
LT + 5% RP	82.03±3.14	91.74±6.45	112.30±6.45	115.12±6.20	132.14±9.64	214.12±5.20	348.12±9.47	567.65±7.64	640.20±5.76	756.42±7.48	
LT + 10% RP	86.03±4.04	94.74±6.24	122.60±7.24	132.12±9.29	230.14±8.44	312.12±7.29	540.12±6.38	662.65±4.24	745.20±8.69	856.42±5.24	
LT + 15% RP	76.24±3.24	88.67±5.24	104.12±8.24	126.17±7.27	230.42±9.64	356.20±6.88	540.12±9.48	646.70±7.34	735.98±9.34	853.80±6.28	
LT + 20% RP	71.04±4.24	84.02±6.14	96.02±6.45	114.24±8.29	224.80±9.14	356.60±6.29	558.40±9.20	650.30±8.29	723.41±9.28	842.46±4.87	
LT + 5% RP + 10% CD	94.67±4.14	124.12±6.24	150.12±7.64	192.34±9.64	284.51±4.84	146.42±6.28	664.16±8.20	834.15±9.60	960.49±8.29	1092.08±8.84	26.80±6.20
LT + 10% RP + 10% CD	102.34±3.20	130.43±6.24	162.16±8.84	200.42±4.24	299.11±4.24	461.43±8.29	679.42±4.24	847.59±6.64	978.80±6.85	1114.78±9.94	28.53±8.20
LT + 15% RP e+ 10% CD	94.42±3.44	119.02±3.24	145,34±9.54	176.34±4.24	233.12±4.24	432.12±9.20	612.12±4.24	794.49±4.28	926.48±6.67	1064.72±9.64	25.50±8.28
LT + 20% RP + 10% CD	90.73±3.44	108.43±4.20	138.65±8.27	160.52±4.24	267.23±4.24	434.42±8.29	610.12±4.14	710.23±4.24	910.24±8.98	1043.74±5.20	24.30±6.14

LT – Leaves of *Tectona grandis;* RP - Rock Phosphate; CD – Cowdung; C. D. at 5%; All values are mean and standard deviation of three replicates.

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