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Short Communication

Comparative evaluation of leaf litter composting methods in homesteads

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Abstract

A major portion of the nutrients absorbed by trees are returned to soil through litterfall and decomposition. Leaf litters in soil take a considerably long time for decay and release of the entrapped nutrients. An experiment on the effectiveness of different composting methods in hastening the decomposition of litters was attempted in mango and cashew leaf litters during March to November 2018 at College of Agriculture, Vellayani, Thiruvananthapuram. The composting methods included co-composting with poultry manure, composting inoculum + vermicomposting, glyricidia + vermicomposting and natural decomposition. The results of the study revealed that pre treatment of the leaf litters with composting inoculum followed by vermicomposting was the most suitable technology for hastening the decomposition of cashew and mango leaf litters (144 and 110 days respectively), on par with glyricidia + vermicomposting. The percentage recovery was higher in the treatment including glyricidia in both litters. Among the two species composting was more rapid in mango compared to cashew, bringing to focus the influence of litter quality on the rate of decay.

Key words: C: N ratio, Compost, Leaf litters, Lignin, Microbes, Quality.

Composting involves the biodegradation of organic wastes to a form that is suitable for addition in soil. The process opens vistas for the safe disposal of biowastes which would otherwise cause environmental and health issues if left unattended. Leaf litters in tree based cropping systems are allowed to decompose naturally and these conserve soil, serve as mulch and on decay, add to the soil nutrient pool. However, under off farm situations they are considered a menace and are often removed and burned. The ash produced provides some amount of potassium in soil, but the air pollution that is associated with the burning is not welcomed. Litter being an organic material, composting is recommended so as to yield an organic manure/ amendment that can be used in crop production. Research on composting of leaf litters including different decomposer organisms has been attempted, and the natural decomposition has been seen to be hastened. Earthworms (Vasanthi et al., 2013), microbial consortia (Maheswari and Anusuya, 2012), N rich additives (Guerra-Rodriguez et al., 2001; Thomas et al., 2013), mushroom (Thomas et al., 1998) are some of the organisms/ materials added to accelerate the composting process and improve the quality of the compost. Apart from the decomposers, climate related factors like temperature, moisture, aeration, and substrate quality are important parameters that govern the rate of decay. This paper attempts to assess the suitability of different methods for compost production from the leaves of mango and cashew, two commonly grown multipurpose trees in the homesteads of Kerala.

The experiment was conducted in the Department of Agronomy, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala Agricultural

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University from March to November 2018. Fallen litter of cashew and mango were collected during March 2018, cleaned of extraneous materials and used for composting. Samples of the collected litters were air dried and then oven dried at 70 ± 5°C to constant weight, powdered and used for the estimation of nutrient content and biochemical parameters as per standard procedures. The parameters estimated were organic C, N, P and K (Jackson, 1973), and lignin (Sadasivan and Manickam, 1992). Microbial counts were recorded adopting the serial dilution and plate count method described by Johnson and Curl (1972). The pH of leaf leachates was measured using pH meter with glass electrode.

The composting experiment was laid out in Completely Randomised Design with two factors (tree species and composting methods) in three replications. The treatments were tree species [s_1- cashew and s_2- mango] and composting methods [c_1: co- composting with poultry manure (PM) @ 10% w/w, c_2: pre-treatment with composting inoculum(CI) @ 20 g kg^{-1} followed by release of earthworms (EW) @ 1000 nos./m^3 after two weeks, c_3: co- composting with glyricidia leaves in 1:1 ratio followed by release of EW @1000 nos./m^3 after two weeks and c_4: natural decomposition (control)]. The leaf litters of the two species were soaked in water overnight, shredded and known weights were composted in cement rings of 120 cm diameter and 50 cm height. The moistened litter was mixed with fresh cow dung in the ratio 2:1 except in c_1 and c_4. The litter in c_1 was mixed with poultry manure and that in c_4 was kept as such for natural decomposition with soil. Irrigation was provided once in two days to maintain a moisture content of 40-50 per cent during composting.

The details of the composting inoculum/ materials used are presented in Table 1.

Composting was inferred as complete when 95 per cent of the litter was converted to a fine powder and C: N ratio was less than 25:1. The compost remaining in the rings were weighed to assess the recovery percentage. The data were statistically analysed to ascertain the significant effects of the tree species and composting methods on the time taken for compost production and percentage recovery.

The initial properties of the leaf litters used for the study are presented in Table 2. Comparing the two species, comparatively higher nutrient contents were recorded in mango litter while lignin, C: N ratio and lignin: N ratio were higher in cashew. Moisture content and microbial counts were also comparatively higher in mango litter. The pH of the leaf leachates indicated the litters to be of acidic nature.

Table 2. Quality parameters of initial leaf litter

Parameters	Cashew	Mango
pH	5.01	5.50
C: N ratio	39.10	32.70
Lignin (%)	20.1	14.8
Lignin: N	23.1	13.2
Moisture content (%)	18.2	22.7
Major nutrients (%)		
N	0.87	1.12
P	0.21	0.29
K	0.10	0.12
Microbial count (cfu g^{-1})		
Bacteria (x 10^6)	25	34
Fungi (x 10^4)	10	24
Actinomycetes (x 10^5)	12	12

Time for compost production

The results on the time taken for compost

Table 1. Composition of the composting inoculum/ material used

Materials/ organism	Composition
Composting inoculum	*Lactobacillus, Pseudomonas putida, Bacillus subtilis, Isaria farisona, Trichoderma viride* and *Pencillium griseofulvum*
Fresh cowdung	1.22% N, 0.45% P_2O_5, 0.31% K_2O
Poultry manure	1.95 % N,1.37% P_2O_5, 0.72% K_2O
Earthworm	African night crawler (*Eudrillus eugineae*)
Glyricidia*(Glyricidia sepium)*	3.82% N, 0.23% P_2O_5 2.80% K_2O

production and percentage recovery are given in Table 3. Significant variations were recorded in the time taken for compost production. Mango leaf litter was found to decompose more rapidly (154 days) compared to cashew leaf litter (189 days). Among the different methods, composting with CI followed by the release of earthworms (c_2) was significantly superior and took the lowest time for compost production (127 days) and on par with co-composting with glyricidia and earthworms (c_3), which took 156 days. The reduction was 45 per cent to that in natural decomposition. The consortium included the microbes, *Lactobacillus, Pseudomonas putida, Bacillus subtilis, Isaria farisona, Trichoderma viride* and *Pencillium griseofulvum* identified as efficient in composting organic residues. This coupled with the voracious feeding habit of the earthworm *Eudrillus eugineae*, made degradation of the litter rapid. It is in accordance with the reports of Singh and Sharma (2002). Further, earthworms require an acclimatisation phase to feed on the substrate which would influence the decay rate in the initial stage of composting (Gajalakshmi et al., 2005). The latter (c_3) was on par with c_1, co- composting with poultry manure (172 days). The litter left to compost naturally (c_4) was slowest, with compost production completed in 230 days. In natural decomposition (c_4), it was the native flora and fauna that acted on the litter. Augmentation was not done and this coupled with the litter chemistry, resulted in the lower rate of decay and greater time for compost production.

Table 3. Effect of litter species, composting methods and their interaction on time for compost production and per cent recovery

Treatments	Time for compost production(days)	Per cent recovery
Tree species (S)		
s_1 – Cashew	189	26.54
s_2 – Mango	154	21.09
SE m(±)	8	1.50
CD (0.05)	23.4	4.62
Composting method (C)		
c_1- Poultry manure	172	19.26
c_2- Compost inoculum + Earthworm	127	20.42
c_3 - Glyricidia + Earthworm	156	30.17
c_4 - Natural decomposition	230	25.39
SE m(±)	11	2.15
CD (0.05)	33.1	6.53
Interaction (S x C)		
s_1c_1	183	22.61
s_1c_2	144	23.64
s_1c_3	187	33.91
s_1c_4	243	25.99
s_2c_1	159	15.90
s_2c_2	110	17.21
s_2c_3	126	26.43
s_2c_4	219	24.79
SE m(±)	16	3.05
CD (0.05)	44.2	9.100

The interaction effect was also significant. Among the interactions, mango leaf litter composted with CI and earthworms (s_2c_2) decomposed rapidly (110 days) and was on par with s_2c_3 (mango leaf litter + glyricidia + EW) and s_1c_2 (cashew leaf litter + CI + EW), the periods being 126 and 144 days respectively. The better suitability of mango litter (in terms of litter physico-chemical properties) and efficiency of CI + earthworm combination resulted in rapid compost production (110 days). The inclusion of CI before vermicomposting could also hasten the decomposition in cashew, proving it to be the most suitable method for compost production from cashew leaf litter. Natural decomposition of both leaf litters took longer time for compost production, i.e., 219 days for mango and 243 days for cashew.

Leaf litters of mango and cashew are known for their persistence and remain intact in soil for long periods. Litter quality, climate and decomposing organisms have significant roles in the decomposition. As the climatic conditions were uniform, it was the litter quality and decomposer organisms that were important in this study.

The initial litter chemistry of mango and cashew leaves (Table 2) reflect the comparatively higher N and P content in mango leaf litter compared to cashew. During composting, microbes break down organic compounds to obtain energy to carry on their life processes and acquire nutrients (N, P and K) to sustain their populations. Of the many elements required for microbial decomposition, C and N are the most critical. A wider C: N ratio indicates that N is insufficient for optimal growth of the microbial populations and hence degradation will proceed at a slow rate. The C: N ratio was observed to be narrower in mango leaf litter (32.7:1). Further the lignin content was comparatively higher in cashew (20.1 %). Among the biochemical constituents, lignin is considered most resistant to degradation. Lignin: N ratio is a better indicator of degradability of the litter (Qu et al., 2019). According to Rahman et al. (2013), even litters with high lignin decompose at a faster rate than low lignin containing litters, and Binkley and Giardina (1997) attributed this to the higher N content. Comparison of the values in the present study revealed a lower ratio (13.2) in mango compared to cashew (23.1), confirming the relevance of lignin and N contents in litter decomposition.

Decomposer organisms are also crucial in composting and several authors have elucidated fungi and bacteria, including actinomycetes, to be the most important, although the population and diversity would vary with the phase of composting (Tuomela et al., 2000). The microbial count in the litters also bear testimony to this as it was comparatively higher in mango litter (Table 2).

Recovery percentage: The per cent recovery of compost also varied significantly with the tree species and method of composting. It was found to be significantly higher in cashew litter (26.54 %) as compared to that in mango (21.09 %).

Composting reduces the volume of the biowastes and this is considered as one of its advantages. Nagar et al. (2018) stated that the reduction in biomass was possibly due to loss of water in the form of water vapour and decomposition of complex organic waste into simple forms. Higher mass loss in mango could be due to narrower C: N ratio, higher N, lower lignin content and lignin: N ratio, which favoured faster activities of decomposers, and hence lower recovery percentage.

Among composting methods, co-composting with glyricidia leaves followed by earthworm (c_3) recorded higher recovery percentage (30.17). This may be due to the equal amount of glyricidia as that of litter being added in the treatment for reducing the C:N ratio. The recovery was in the range of 19.26 per cent in poultry manure to 30.17 per cent in glyricidia + EW among composting methods.

Among the interactions, the highest per cent recovery was recorded in cashew leaf litter composted with glyricidia and earthworms (33.91) and it was on par with the treatment s_2c_3 (mango litter + glyricidia + earthworms) and s_1c_4 (cashew litter + natural decomposition), i.e., 26.43 and 25.99 per cent respectively. The recovery was in the range of 15.90 per cent in poultry manure composted mango leaf litter to 33.91 per cent in glyricidia + EW composted cashew litter compost.

Based on the results it can be concluded that co-composting with composting inoculum/glyricidia followed by vermicomposting is the most suitable method for rapid composting of leaf litters of mango and cashew. Taking into account the cost of inputs, glyricidia + EW would be a better option as glyricidia leaves are locally available and percentage recovery was also higher in both species.

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