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UTILIZATION OF CASHEW LEAF LITTER AND SUGAR MILL WASTE PRESSMUD FOR THE CULTURE OF A COMPOST EARTHWORM *EUDRILUS EUGENIAE* (KINBERG)

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ABSTRACT
The unutilized cashew leaf litter and under utilized sugar mill waste pressmud cause environmental pollution. Using cashew leaf litter (CL) and pressmud (PM) in 1:3 ratio as the basic feed substrate, the following treatments were prepared in triplicates on weight basis: **C**-PM alone; $\mathbf{T_1}$–CL+PM; $\mathbf{T_2}$–CL+PM+GW (1:1:2); $\mathbf{T_3}$–CL+PM+ Urea (10g/kg); $\mathbf{T_4}$–CL+PM+ Tv (500 mg/kg); $\mathbf{T_5}$–CL+PM+ Pp (500 mg/kg); $\mathbf{T_6}$–CL+PM+Tv + Pp (250 mg/kg+ 250 mg/kg). In each treatment one kg of feed substrate were prepared in plastic trays. Ten hatchlings of *E.eugeniae* were cultured in each treatment and control under laboratory conditions at room temperature with 60-70% moisture. Once in 15 days, upto 90 days the weight of earthworms, worm growth rate and number of hatchlings were determined and analysed statistically. On the basis of results the efficiency of six treatments to support the growth and reproduction of *E.eugeniae* could be ranked in following order: $T_6 > T_2 > T_3 > T_5 > T_4 > T_1$. The higher growth rate, weight gain, and hatchlings production observed in T_6, T_2 and T_3 could be due to the addition of nitrogen as well as contribution of nutrients because of biodegradation of cashew leaves by lignocellulolytic fungi in addition to the contribution of nutrients by pressmud.

INTRODUCTION

The world production of commercial crop cashewnut (*Anacardium occidentale* L.) is around 9 lakhs tones per year and highest production (42%) has been recorded in India (Mandal, 1979). The waste from cashew plants (Leaf litter) occupying waste area of land and causes environmental pollution, forest fire, nutrient loss etc. Leaf litter is a potential but unexploited source of nutrients and its decomposition enriches soil nutrient pool. However, the rates of decay and pathways of decomposition are determined by the quality of litter material, the physical environment and the qualitative and quantitative composition of decomposer organisms (Swift *et al.*, 1979).

At present the potential of vermicomposting as a viable alternative for waste management is gaining momentum in India. In sugar factories, during sugarcane juice clarification, pressmud (PM) is produced as a by product about 4-5% of the cane weight. The production of pressmud amount to 3 million tons annually in India. One of the author's (Ramalingam, 1997) earlier studies have established that PM not only serving as an ideal medium for vermiculture but also vermicomposted into good quality organic manure besides acting as a booster for biodegradation of other waste.

Earthworms along with soil micro-organisms decompose the organic materials and produce vermicasting of high nutrient value (Kale, 1994; Ramalingam, 1997). Our previous studies had shown that though cashew leaf litter can be used as a feed source by epigeic earthworms, it could not be used alone as feeding media. So cashew leaf litter need to be mixed with other nitrogen rich sources such as urea, organic wastes, pressmud, gramwaste, etc; in order to provide nutrients and inoculum microorganisms. Cashew leaf litter, despite of its plant origin resists general microbial decomposition owing to its relatively high lignin (134g/kg) and cellulose (459 g/kg) content. Hence, it become mandatory to employ specific microbes that are lignocellulolytic in nature. *Eudrilus eugeniae*, an African epigeic (surface dwelling) earthworm has been effectively used in India for vermicomposting of organic wastes (Kale, 1994).

The survey of literature indicated that data on growth and reproduction of compost worms cultured in varieties of organic wastes are available in plently but information about the growth and reproduction of worms cultured in cashew leaf litter is scanty. So in the present investigation an attempt has been made to study the influence of cashew leaves – pressmud mixture in combination with gramwaste, urea and lignocellulolytic fungi (Tv and Pp) on the growth and reproduction of *E. eugeniae*.

MATERIAL AND METHODS

Pressmud (PM) was collected from a nearby sugar factory, cured by mixing with water and repeated air drying to remove heat and odour. Cashew leaves (CL) were collected from cashew field and gramwaste was collected from Annamalai University Agricultural Farm. Lignolytic fungi *Trichoderma veride*(Tv), cellulolytic fungi *Plurotus platypus* Pp and urea were purchased from fertilizer shop.

Pressmud alone was considered as control. Cashew leaf litter and cow dung in the proportion of 1:3 ratio (w/w) was considered as basic feed substrate (on the basis of trail study). Further, gramwaste, urea and lignocellulolytic fungi (Tv and Pp) were added to the basic feed substrate. The following treatments were prepared in triplicates on weight basis: **T_1** - CL + PM, **T_2**- CL + PM + GW (1:1:2), **T_3** – CL +PM + Urea (10 g/kg), **T_4** – TL + PM + Tv (500 g/kg), **T_5** – CL + Pp (500 g/kg), **T_6** – CL + PM + Tv (250 mg/kg) + Pp (250 g/kg). In each treatment one kg of substrate was prepared using water (60-70% moisture) in circular plastic trough (35 cm dia x 15 cm depth) and pre-decomposed for 30 days.

Ten hatchling of *E. eugenia* (5-10 days old) were collected from the stock culture and introduced in T_1-T_6 and control troughs after recording their individual initial weight. The plastic troughs were covered by nylon nets. Once in 15 days upto 90 days weight of the earthworms were recorded. Every time hatchlings and adults were counted and weighed separately, then adults were reintroduced in the respective plastic troughs, but the hatchlings were discarded. Once in a month the newly prepared (in specific proportions) feed mixtures were added and surface layer of vermicast was removed and discarded after checking cocoons and hatchlings. The worm growth rate (for specific periods) was calculated using the following formula specified by Mazatseva (1982).

Worm growth rate(mg worm^{-1} day^{-1}) =

$$\frac{\text{Maximum weight - Initial worm weight}}{\text{Number of days to attain maximum weight}}$$

The statistical significance of the data were tested by Student's 't' test.

RESULTS

Changes in the body weight of *Eudrilu eugeniae* cultured in cashew leaves – pressmud mixture (1:3 ratio) with the addition of gram waste, urea and lignocellulytic fungi is given in Table-1 and the worm growth rate is given in Table-2. Generally the body weight of *Eudrilus eugeniae* increased continuously (but in different magnitude) upto 90 days in all the experimental media. The results indicated that *E.eugeniae* gained lesser weight in T_1 and more weight in all other treatments (T_2 – T_6) compared to control (C) (Table-1). The efficiency of different treatments to support the growth of *E. eugeniae* could be ranked in the following order: CL+ PM + Tv+ Pp (T_6) > CL + PM + GW (T_2) > CL + PM + urea (T_3) > CL + PM + Tv

Table – 1: Growth and hatchlings production by *Eudrilus eugeniae* cultured in cashew leaves + pressmud mixture (1:3 ratio) with addition of gramwaste (GW), urea, lignolytic fungi (Tv), celluloytic fungi (Pp) for a period of 90 days.

Days	Pressmud (control) (C)		T_1 CL + PM			T_2 CL + PM + GW			T_3 CL + PM + Urea			T_4 CL + PM + Pp			T_5 CL + CD + Tv			T_6 CL + PM+ Tv + Pp		
	WB (g)	HP (Nos)	WB (g)	BID(%)	HP (Nos)	WB (g)	BID(%)	HP (Nos)	WB (g)	BID(%)	HP (Nos)	WB (g)	BID(%)	HP (Nos)	WB (g)	BID(%)	HP (Nos)	WB (g)	BID(%)	HP (Nos)
1	0.080 ± 0.0071	-	0.080 ± 0.0052	-	-	0.080 ± 0.0010	-	-	0.080 ± 0.0011	-	-	0.080 ± 0.0017	-	-	0.080 ± 0.0010	-	-	0.080 ± 0.0011	-	-
15	0.301 ± 0.0035	-	0.301 ± 0.0018	-2.90NS	-	0.524 ± 0.0061	69.0*	-	0.523 ± 0.0066	68.70*	-	0.416 ± 0.0017	34.19*	-	0.418 ± 0.0064	34.8*	-	0.626 ± 0.0073	101.0*	-
30	0.721 ± 0.0052	-	0.716 ± 0.0052	-0.69NS	-	0.984 ± 0.0027	36.6*	-	0.980 ± 0.0037	35.92*	-	0.878 ± 0.0035	21.7*	-	0.880 ± 0.0067	22.0*	-	1.099 ± 0.0055	52.42*	-
45	0.902 ± 0.0048	70.0 ± 5.74	0.912 ± 0.0050	1.1NS	64 .0 4.10	1.186 ± 0.0066	31.5*	122.0 ± 7.51	1.195 ± 0.0206	32.48*	116.0 ± 4.06	1.066 ± 0.0066	18.18*	112.0 ± 4.0	1.076 ± 0.0067	19.29*	106.0 ± 8.14	1.321 ± 0.0055	46.45*	138.0 ± 5.19
60	1.430 ± 0.0067	197.0 ± 7.50	1.427 ± 0.0064	-0.20NS	172.0 5.52	1.686 ± 0.0055	17.9*	247.0 ± 8.39	1.684 ± 0.0053	17.76*	216.0 ± 5.19	1.547 ± 0.0075	8.18*	211.0 ± 7.31	1.566 ± 0.0056	9.51*	223.0 ± 4.63	1.892 ± 0.0062	32.3*	274.0 ± 4.58
75	1.510 ± 0.0025	216.0 ± 7.79	1.501 ± 0.0055	-0.59NS	260.0 4.58	1.752 ± 0.0070	16.02*	266.0 ± 4.89	1.746 ± 0.0066	15.62*	252.0 ± 5.19	1.636 ± 0.0064	8.34*	246.0 ± 4.5	1.650 ± 0.0069	9.27*	244.0 ± 9.79	1.996 ± 0.0058	32.1*	287.0 ± 11.55
90	1.691 ± 0.0069	263.0 ± 5.24	1.687 ± 0.0055	-0.23NS	224.0 3.46	1.896 ± 0.0064	12.1*	312.0 ± 4.12	1.881 ± 0.0071	11.2*	274.0 ± 4.69	1.734 ± 0.0064	2.54*	268.0 ± 10.0	1.740 ± 0.0061	2.89*	272.0 ± 4.89	2.081 ± 0.0064	23.06*	314.0 ± 6.32
THP		**741**			**666**			**947**			**858**			**837**			**845**			**1013**

Values are mean of 30 observations ±S.E; WB–Worm Biomass; THP–Total Hatchlings Production; BI-Biomass Increase or Decrease over control; HP – Hatchlings Production by 10 worms; * - Significant at 1% level ($P<0.01$); NS – Not Significant ($P>0.05$).

(T_5) > CL + PM + Pp (T_4) > CL + PM (T_1). BID values showed that, except T_1 in all other treatments (T_2 – T_6), the biomass of *E.eugeniae* was increased significantly ($P<0.01$) over control (in all the periods). On the other hand in T_1, biomass was decreased insignificantly ($P>0.05$) during all the periods (barring 30th day value) (Table – 1).

Comparison of growth rate values indicated that on 45th day during pre-reproductive period (1-45 days) growth rate was higher than the reproductive period (45-90 days). Further, in all the three periods viz., pre-reproductive, reproductive and total period, the growth rate was maximum in T_6 followed by T_2 and T_3 compared to other treatments (Table-2). The growth rate values between different treatments, in all the three periods of growth (1-45 days, 45-90 days & 1-90 days) could be ranked in the following order: $T_6>T_2>T_3>T_4>T_5>T_1>C$ (Table-2). *Eudrilu eugeniae* in 90 days of culture produced maximum number of hatchling in T_6(1013) followed by T_2 (947); T_3 (858); T_5 (845); T_4 (837); C (741); T_1 (666).

Table 2: Growth rate (mg^{-1} day^{-1}) of *Eudrilus eugeniae* cultured in cashew leaves + pressmud mixture (1:3 ratio) with the addition of gramwaste (GW), urea, lignolytic fungi (Tv), celluloytic fungi (Pp) for a period of 90 days.

Treatment	Pre-reproduction period (1-45 days)	Reproduction period (45-90 days)	Overall growth period (1-90 days)
C	18.2	17.5	17.9
T_1	18.4	17.2	17.8
T_2	24.6	15.8	20.1
T_3	24.8	15.2	20.0
T_4	21.9	14.8	18.4
T_5	21.9	14.8	18.3
T_6	28.0	17.0	22.2

DISCUSSION

The growth and reproduction of earthworms are highly influenced by the quality and availability of feed, various physiochemical parameters etc. (Reinecke and Hallatt, 1989). Different types of organic wastes originated from different sources have been used for vermicomposting (Edwards *et al*., 1985; Ramalingam and Thilagar, 2003; Isacc and Achuthan Nair, 2005). But all the wastes are not either readily acceptable by the worms or effectively support the growth and reproduction. It is already reported that PM containing higher quantities of N, P, K, Ca, Mg, S, Fe (Ramalingam, 1997; Ramalingam and Ranganathan, 2001) and cashew leaves containing higher quantities of organic carbon 42.78%, nitrogen 1.07% calcium 0.51% and other macro and micro nutrients (Isacc and Achuthan Nair, 2005).

Cellulose, hemicellulose and liginin are the main constituents of lignocellulosic materials like cashew leaves and resist degradation (Deobald and Rawford, 1997). No single microbe can bring out a complete breakdown of lignocellulosic material but requires a consortia of specific microbes like *Trichoderma* species and *Pleurotus* species. In the present study, inoculation of either cullulolytic fungi, *Trichoderma veride* (T_5) or lignolytic fungi, *Pleurotus platypus* (T_4) to the feed substrate could not effectively support the growth and reproduction of *Eudrilus eugeniae* (compared to T_6). When Tv and Pp were inoculated together into the CL + CD feed mixture (T_6) enhanced both growth and reproduction of *E. eugeniae* which was evident from the observed higher rate of biomass production, higher growth rate and more number of hatchlings production (Tables 1 & 2). This may be probably due to either Pp or Tv when inoculated separately they were not able to degrade cashew leaves effectively. On the other hand, the combined activity of Pp and Tv in T_6 might have accelerated the biodegradation of cashew leaves and increased nutrients availability for earthworms in addition to the contribution of nutrients by pressmud.

It is well known that gramwaste and urea contain higher quantity of nitrogen. Early investigators proved that earthworms prefer food with higher content of nitrogen and sugar (Lee, 1983; Edwards and Bohlen, 1996). The rate of growth is closely proportional to the nutritional level of feed substrate and synthesis of specific enzyme may be stimulated by appropriate food (Prosser and Brown, 1965). On the basis of above reports, the higher growth and reproductive performance recorded in T_2 and T_3 could be due to the contribution of more quantity of nitrogen by added urea or gram waste. Cashew leaves – cowdung mixture (T_1) could not effectively support the growth and reproduction of *E. eugeniae*. It is evident from the insignificant reduction in weight compared to control. This might be due to the fact that cashew leaves resist natural degradation because of its high lignin (134 g/kg) and cellulose (45 g/kg) content (Isacc and than Nair, 2005) which in turn might have reduced nutrients availability.

The observed higher growth rate during the reproductive period reflected the active growth of worms due to the availability of more energy. Since *Eudrilus eugeniae* attains sexual maturity at about 35-40 days, energy is diverted to reproductive activities and hence leads to a decline in the growth rate during reproductive period as reported by Nowak (1975) and Ramalingam (1979). In nutshell, the unutilized organic matter rich cashew leaves in combination with nutrients rich sugar mill waste pressmud and urea/gram waste/lingocellulolytic fungi could be used as a culture medium for *E.eugeniae* and production of vermicompost besides abating environmental pollution caused by cashew leaves and pressmud.

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