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Full Length Research Paper

Assessment of decomposition rate and recovery number of earthworm *perionyx excavatus* perrier during vermicomposting by combined index (CBI)

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Earthworms not only turn over wastes into worm-casts in the process of vermicomposting but also multiply enjoying conducive ecological conditions vis-à-vis suitable temperature, pH, oxygen and food. The overcrowding reduces population density, hamper body growth and reproduction of earthworms. The present study has attempted to establish the optimum inoculation number of a selected indigenous earthworm species *Perionyx excavatus* which is required for obtaining maximum decomposition rate as well as recovery number of earthworms. Different experimental trails were carried out with various number of this species (*30, 60* and *90*) in a fixed amount of selected organic waste materials. The Combined Index (CBI) has been formulated in order to evaluate and also to assess two biological attributes viz. the decomposition rate (DR) and recovery number of earthworms (RN) after 45 days of experiment. Equal weightage was assigned both to decomposition rate (DR) and recovery number of earthworms in the construction of Combined Index (CBI). The experiment, carried out using 60 earthworms resulted maximum decomposition rate (%) as well as recovery number of earthworms and also was found statistically significant at 0.01 level.

Keywords: Optimum inoculating number, decomposition rate, earthworm recovery number, combined index

INTRODUCTION

Earthworms, representing an important faunal component among soil macro invertebrates are known for their contribution to soil formation and turn over because of their widespread global distribution. Nutrient status of vermicompost has been found to increase during the process of vermicomposting (Chanda et al, 2009). Composting of rural and urban wastes is a century old practice, Vermitechnology ensures effective bio-conversion of organic residues into vermicasting endowed with plant nutrients and other growth factors, which promote better growth of plants. Conventional composting of organic solid wastes mainly by microbial decomposition without the presence of earthworms invariably develops acidic condition and may lead to loss of nutrients through acidic leachates. Litter decomposition being a complex process involves the gradual transfer of fresh litter into refractory soil organic matter conditioned by edaphic factors and biotic agents and represents one of the most crucial process in the biogeochemical cycle of forest ecosystem (De Catanzaro and Kimmins, 1985).

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The optimum C/N ratio is an important factor influencing the fertility of soil in one hand, and promoting the decomposition rate on the other. Reduction of C/N ratio of soil and relative deviation of C/N ratio of vermicompost at definite interval during vermicomposting were observed and Ordinary List Square (OLS) method was applied to estimate trend equation of relative deviation for carbon, nitrogen and C/N ratio separately (Chanda and Chakraborty, 2005). The fragmentation of litter further accelerates microbial invasion and tissue breakdown initiated by the microflora which in turn favor further appearance of other soil faunal components and accelerate this process. The microbes convert most of the organic materials and complex substances, in the form of humus, through a process, known as humification (Edwards and Fletcher, 1988). Vermitechnology promotes the upliftment of socioeconomic condition of rural people through the livelihood generation on one hand and abatement of pollution by recycling of solid wastes on the other (Chanda et al, 2006).

The plants and small animals having soft tissues are usually decomposed by soil micro flora. The tougher and chemically stable tissues are broken down by the action of both soil fauna and micro flora (Seastedt, 1984). Prior to conducting this experimental study, the total number of earthworms to be utilized for decomposting was determined in respect of total amount of waste materials vis-à-vis food of earthworms following the guideline as mentioned in the comprehensive experimental studies of Edwards and Lofty (1977). It was found from their research that one mature earthworm per day require 100-300mg organic waste materials as food. However, Kale (1998) from her research study on the rate of consumption of earthworms concluded that one kg. of earthworms usually feed an amount of 5 kg of wastes having 45% to 50% moisture per day. The present paper has highlighted the results of the experimental studies having different trials (*30,60* and *90*) to find out the optimum number of earthworms belonging to a particular species (*Perionyx excavatu*) which are required to convert maximum amount of wastes during the experimental period.

MATERIALS AND METHODS

Different experimental trials were carried out with various numbers (30, 60 and 90) of *Perionyx excavatus* (average weight 0.96g) in a fixed amount of selected organic waste materials. The experiments were started with 2 kg feed comprising of different kind of wastes (Teak leaves, Water hyacinth, Paddy straw and Sal leaves) and cowdung at 9:1 ratio. All total 36 plastic trays (45cm x35cm x 15cm) were used in the present experimental set-ups (Figure 1). Three replicates of each waste along with a definite number of earthworms belonging to the same species were used. The experiment was undertaken under covered shed (20ft x 5ft), all the four sides of which were enclosed by metallic nets in order to allow free ventilation of air and light and also to prevent the entry of predators of earthworms like birds, rats etc. The average moisture content of each experimental tray was maintained at 45%-50% by sprinkling of required quantity of water on the decomposing materials. The temperature was kept within 27^0C -29 ^{0}C. This experimental study has been designed to find out the optimum number of earthworms of a particular species, which are required to convert a certain amount of particular waste material to vermicompost (Figure 1). After 45 days, decomposing materials (compost) were carefully sieved to separate other particles, followed by the drying up of castings at105^0C to estimate the rate of decomposition following the formula as mentioned below. Percentage of decomposition was calculated (Gajalakshmi et al, 2001) and the number of earthworms of each tray was recorded by counting the number.

% of Decomposition = $$\frac{\text{Dry weight of decomposing waste materials}}{\text{Dry weight of used waste materials}} \times 100$$

Deduction of combined Index (CBI)

The Combined Index (CBI) has been formulated in order to evaluate and also to assess two important attributes viz. the decomposition rate and recovery numbers relating to earthworm-waste materials in the process of vermicomposting. The decomposition rate highlighting the changing pattern of physical-chemical features of decomposing wastes and the recovery numbers representing the fecundity-mortality ratio in the population dynamics of earthworms utilized for vermicomposting, could be assessed with this method. Earlier evidence indicates that such similar indexing was made to construct an index of forest status combining density and diversity of plant species composing the forest coverage (Dutta et al, 2005). In the present study, equal weightage was assigned both to decomposition rate (%) and recovery number of earthworms in the construction of Combined Index. This was in tune with the preparation of human development index which utilized three variables (per capita income, life expectancy and education) and thereby provided 1/3rd weightage of each variable (Misra and Puri, 2001).

The combined index (CBI) has been deducted by following formula

Combined index (CBIn) = 0.5 X DRn + 0.5 X RNn

Where, DRn = Index of Decomposition Rate

RNn = Index of Recovery Number of Earthworm

In order to find out the optimum number of this suitable earthworm species, Combined Index (CBI) was applied. The index was devised by adding values of DRn and RNn of this species. The index has been standardized giving due equal weight age to each of DRn and RNn

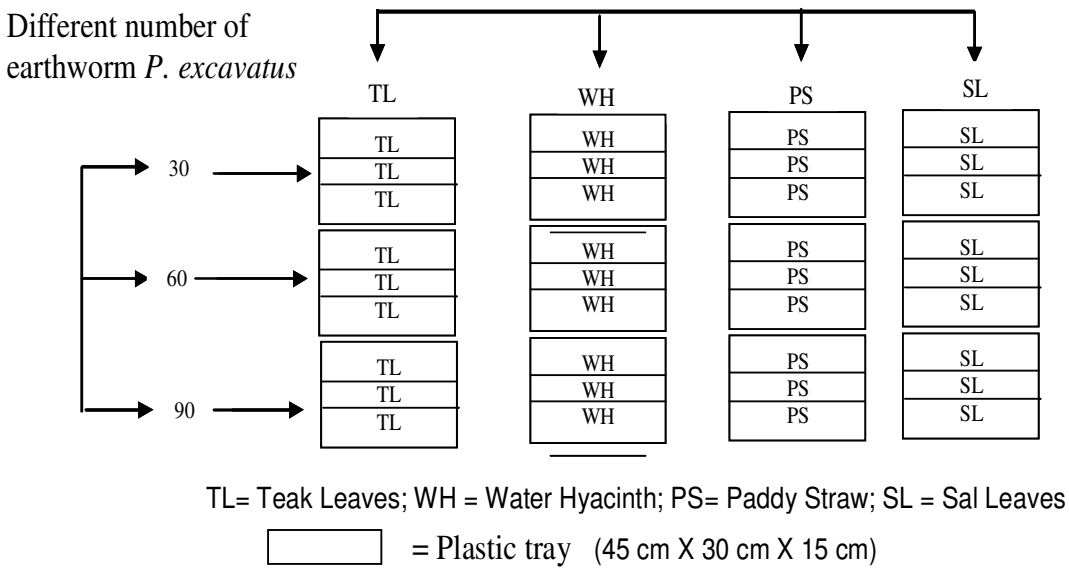

Figure 1. Flow sheet of experimental design to find out optimum number of earthworms belonging to a particular species (*Perionyx excavatus*) in respect of different wastes

values. Three combined indices were derived with three different experimental set ups inoculating different density of earthworm's population viz. 30, 60 and 90 in each experimental tray having the same waste materials in respect of type, weight and volume. The combined index (CBI) was calculated in the following manner.

DRn=

$$\frac{\text{Value of decomposition rate of particular species} - \text{Minimum decomposition rate of that particular species}}{\text{Maximum decomposition rate of that particular species} - \text{Minimum decomposition rate of that particular species}}$$

RNn=

$$\frac{\text{Value of recovery number of particular species} - \text{Minimum recovery number of that particular species}}{\text{Maximum recovery number of that particular species} - \text{Minimum recovery number of that particular species}}$$

Combined index is obtained (CBIn) as the simple average of DRn and RNn.

□□CBIn = 0.5 □□DRn + 0.5 □□RNn.

RESULTS

The experiment carried out in the present research using 60 worms of *Perionyx excavatus* exhibited maximum decomposition rate as well as recovery number of earthworms(Table 1). However, application of 90 worms of *Perionyx excavatus* resulted a bit increase (2-3%) in the decomposition rate but such application resulted in the reduction of earthworm's recovery rate (Table 1). The decomposition rate (%) and recovery number of earthworms belonging to the experimental earthworm (Table 1) species in different wastes were such that it was difficult to reach any final conclusion in respect of the standardized number of earthworms of a particular species which are required for the best result. It was found that high decomposition rate might result low recovery numbers (Figure 2). It was also noted that the application of optimum number of earthworms could ensure to high decomposition rate and high recovery number of earthworms.

The deduction of three combined indices (CBI30, CBI60 and CBI90) and analysis of variance of three indices suggested that highest average value of such index (CBI60) was 0.70, which was statistically significant at 1% levels (Table 1).

DISCUSSION

In order to make the entire vermicomposting process smooth, successful and cost effective, the quality and proportion of food materials (organic wastes) and total number of earthworms to be inoculated are important. During the composting period, finding conducive ecological conditions, earthworms start breeding and produce cocoons, from where juvenile earthworms are emerged. Rate of reproduction is dependent on the availability of food materials and also quality of organic wastes (Edwards et al, 1998; Dominguez et al, 2000). Besides, rate of reproduction, life cycle and rate of juveniles hatched out from each cocoon are probably influenced by the population density. Such interactions

Table 1. Combined Index (CBI) for different number of *Perionyx excavatus* Perrier for composting of different organic wastes

Earthworm species	Different wastes	Number of *Perionyx. Excavatus*						CBI 30	CBI 60	CBI 90
		30		60		90				
		DR (%)	RNE	DR (%)	RNE	DR (%)	RNE			
Perionyx excavatus	TL	50.16	637	75.2	1509	76.25	1241	0.24	0.79	0.71
		55.37	660	69.73	1378	72.51	1554	0.30	0.69	0.78
		48.55	627	84.3	1657	84.16	944	0.22	0.93	0.68
	WH	58.15	655	80.15	1451	81.12	1081	0.32	0.82	0.70
		49.75	648	74.71	1202	79.39	1354	0.24	0.68	0.78
		66.91	673	89.1	1719	85.94	827	0.41	0.78	0.66
	PS	53.5	511	78.12	1040	86.42	831	0.22	0.65	0.66
		47	533	75.24	954	75.42	1037	0.17	0.59	0.63
		62.39	465	87.12	1152	71.36	624	0.30	0.78	0.44
	SL	45.2	327	72.15	744	79.48	621	0.08	0.49	0.52
		38.29	297	64.82	676	78.34	657	0.00	0.39	0.52
		58.26	344	80.17	842	72.61	575	0.21	0.60	0.44
Average								0.23	0.70	0.62

F= 41.91; p= 0.006; DR = Decomposition rate, RNE = Recovery number of earthworm.
TL = Teak leaves, WH = Water hyacinth, PS = Paddy straw, SL = Sal leaves.

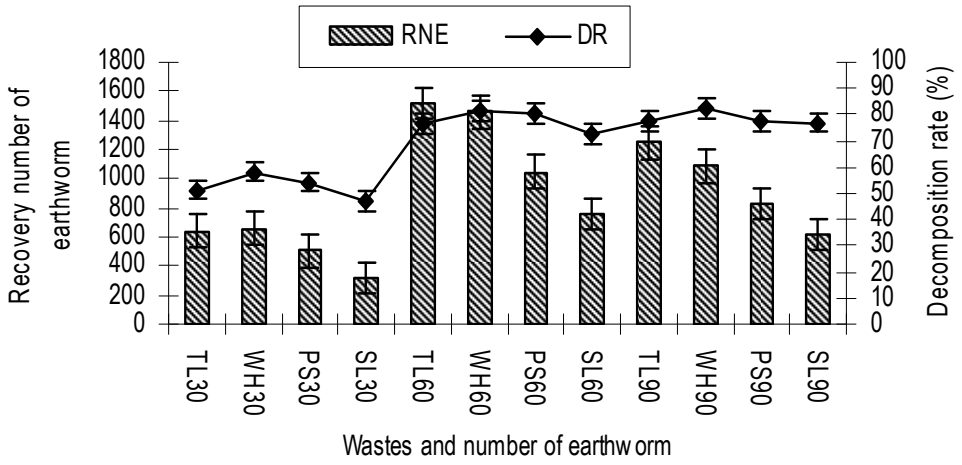

Figure 2. Decomposition rate of four selected wastes by three different numbers (30,60 and 90) of *Perionyx excavatus*

between earthworms and decomposing waste materials, vary from species to species. In the present study, through the analysis of combined index (CBI), experimental earthworm species *Perionyx excavatus*, was found to show significant result ($p < 0.01$) with initial inoculated earthworms density. During composting period, inoculation of 90 earthworms (*Perionyx excavatus*) exhibited lower recovery numbers (Table 1) which was supposed to be due to the overcrowding, resource unavailability and accumulation of excreta which led to higher mortality.

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