Impact of Press mud on the Growth and Reproduction of the Eisenia foetida (Savigny)

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Abstract- *The present study was aimed to decomposition of the press mud with different ratios of cow dung with using epigeic earthworm Eisenia foetida. To achieve the objective press mud and cow dung were mixed in ten different ratios to produce ten different vermicomposting. Among the ten different ratios, (control, T1, T2, T3, T4, T5, T6, T7, T8 and T9) feed mixture T3 and T2 has shown a high significant increase in biomass, cocoon, and hatchling. Thus suggestive of the vermicomposting could be an efficient tool to convert sugar industry solid waste pressmud into some value added products for ecological refurbishment practices. Therefore, the present study ten vermicompost were prepared with different ratios of press mud (PM) and cow dung (CD) and its effect on growth and reproduction of earthworm, E. foetida and physio-chemical properties and soil was carried out. The highest worm biomass and cocoon production noticed in T3 mixture after 14 weeks.*

Keywords- Cow dung , Earthworm , Epigeic , Garden soil , Sugar industry

I. INTRODUCTION

Sugar cane (Saccharum offcinarum L.) is a globally important cash crop. According to the latest statistics from Food and Agricultural Organization (FAO), this crop was cultivated on an area of 26.94 million ha with a total production of 1.91 billion metric tons in 2013 (FAOSTAT 2015). A significantly large amount of waste in generated during the manufacture of sugar that contains high levels of bagasse, effluent and press mud (Muthusamy et al. 2012). Earthworms play an important role in soil structure and consequently in the regulation of soil ecological functions (Birkhofer et al. 2008; Lavelle et al. 2006; Blouin et al. 2013). In particular, worms are known to influence H_2O and solute transportation by creating burrows in the soil matrix (McCoy et al. 1994). The increased mineralization of the organic matter leads to a high nutrient obtainability (Bityutskii et al. 2012).

The microflora in the intestine of worms and gut enzymes, microflora present in the waste, are involved in decomposition (Kavian and Ghatnekar 1991). Earthworms burrow through the soil, it can improve soil nutrition, change soil structure, and thereby stimulate indigenous soil microbial activity and change microbial community composition, which may in turn affect N_2O emissions (Rizhiya et al. 2007; Luo et al. 2008) mixing it in their guts and changing the chemical and physical properties of the soil (Eijsackers et al. 2001).

Earthworms increase the contact between a contaminant and soil micro-organisms (Hickman et al. 2008). Moreover, adding earthworms can increase the removal of a contaminant from the soil (Alekseeva et al. 2006). Earthworm is cold-resistant, able to digest aggressive substrates, such as poultry manure, cattle dung, and the substrate with a high concentration of bark and sawdust. (Kachina et al. 2015).

The present study was aimed to decomposition of the press mud with different ratios of cow dung with using epigeic earthworm Eisenia foetida. Its effect on growth and reproduction of earthworm, E. foetida. The highest worm biomass and cocoon production noticed in T3 mixture after 14 weeks.

II. MATERIALS AND METHOD

A. Collection of Earthworm

The earthworm species were purchased from an organic farming society at sathyamangalam in Erode district, Tamil nadu, India. The healthy non-clitellated, damage free worms were selected for the experiment.

B. Collection of Press mud

Press muds were collected from E.I.D Parrys Sugar mill, Nellikuppam, Cuddalore District.

C. Collection of Cow dung

Cow dung was collected from a dairy form of Agriculture Department and Botanical garden of Annamalai University respectively. The work was done by the Botanical Garden, Department of Botany, Annamalai University, Tamilnadu.

D. Physicochemical Characteristics of the press mud and cow dung

The initial Physico-chemical characteristics of pressmud and cow dung are summarized in Table 1. The different Physico-chemical parameters weighing 500-750mg, were inoculated in each container. Three replicates for each container were maintained. All containers were kept in dark at temperature 25±1ºC. Biomass gain and cocoon production were recorded weekly for 13 weeks. The feed in the container was turn out and earthworms, cocoons were separated from the feed by hand sorting, after which they were counted, examined for cocoon development and weighed after washing with water and drying them by paper towels. The Potential of Hydrogen (pH) and electrical conductivity (EC) were determination using a water suspension each waste in the ratio 1:10 (w/v) that be necessary agitated mechanically for 30min and filtered done Whatman filter paper No 1. The total organic carbon (OC) was measured using the method of Nelson & Sommers (1982). The moisture content and humus of the soil was determinates by the standards of (Thorex et al. 2008). Organic carbon, Phosphate, nitrogen and potassium in the soil sample were analyzed by using a soil analysis kit (Jyoti Scientific, India). OC was estimated by chromic acid wet digestion method of Walkley and Black (1934). The levels of total nitrogen (TN) present in the samples were estimated using Kjeldhal method of Jackson (1973). The levels of total phosphorous (TP) present in the organic samples were estimated using ammonium phospho-molybdate method of Pemberton (1945). The levels of total potassium (TK) present in the organic samples were estimated by using Flame photometry method of Stanford and English (1949). The ratio of the percentage of carbon to that of nitrogen (C/N ratio) was arrived at by dividing the percentage of carbon with the percentage of nitrogen estimated in the given organic sample. The levels of micronutrients such as manganese (Mn), zinc (Zn), copper (Cu) and iron (Fe) present in the organic samples were estimated by Atomic Absorption Spectrophotometry method of Lindsay and Norwell (1978).

E. Experimental design

Present study were conducted in Botanical garden of Annamalai University under green shade net. Ten test earthen pots (with 3 replications for each combination) were filled with the press mud and cow dung. In to each pot, 10 individuals of Eisenia foetida of known biomass were introduced. The ten feed mixture having different ratios of press mud, cow dung. Without press mud is consists of control were established (table - 2). One kilogram of the mixture (dry material) was put in each earthen pot. This is provided an area of 550cm2 of exposed top surface. These mixtures were mixed manually every 24hrs for 15 days in order to remove volatile substances potentially toxic to an earthworm. After 15days, 10 adult individuals of E.foetida were introduced in each pot. The moisture content was maintained at 65-70% of water holding capacity by a periodic sprinkling of an adequate quantity of water all the earthen pot were kept under shade house. The experiments were replicated thrice for each feed mixture. After every three weeks, the biomass, cocoons, and hatchling were counted.

III. RESULTS AND DISCUSSIONS

A. Growth and reproduction

The chemical analyses of press mud separate and cow dung are presented in Table 1. The different levels of growth and reproduction of Eisenia foetida were observed in the press mud and cow dung material mixtures. The reproduction of earthworm for one type and different ratio of treatments is presented in table 2. Table 3 shows the values obtained for dissimilar parameters of growth and reproduction of Eisenia foetida over the experimental period. Generally, most of the plots for the treatment (T1 to T3) showed positive results with the increasing number and weight compared to other treatments (T4 to T9). The changes in worm biomass over the period of 7-8 week with various combination of substrate are presented in Table 3. Among the various experimental conditions such as control, T1, T2, T3,.....T8, and T9, the maximum worm biomass was observed in (70:30) bedding material, i.e., in T3 (1090.42±0.868g), the least growth was observed in T9 (779.41±0.535g) and the maximum net biomass achieved in the T3 (948.32±0.760g) ratio, among the all treatment the lowest net biomass is T9 (651.39±0.422g).

In all the experimental media the maximum worm biomass was attained in pot T3 at 8th week (1090.42±0.868g) and minimum in pot T9 (779.41). Fig 2 summarizes the cocoon and hatchling production by E. foetida in different treatment. The cocoon production started from 4th week in control and first four vermibeds however, it started from 5th week in vermibed T4 and T5. E. foetida showed the maximum cocoon production in T3 followed by T2, T1, control ($p=0.005$) for all. Although, the reproduction rate (cocoon worm-1 day-1) ranged between 0.11 (T9) and 0.79 (T3), among different treatment. Cocoon and hatchling production were significantly higher in pot 3(0.79±0.015 and 75.06±0.80) than in the other mixtures. The lowest cocoon and hatchlings production were achieved in the pot 9 (0.11±0.450 and 27.55±0.815).

In all the experimental media respectively, which were most significantly ($p<0.05$) higher than the initial biomass. The mean hatchling success of cocoon produced in the T3 group was (0.79±0.015) and significantly lower than the (0.11±0.450) in the T9 treatment. The Total number of hatchling was 75.06±0.80 for the T3 and 27.55±0.82 for T9 treatment, with no significant difference (p>0.05) between the two values.

IV. DISCUSION

Nutrition is an necessary element to determine the maximum growth of an organism. The optimal growth, maturation, cocoon production and multiplicative potential of earthworms have been recounted to depend on the quality and quantity of the available feed and various physicochemical parameters (Ramalingam R 1997, Karmegam N and Daniel T 2000). The best results regarding nutritious quality of the vermicomposting and the growth and reproduction of E. foetida were obtained when worms were allowed to feed on cow dung exclusively (Kaushik P and Garg V K 2003). Highest earthworm biomass was observed in the treatment no 3 (904 mg/earthworm) which was significantly higher from all other treatments. The lowest biomass was observed in treatment no 6 (519 mg/earthworm). The maximum net biomass gain was observed in treatment no 3 (764 mg/earthworm) and minimum was observed in treatment no 6 (398mg/earthworm) (Mohamad ishaq bhat 2013). Ramalingam (1991) in L. mauritti cultured under press mud (±0.4 cocoon/worm/day), Bouwman and Reinecke (1991), Venter and Reinecke (1988), and Edwards and bater (1992) in E. foetida cultured under cow manure, cattle manure and animal + plant wastes (0.546, 0.5 and 0.542 cocoon/worm/day respectively), Namita and Madhuri (2008) in D. nepalensis cultured under cow manure (0.74 cocoon/worm/day), and Monroy et al. 2007 in O. complanatus exposed to cow manure (0.82±0.14 cocoon/worm/week) showed more or less a similar cocoon production values as noticed in the current study.

The importance of the earthworms in waste management, environmental conservation, organic farming and sustainable agriculture has been highlighted by several workers (Senapati 1992, Bhawalkar 1993, Ghatnekar et al. 1998, Talashikar and Powar 1998). Vermicomposting has been used for the management of agro-industrial waste. It is well established that organic wastes can be ingested by earthworms and egested as peat like material termed as vermicompost (Anbalagan et al. 2012) (Loeher et al. 1985). It is much more fragmented, porous and microbially active than parent material (Edwards and Bohlen 1996) due to humification and increased decomposition. An important point in relation to this practice is the quality of the organic sludge. In this context, the biodegradation process is the most commonly used treatment to stabilize industrial organic sludge and in recent years the bio-treatment of organic wastes has also been associated with energy recovery (Pognani et al. 2009). Vermitechnology is the use of surface and subsurface local varieties of earthworm in composting and management of soil (Ismail, 2005). Earthworms along with other animals have played an important role in the regulating soil processes, maintaining soil fertility and in bringing about nutrient cycling (Ismail, 1997). Thus vermin-composting, being eco-friendly is a technological option for organic solid waste management, avoiding foul smell and other environmental problems associated with dumping or landfill of waste and generating equal or more amount of revenue from the sale of its products. The concept of commercial vermicomposting is of recent one and being practiced for a decade or more. Many scientific investigations have established the viability of using earthworms as a treatment technique for numerous waste streams. (Hand et al. 1998) and also environmentally friendly and economical alternative method for treating solid organic waste (Saranraj and Stella 2012, 2014; Sherman 2011) including from sugar industry.

Table 1. Physio-chemical parameters of press mud and Cow dung

Parameters	pH	Electrical Conductivity (EC) (mS cm-1)	Moisture content	Total Organic Carbon (TOC)(g/Kg)	Total Nitrogen (TN)(g/Kg)	Total Phosphorus (TP)(g/Kg)	Total Potassium (TK)(g/Kg)	Total Calcium (TCa)(g/Kg)	Total Sodium (TNa)(g/Kg)	C/N ratio	Iron (Fe) (mg/Kg-1)	Zinc (Zn) (mg/Kg-1)	Manganese (Mn)(mg/Kg-1)	Copper (Cu)(mg/Kg-1)
Cow Dung	8.9±0.20	3.4±0.27	33.85±0.17	234.11±2.72	9.68±0.52	3.51±0.29	19.5±0.81	1.87±0.10	2.93±0.32	24.25±1.37	1.74±0.13	14.33±0.52	5.26±0.47	3.12±0.44
PressMud	7.76±0.03	7.51±0.06	55.58±0.16	189.67±0.81	17.4±0.15	7.31±0.10	18.9±0.47	0.194±0.01	0.303±0.01	11.02±0.10	21.82±0.34	11.32±0.64	12.98±0.52	4.3±0.40

Table 2. content of different wastes initial feed mixtures

Treatments	Cow dung (CD)%	Press mud (PM) %
Control	100	0
T1	90	10
T2	80	20
T3	70	30
T4	60	40
T5	50	50
T6	40	60
T7	30	70
T8	20	80
T9	10	90

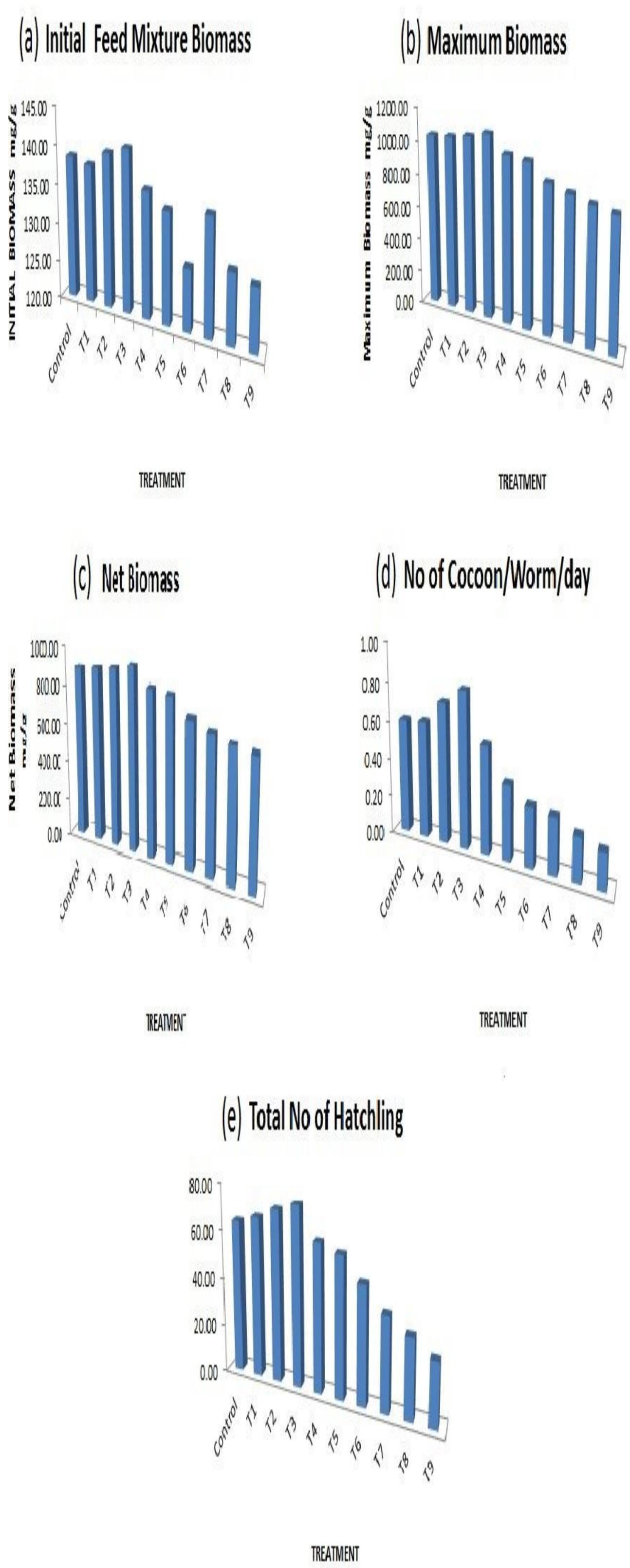

Figure 1. Earthworm growth and Reproduction, (a)Earthworm initial feed mixture biomass, (b)Earthworm maximum biomass, (c)Earthworm Net biomass, (d)Earthworm cocoon and worm reproduction, (e)Earthworm Total number of hatchling

V. CONCLUSION

The study thus revealed that pressmud provided a better environment for the earthworm to grow and it produced a higher quantity of vermicomposting than did cow dung. Earthworms in T3 (70:30) produced a higher number of cocoons and young worms. However, the hatchability of the cocoons was affected by the T9 (10:90) treatment.

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