International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Domestic Method of Kitchen and Garden Waste Management

Puneeta Dandotiya[1], O. P. Agrawal[2]

Vermibiotechnology Centre, School of Studies in Zoology, Jiwaji University, Gwalior – 474011, India

Abstract: ***Current methods of disposal and management of nutritionally rich food, kitchen waste and garden waste are not satisfactory. They are source of foul smell, pollution, unhygienic conditions and infectious diseases. Incineration of garden waste is also source of pollution. The present study was undertaken for the management of kitchen and garden waste. Free choice experiment on soil, kitchen waste, garden waste and dung in different ratios revealed the best culture media was mixture of these wastes in proportion of 1:1:1:1. Further study in soil, kitchen waste, garden waste and dung mixture followed by release of earthworms and maintained for 80 days resulted the best results were obtained in soil-kitchen waste-garden waste-dung ratio (1:4:4:4) in which maximum increase (4803.33 %) in total bio-number (adults, juveniles and cocoons) and net biomass (743.51 %) was recorded. The maximum amount of nitrogen (1.94%), phosphorus (1.12%) and potassium (1.18%) content were also noticed in this mixture. The study concluded that releasing of Eudrilus eugeniae worms play important role in waste management with great output of vermicompost and releasing of these earthworms in organic waste rich moist soils can be best for in situ recycling of waste biomass and for remediation of soil fertility.***

Keywords: Eudrilus Eugeniae; Garden waste; Kitchen waste; Vermicomposting; Waste recycling.

1. Introduction

The municipal solid waste is a major unavoidable source of waste products released by human beings very abruptly without proper treatment. The production of municipal solid wastes (M.S.W.) has been increased day by day due to increase in human population and their requirements. Moreover, the organic kitchen waste by products in the urban areas, chief source of pollutant can be used as a source of organic matter or manure for soil rejuvenation and also a chief source of nutrients. Incineration or burning of dry leaves, flowers and fruits of garden waste is also a major source of environmental pollution. This is not the proper management of garden waste. The effluents of organic matter from rural and urban areas can be used as a vermicompost (manure), which is composed of organic matter, without toxicants. The conversion of bio-wastes into vermicompost has became safe, proper and appropriate way for the safe hygienic [24]. Management of soil fertility is one of the most effective ways for farmers to increase crop productivity and profit-ability while improving the environment. Earthworms play important role in soil ecosystem because majority of biomass is handled through them, in collaboration with microorganisms. They improve soil fertility in several ways and act as aerator, crusher, mixer, grinder, chemical degrader and biological stimulator in soil. They mix organic matter with mineral soil, release nutrients and make them available to the plants. They also improve infiltration of water through burrowing and contribute to the formation of stable soil aggregates, producing the crumbly texture of a fertile soil by the intimate mixing of organic matter, microorganisms, mineral soil and secretions from the worm skin and gut [20]. Earthworms are well known to help the soil in respiration, nutrition, excretion and stabilization. They cause tunneling, show buffering action, regulate soil temperature and thus stimulate useful activity of aerobic microorganisms.

But in modern agriculture the contribution of earthworms has not been given due consideration and their diversity and density are declining. Earthworms can quickly decompose and stabilize animal manure and in doing so, they increase soil biochemical characteristics making it more suitable for plant growth [1], [2]. A number of authors have been reported that exchangeable cations such as Ca, Mg, Na, K, available N, P and Mo in earthworms cast was significantly higher than in surrounding soil [16], [17], [21]. [10], [9] pointed out that earthworms breakdown the complex organic matter into available nutrients and help to maintain the physio-chemical and biological properties of the soil.This study has been conducted for popularizing simple and suitable method of kitchen and garden waste management at home level with the help of vermicomposting, which may be helpful in waste management and in improving soil fertility in kitchen gardens and in agricultural / horticultural fields.

2. Material and Methods

For developing a simple and suitable method for "the management of kitchen and garden waste at home level" garden waste (included dry leaves, fruits and flower waste), organic kitchen waste with soil and dung in different ratio were used for vermin composting. The earthworms for the study were taken from Vermicomposting Centre of School of Study in Zoology, being maintained in Charak Udhyan of Jiwaji University, Gwalior. Firstly a free choice experiment was conducted in a ceramic tank for showing the survivability of African night crawlers *Eudrilus eugeniae*. The sink was divided into four equal size chambers with the help of thermocole sheets arranged around a middle chamber (perforated plastic container). These four chambers were filled with following culture media; (A) Soil + Kitchen waste (1:1), (B) Soil + Garden waste (1:1), (C) Dung + Kitchen waste+ Garden waste (1:1:1) and (D) Soil + Kitchen waste + Garden waste + Dung (1:1:1:1). Thermocole sheets were provided with some holes so that earthworms can pass through from one chamber to another, according to their preferential habits. In the middle chamber, 100 adult earthworms were filled and the whole assembly was covered by garden mash net. The worms had a freedom to migrate and distribute themselves in any one of the media of their own choice. Free choice experiment was repeated three times and the results were recorded after 15 days by counting the number of earthworms and calculating the percent distribution of earthworms in each chamber. For further study the mixture of soil, kitchen waste, garden waste (included dry leaves and flowers waste) and dung in different ratios has been used**,** earthen flower pots were employed as experimental units. Experiments were conducted in two sets (each in triplicate) in first set, the amount of dung was kept constant and that of soil, garden waste and kitchen waste was altered and in the second set, the amount of soil was constant and that of garden waste, kitchen waste and dung were changed. The experimental pots were filled with 10 kg of equilibrated culture medium in different combination of soil, garden waste, kitchen waste and dung mixture. After pre-decomposition period of 10 days and 10 baby worms (weighing 6.23 - 7.89 gm) were introduced in each culture unit or earthen pot for 80 days. The earthworm population and cocoons were estimated by hand sorting and counted at the completion of 80 days through washing over a sieve [6]. The observations on the number and weight of adult, baby worms, juveniles and cocoons, worm population growth and biomass production were recorded.

The quality of compost was assessed by determining the values of nitrogen (N), phosphorus (P) and potassium (K). The followings chemical parameters of vermicompost were analyzed: Total Kjeldahl nitrogen (N) was determined as per method [3]. Available phosphorus was analyzed by employing method [18] and Potassium was determined by ammonium acetate extractable method [25]. The pH of the composts was determined using glass electrode pH meter [5].

3. Results

The number and weight of adult earthworms are the indicators of growth and biomass production, whereas the number and weight of cocoons and juveniles are the parameters of reproductive performance. Observations of the free choice experiment of soil, kitchen waste, garden waste and dung mixture in different ratios revealed that highest percentage of earthworms (47%) was found in mixture of soil (S), kitchen waste(KW), garden waste (GW) and dung (D) (1:1:1:1) are depicted in fig. 1. Therefore further study has been conducted in mixture of soil, kitchen waste, garden waste (included dry leaves and flowers waste) and dung in different ratios. All the experimental culture media were not found to be equally suitable for survival, growth and reproduction of *E. eugeniae*. The results on average number of adults, cocoons and juveniles, dealing with two sets of experiments, are depicted in Table 1 and 2. Similarly the average results on the weight of adults, cocoons and juveniles are depicted in Table 3 and 4. The quality of the vermicompost by estimation of pH and Nitrogen (N), Phosphorus (P), Potassium (K) values were shown in fig. - 3 and 4 respectively.

It was observed that in all combinations of substrates, the earthworms showed variable degree of growth and reproduction with minimum performance in soil alone and zero degree of growth and reproduction performance in kitchen waste alone and garden waste alone. The numbers of *E. eugeniae* varied from 10.00 to 26.33 in combinations of soil, kitchen waste, garden waste and dung. In first series of experiment, the number of worms decreased only in soil alone from 10 to 5.0 (-50 %) and in second series from 10 to 5.5 (-45%) decrease was found. During 80 day period of experiment, the pre-mature worms became fully mature and increase in adult worms and the presence of significant number of cocoons and baby worms indicate their reproductive activity. The number of adult worms could not survive in garden waste alone and kitchen waste alone. The number of cocoons was found to be increased with decreasing amount of soil, kitchen waste and garden waste *i.e.* 45.00 in S+ KW+GW+D (4:4:4:1), 65.00 in S+ KW+ GW+D (3:3:3:1), 100.00 in S+ KW+ GW+D (2:2:2:1), 205.00 in S+KW+ GW+D (1:1:1:1) and 200.66 in dung alone (control). Maximum number of cocoons (205.0) was recorded in S+KW+ GW+D (1:1:1:1). Similar to the number of cocoons, minimum cocoon weight (1.5gm) was also observed in S+KW+ GW+D (4:4:4:1) and an increasing trend was noticed with decreasing amount of soil, kitchen waste and garden waste, *i.e.,* 1.833 gm in S+KW+GW+D (3:3:3:1), 2.0 gm in S+KW+GW+D (2:2:2:1), 4.0 gm in S+GW+KW+D (1:1:1:1) and 3.933 gm in dung alone. Maximum weight of cocoons (4.0 gm) was recorded in S+GW+KW+D (1:1:1:1) shown in Table 1, 3. In first series of experiment, in which ratio of soil, kitchen waste, garden waste was altered and dung was constant the weight of adult worms increased as 39.36 % in soil alone, in S+KW+GW+D (4:4:4:1)108.28%, S+KW+GW+D (3:3:3:1)145.42 %, in S+KW+GW+D (2:2:2:1) 212.62 %, in S+KW+GW+D (1:1:1:1) 293.62% and in dung alone 445.40 % increased (shown in fig 2a). In second series of experiment where ratio of soil was remain constant and kitchen waste, garden waste and dung ratio were altered, higher values of both parameters (number and weight of adult worms) were reported *viz.* the weight of adult worms increased as in soil alone 49.15%, in S+KW+GW+D (1:1:1:1) 293.62%, in S+KW+GW+D (1:2:2:2) 347.66%, in S+KW+GW+D (1:3:3:3) 494.64%, S+KW+GW+D (1:4:4:4) 591.05% and in dung alone 448.25% increased (shown in fig. 2b). In combinations containing low amount of soil and high amount of garden waste, kitchen waste and dung i.e., 1:1:1:1, 1:2:2:2, 1:3:3:3, 1:4:4:4 and in dung alone, population growth and biomass production of *E. eugeniae* were higher. Data of experiments were converted into percentile of parameters (% growth rate and biomass production) and average of these values indicates the net percentile rank of a particular medium. Medium showing highest rank should be considered to be the best suitable medium for *E. eugeniae.* Two types of culture media can be recognized according to their percentile scores: (a) Highly suitable with percentile score of 100-80, (b) Moderately suitable (80-60 percentile), (c) Suitable (60-40 percentile) and (d) Un-suitable (40-0 percentile) were depicted in table 5.

In the present study an attempt has also been made to demonstrate the quality of the vermicompost by estimation of pH, N P K values (shown in fig. – 3 and 4). Nitrogen is the chief constituent of all kinds of fertilizers including chemical and bio-fertilizers followed by potash (potassium) and phosphorus. In the first set of experiment it was observed that the quantity of total nitrogen was highest (1.91%) in vermicompost obtained from dung (shown in fig. 4) and in the second set of experiment the quantity of total nitrogen was maximum (1.94 %) in the vermicompost prepared from soil, kitchen waste, garden waste and dung (1:4:4:4) are depicted in fig. 4. Whereas, the nitrogen content was lowest (0.29 %) in the vermicompost produced from soil alone. The values of nitrogen in other combinations of soil, garden waste and dung mixture were observed to stand in between the lowest and highest recorded values (shown in fig. 4). The values of phosphorus content showed a range of variations from 0.18 – 1.12 % in both sets of experiment (shown in fig. 4). The potassium content varied from 0.13 – 1.18 % in different combinations of the substrate media used in both sets of experiments and the difference between them was not significant (shown in fig. 4).

4. Discussion

Vermicomposting is an effective means of composting the decomposable organic wastes using earthworms naturally present in the soil. Vermicomposting is a mixture of worm casts enriched with macro and micronutrients (N, P, K, Mn, Fe, Mo, B, Cu and Zn.), some growth regulating substances (such as gibberellins and auxins) and useful micro flora (Azospirillum, Actinomyces and Phosphobacillus) etc. The observations from this study revealed that the number and weight of adult earthworms, and number and weight of cocoons and juveniles were increased in all waste combinations containing high or low amount of dung. The soil alone, kitchen waste alone and garden waste alone was not much suitable for the survival and reproduction of adult worms. The number of adult worms was found to slightly reduce in soil alone and not found in kitchen waste alone and garden waste alone as compared to the initial value. Such a reduction in the number of worms might be due to escape or migration or natural death of the worms on account of lack of nutrients, proper aeration, hostile environment etc. The conditions in soil-enriched media were observed to be unfavorable not only for the survival of the adult worms and also for reproductive performance of the surviving worms while with increasing percentage of dung, the conditions became favorable.

The best results were obtained in soil-kitchen waste-garden waste-dung ratio (1:4:4:4) in which maximum increase (4804.33 %) in total bio-number (adults, juveniles and cocoons) and net biomass (743.51 %) was recorded. According to Shweta *et al.* (2006) flower waste in combination with dung gave faster multiplication but when mixed with dung was best substrate in to increase the biomass production. pH was neutral being around 7 and increased gradually from substrate to compost to vermicmpost [13], [14]. The near-neutral pH of vermicompost may be attributed by the secretion of NH_4^+ ions that reduce the pool of H^+ ions [4] and the activity of calciferous glands in earthworms containing carbonic anhydrase that catalyze the fixation of CO_2 as $CaCO_3$, thereby preventing the fall in pH [6]. The increased trend of pH in the vermicompost and compost samples is in consistence with the findings of [27], which was due to higher mineralization whereas the present findings (shown in fig.3) are in contradiction to that of [4], [15] and [26], who reported lower pH. The increased trend of NPK in the vermicompost and compost samples (shown in fig. 4) is in consistence with the findings of [7] described composition of the vermicompost as: total nitrogen - 0.5 to 1.5%, available phosphorus - 0.1 to 0.3%, available potassium - 0.15 to 0.56%. The vermicompost acts as an excellent base for the establishment and multiplication of beneficial / symbiotic microbes. It being a natural means of soil fertility management fits well into integrated plant nutrient management strategy for sustainable agriculture. Similar nutrient pattern was reported by [8] in different weed species, [19] in vegetable wastes, [23] in sugarcane trash and byproducts of sugarcane and [11] in vegetable market waste, paddy straw, weeds, and sugarcane trash. [28] showed high nutrient content in the dung followed by garden waste and kitchen waste using *Eisenia fetida.*

5. Conclusion

Chemical fertilizers were the major tools for 'green revolution' during 1950-60s. The green revolution was need of that time, since increasing human population was struggling for availability of food. The chemical agents were considered as boon, but in fact they brought 'mixed blessings' for mankind. They boosted food productivity, but at the cost of environmental pollution, deteriorating crop quality and increasing health hazards. In conclusion, it may be stated that: (a) soil-kitchen waste-garden waste-dung can be a good additive for preparation vermicompost and biomass production using *E. eugeniae*, (b) the kitchen waste alone, soil alone and garden waste alone is not a very suitable medium even on mixing with dung in large amount, (c) soil, kitchen waste, garden waste and dung mixed in (1:4:4:4) ratio to get satisfactory results of waste management and production of vermicompost and to develop a suitable and simple method of kitchen and garden waste management using earthworms so that the practice of vermicomposting could be promoted among general public using container units for waste management at home level and releasing of earthworms in organic waste rich moist soils can be best for *in situ* recycling of waste biomass and for remediation of soil fertility in kitchen gardens, agricultural and horticultural fields.

6. Acknowledgement

We are highly thankful to Head of the department for providing all the laboratory facilities during tenure of work. We are also thankful to UGC-SAP, New Delhi.

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Table 1: Showing average number of adults, juveniles and cocoons of *E. eugeniae* in first set of experiment using different combinations of soil, garden waste and dung mixtures

S. No.	*Composition of culture medium*	*Initial no. of worms*	*No. of adult worms (Mean±S.E.)*	*No. of baby + juveniles (Mean±S.E.)*	*No. of cocoons (Mean ± S.E.)*
1.	Kitchen waste alone (KW)	10	0.0	0.0	0.0
2.	Garden waste alone (GW)	10	0.0	0.0	0.0
3.	Soil (S)	10	5.00 ± 0.577	1.66 ± 0.33	0.0
4.	S+KW+GW+D (4:4:4:1)	10	8.67 ± 0.82	65.00 ± 2.88	45.00±2.88
5.	S+KW+GW+D (3:3:3:1)	10	9.67± 0.88	75.00 ± 2.88	65.00±2.88
6.	S+KW+GW+D (2:2:2:1)	10	13.00±1.15	138.333 ± 7.26	100.0 ±5.77

7.	S+KW+GW+D (1:1:1:1)	10	15.33±0.88	181.666±2.88	200.66 ± 2.88
8.	Dung (D)	10	18.33±0.88	213.33 ± 7.26	205.00 ± 2.96

Table 2: Showing average number of adults, juveniles and cocoons of *E. eugeniae* in second set of experiment using different combinations of soil and dung mixtures.

S. No.	*Organic matter*	*Initial no. of worms*	*Final no. of worms (Mean ± S.E.)*	*No. of juveniles (Mean ± S.E.)*	*No. of cocoons (Mean ± S.E.)*
1.	Kitchen waste alone (KW)	10	0.0	0.0	0.0
2.	Garden waste alone (GW)	10	0.0	0.0	0.0
3.	Soil (S)	10	5.50 ± 0.33	1.74 ± 0.33	0.0
4.	S+KW+GW+D (1:1:1:1)	10	15.33± 0.88	178.95 ± 2.88	196.92 ± 2.96
5.	S+KW+GW+D (1:2:2:2)	10	18.66± 0.88	215.00 ± 2.88	216.66±12.01
6.	S+KW+GW+D (1:3:3:3)	10	23.00± 0.88	235.00 ± 2.88	220.00±5.77
7.	S+KW+GW+D (1:4:4:4)	10	26.33± 0.88	241.00 ± 5.19	223.33±8.81
8.	Dung (D)	10	18.33± 0.88	212.82 ± 7.26	204.92 ± 2.88

Table 3: Showing average weight of adults, juveniles and cocoons of *E. eugeniae* in first set of experiment using different combinations of soil, garden waste and dung mixtures

S. No.	Organic matter	Initial wt. of worms (gm)	Final wt. of worms (gm) (Mean ± S.E.)	Wt. of juveniles (gm) (Mean ± S.E.)	Wt. of cocoons (gm) (Mean ± S.E.)
1.	Kitchen waste alone (KW)	8.29±0.13	0.0	0.0	0.0
2.	Garden waste alone (GW)	7.48±0.09	0.0	0.0	0.0
3.	Soil (S)	6.46±0.44	9.00 ± 0.99	0.13 ± 0.03	0.0
4.	S+KW+GW+D (4:4:4:1)	7.39±0.42	15.40±1.86	4.10 ± 0.11	1.50 ± 0.05
5.	S+KW+GW+D (3:3:3:1)	7.33±0.81	17.99±1.93	4.56 ± 0.12	1.83 ± 0.05
6.	S+KW+GW+D (2:2:2:1)	7.89±0.96	24.61±1.86	6.46 ± 0.08	2.00 ± 0.05
7.	S+KW+GW+D (1:1:1:1)	7.33±0.47	28.85±1.14	6.80 ± 0.05	3.93 ± 0.06
8.	Dung (D)	6.23±0.31	34.42±1.95	6.93 ± 0.08	4.00 ± 0.05

Table 4: Showing average weight of adults, juveniles and cocoons of *E. eugeniae*in second set of experiment using different combinations of soil, garden waste and dung mixtures

S. No.	*Organic matter*	*Initial wt. of worms (gm)*	*Final wt. of worms (gm) (Mean ± S.E.)*	*Wt. of juveniles (gm) (Mean ± S.E.)*	*Wt. of cocoons (gm) (Mean ± S.E.)*
1.	Kitchen waste alone (KW)	7.44±0.19	0.0	0.0	0.0
2.	Garden waste alone (GW)	7.43±0.05	0.0	0.0	0.0
3.	Soil (S)	6.46±0.44	9.64 ± 0.31	0.16 ± 0.03	0.0
4.	S+KW+GW+D (1:1:1:1)	7.33±0.47	28.85±1.14	6.94 ± 0.08	4.01 ± 0.05
5.	S+KW+GW+D (1:2:2:2)	7.46±0.85	33.42±1.79	7.80 ± 0.05	4.13 ± 0.14
6.	S+KW+GW+D (1:3:3:3)	6.91±0.54	41.09±0.69	7.90 ± 0.05	4.20 ± 0.05
7.	S+KW+GW+D (1:4:4:4)	8.02±0.84	55.44±1.19	7.96 ± 0.12	4.26 ± 0.12
8.	Dung (D)	6.23±0.31	34.17±1.95	6.89 ± 0.05	3.945 ± 0.06

Table 5: Accordingly different substrate combinations may be grouped in the following manner:

Suitability range	Substrate combinations
Highly suitable	S+KW+GW+D (1:4:4:4), (1:3:3:3), (1:2:2:2), (1:1:1:1) and Dung
Moderately suitable	S+KW+GW+D (2:2:2:1)
Less suitable	S+KW+GW+D(3:3:3:1) and (4:4:4:1)
Un-suitable	S (soil alone), GW (Garden waste alone) and KW (Kitchen waste alone)

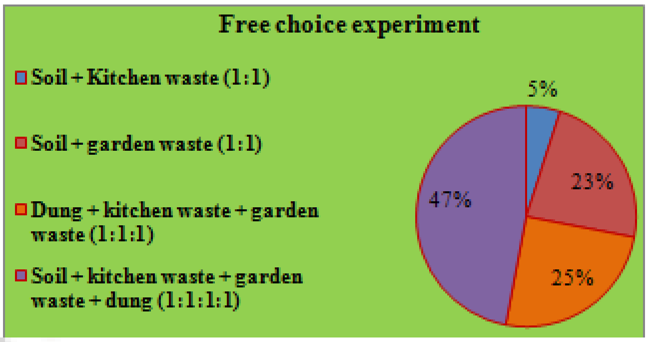


Figure 1: Showing the relative preference of earthworms towards different culture media

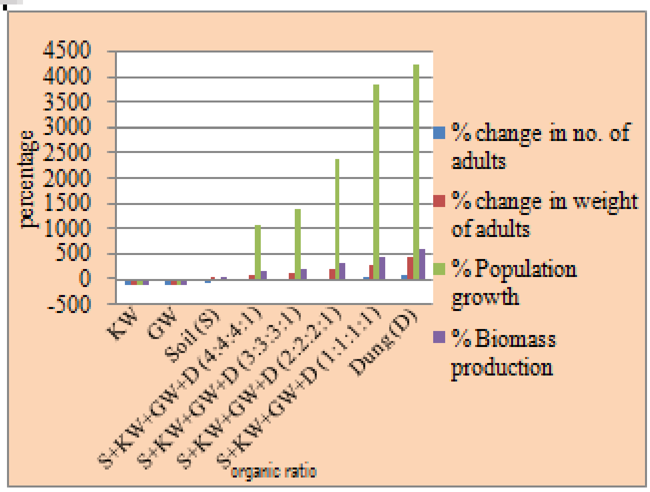


Figure 2a- Percent change in number, weight of adults, Population growth rate & % biomass production in different combinations of soil, garden waste and dung (first set of experiment)

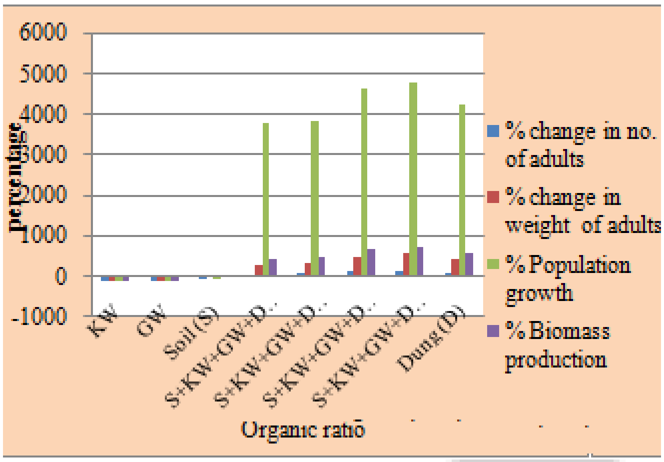


Figure 2b: Percent change in number, weight of adults, Population growth rate & % biomass production in different combinations of soil, garden waste and dung (second set of experiment)

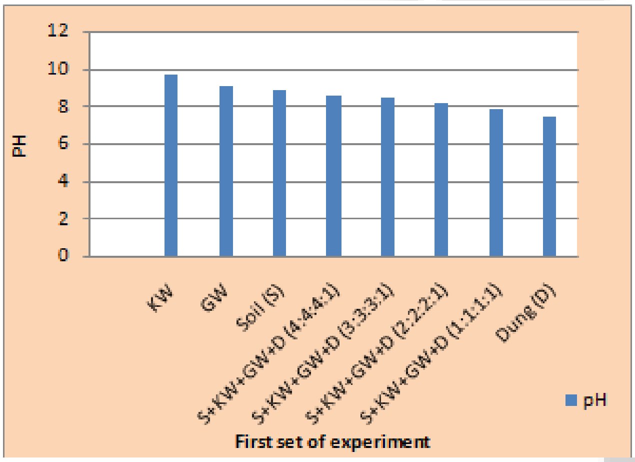


Figure 3: Showing variation of pH in different culture media (organic ratio) in I and II set of experiment

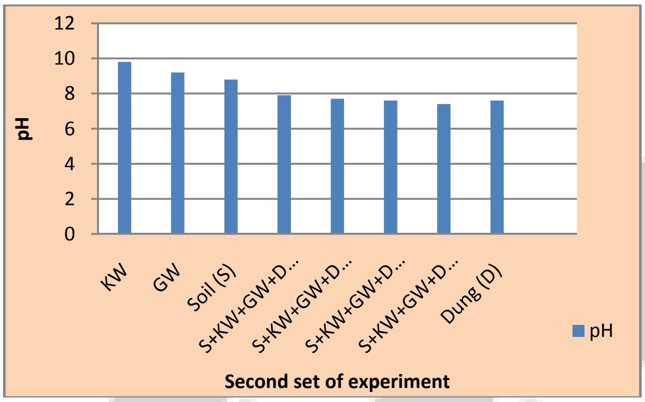
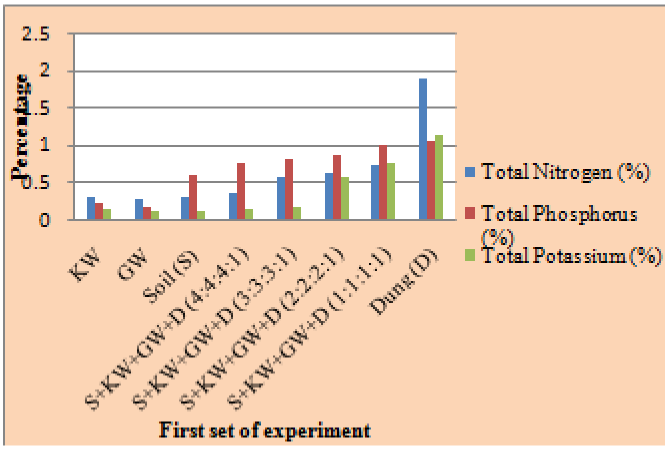
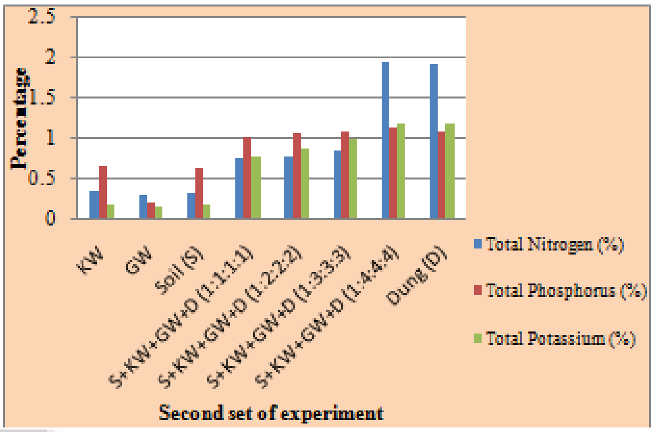


Figure 4: Showing variation of Total Nitrogen, Total Phosphorus and Total Potassium in different culture media (organic ratio) in I and II set of experiment





Author Profile

Puneeta Dandotiya is Ph.D. Research Scholar, S.O.S. in Zoology, Jiwaji University, Gwalior (M.P.) India

Dr. O. P. Agrawal (ex-vicechancellor) is Co-ordinator-Vermicomposting Centre & Entomology Research Lab, School of Studies in Zoology, Jiwaji University, Gwalior (M.P.), India