

Nutrient Composition of Vermicompost and Vermiwash as Influenced by Different Substrates

ABSTRACT

Nutrient enrichment in vermicompost and vermiwash by using raintree litter waste and mushroom spent compost was studied at Vermicompost Yard of Division of Soil Science, College of Agriculture, Pune during 2022-23. HDPE vermibeds of size 12X4X2 feet were used for production of vermicompost and 200 litre capacity plastic drums were used for vermiwash preparation. There were five substrate combinations viz. 25% raintree litter (RTL) +75% paddy straw spent mushroom compost (PSSMC), 50% tree litter +50% paddy straw spent mushroom compost (PSSMC), 75% tree litter +25% paddy straw spent mushroom compost (PSSMC), 100% raintree litter, 100% paddy straw spent mushroom compost (PSSMC) made for the preparation of vermicompost with earthworm species *Eisenia fetida* and replicated four times in a completely randomized block design. There were ten plastic drums of 200 litre capacity were used for vermiwash preparation by using vermicompost prepared by different treatments. The drums were kept for conduct of experiment and sampling in duplicate for first and second harvest of vermiwash from each drum for assessing characterization and nutrient composition. It can be revealed from the data that pH, EC, organic matter, C: N ratio, total nitrogen, phosphorus, potassium, iron, zinc, manganese, copper in vermicompost were significantly influenced by different proportions of rain tree litter and paddy straw spent mushroom compost. The C: N ratio of these vermicompost prepared by using rain tree litter and paddy straw spent mushroom compost was ranged between 9.02 and 14.26. Significantly higher total nitrogen (2.23%), phosphorus (1.13%), potassium (0.823%), iron (1150 ppm), manganese (276.5 ppm), zinc (276 ppm) and copper (73.25 ppm) were found significantly higher in vermicompost prepared from 100% raintree litter. Significantly higher EC (total soluble salts) of vermiwash was observed at first (7.20 dSm⁻¹) and second (5.58 dSm⁻¹) harvest when it was prepared by using 100% raintree litter vermicompost than rest of the treatments. Vermiwash prepared by using 100% raintree litter vermicompost reported significantly higher nitrogen (0.65 and 0.51%), phosphorus (0.33 and 0.27%) and potassium (0.27 and 0.23%) content at both harvest respectively but higher content was in first harvest. Vermiwash prepared from 100% raintree litter vermicompost reported significantly higher Fe, Mn, Zn and Cu content at both harvesting stage.

Keywords: Raintree litter waste, spent mushroom compost, vermicompost and vermiwash

Introduction

Soil fertility decline over the globe is one of the major cause for decreasing nutrient use efficiency and crop productivity. Health and quality of soil deteriorating consistently due to soil erosion, less use of organic manures, injudicious use of irrigation water and fertilizers, monocropping, no soil testing, poor crop management, reluctant for green manuring crops etc. are the major causes for declining soil fertility resulted in less nutrient use efficiency. In order to improve health and quality of soil, it is necessary to adopt integrated nutrient management system. Green manuring, compost, vermicompost, vermiwash etc. are important components of INM. Uses of FYM and compost have high bulkiness per unit nutrient content which seems to be a constraint for transport and application. Compost enrichment and vermicomposting is an efficient way of recycling various bio-wastes into compost or vermicompost by using microbes and earthworms. Earthworms are voracious feeders on

Comment [U1]: microorganism

organic waste and while utilizing it only a small portion for their body synthesis they excrete a large part of these consumed waste material in a half digested form. Since the intestine of earthworms harbor wide ranges of microorganisms, enzymes, hormones, etc., these half-digested substrates decompose rapidly and are transformed into a form of vermicompost within a short time (Edwards and Lofty 1972). The final product is a stabilized, well humidified, organic manure, with adhesive effects for the soil and stimulator for plant growth and most suitable for agricultural application and favourable environmentally. (Reference?). Biochemical changes in the degradation of organic matter are carried out through enzymatic digestion, enrichment by nutrient excretion, and transport of organic and inorganic materials. About 5-10% of ingested material is absorbed into the tissue for their growth and metabolic activity and rest is excreted as vermicast. The vermicast is mixed with mucus secretion and of the microbes of the gut wall that, and of the microbes and transformed into vermicompost (Edwards and Lofty 1972). The decomposition process continues even after the release of the cast by the establishment of microorganisms. The studies on the effect of vermicomposting on some components of organic waste showed that vermicompost enhances degree of polymerization of humic substances along with a decrease of ammonium N and an increase of nitric N (Cegarra et al. 1992). The plant growth regulators and other plant growth influencing materials, that is, auxins, cytokinins, humic substances, etc., produced by microorganisms have been reported from vermicompost (Atiyeh et al. 2002).

Vermiwash is a natural liquid product formed by vermicomposting of organic matter from rich population of earthworms and vermicompost. The composition of vermiwash and its quality depend on the type of raw organic matter used during vermicomposting. Vermiwash contains hormone, mucous, enzyme, vitamins, proteins, different macro and micronutrients, and a large number of microbes. As compared to application of solid vermicompost, its liquid form (vermiwash) is more suitable due to its bioavailability to reach quickly to targeted area around the roots of plants (Gudeta et al (2020). Further, vermiwash is a coelomic fluid of earthworms which contains several enzymes, plant growth hormones, vitamins along with micro and macronutrients. (Reference)? Vermiwash is a liquid bio-fertilizer can be collected through the column of activated earthworm. It contains excretory products of earthworm secretions, the worm coelomic fluid oozing through dorsal pores, mucus, enzymes secreted by worm & microorganisms, plant nutrients, vitamins & plant growth promoting substances. It also contains plant growth hormones (auxin & cytokinin) and nitrate fixing bacteria and phosphorus solubilizing bacteria.

Enrichment of compost or vermicompost by using locally available nutrient rich organic matter like rain tree litter available abundantly can be used efficiently for nutrient enrichment. Its leaves and twigs contain substantial amounts of N, P, K, S and other micronutrients. In the urban areas many government and private organizations have various trees particularly rain trees in their campuses. The litter falls every year in these campuses is not used for composting due to the constraints in the collection and transport. At present this litter is collected or burned on site which increases CO₂ in the air causing air pollution. Rain tree leaves can be used in soil as green or brown manure to increase soil and crop productivity (Haque et al., 1999). Higher nitrogen content in the rain tree litter ranges from 1.88 to 2.25 while phosphorus was 0.8 to 1.1% and potassium to the tune of 1% can be suitably used for nutrient enrichment (Unchalika et al., 2021) and (Ritu Nagaret al., 2017).

The rain trees in College of Agriculture, Pune campus, which are over 25-30 meters high and 125 - 150 years old, produce large quantities of tree leaf litter in every winter. Mushroom spent compost is also generated in the campus after the harvest of oyster mushrooms. Hence, the attempt was made to study the enrichment of vermicompost and vermiwash by using rain tree litter waste and spent mushroom compost. The use of rain tree leaves and their proper management not only reduces the need for chemical fertilizers but also decreases CO₂ release in air. However, in view of this, nutrient enrichment in the vermicompost and vermiwash through mineral rich leaves and litter of rain trees was assessed. Therefore an experiment was conducted to develop and optimize the method for the preparation and development techniques for enriching the nutrient status in vermicompost and vermiwash.

Comment [U2]: Please avoid repeating vermiwash in successive sentences

Comment [U3]: Repetitive concepts

Comment [U4]: Please use references at the end of each paragraph

h.

MATERIALANDMETHODS

Comment [U5]: This section has nothing to do with the introduction, it is better to delete it or move it to another section

UNDER PEER REVIEW

An experiment was conducted to assess the nutrient enrichment in vermicompost and vermiwash by using rain tree (*Samanea saman*) litter waste and mushroom spent compost at Vermicompost Yard of Division of Soil Science, College of Agriculture, Pune during 2021-22. Different proportion of rain tree litter and paddy straw spent mushroom compost were used for the production of vermicompost. HDPE vermibed of size 12 X 4 X 2 feet (Figure 2) were used for this study. The five substrate combinations viz. 25% rain tree litter (RTL) + 75% paddy straw spent mushroom compost (PSSMC), 50% tree litter + 50% paddy straw spent mushroom compost (PSSMC), 75% tree litter + 25% paddy straw spent mushroom compost (PSSMC), 100% rain tree litter, 100% paddy straw spent mushroom compost (PSSMC) were studied in completely randomized block design replicated four times.

Method for preparation of vermicompost:

There were total 20 HDPE vermibeds were installed by using sixteen bamboo sticks of 2.5 feet height (Figure 1). The required quantity of rain tree litter was collected from the campus of College of Agriculture, Pune. Paddy spent mushroom compost (PSSMC) was procured from AICR Pon Mushroom Project, College of Agriculture, Pune. Rain tree litter and paddy straw spent mushroom compost was mixed thoroughly on dry weight basis as per the treatment. Total quantity of organic matter either from rain tree litter or paddy straw spent mushroom compost was kept 4000 kg in each bed (Table 1). The treatment wise rain tree litter and paddy straw spent mushroom compost were allowed to partially degrade for 45 days by adopting pit method and thereafter used for vermicomposting. The vermibeds were filled layer wise first layer of 10-15 cm thick undecomposed fresh rain tree litter and paddy straw spent mushroom waste was given as per the treatment. Second layer of similar thickness was given with partially decomposed organic waste of respective treatment. Third layer was given uniformly over second layer with cow dung slurry (40 lit. cow dung + 100 lit. water + 1 kg decomposing culture). Similar type of alternate layering was completed up to a height of 70 to 80 cm of the HDPE vermibeds. Then watering was started and whole material was allowed to soak water. After 15-20 days, 3 kg earthworms of species *Eisenia fetida* (Figure 1) were released in each vermibed. Moisture content 50-55% was maintained till harvesting of vermicompost. The wet gunny bags were used for cooling purpose over the surface. The composition of rain tree litter and paddy straw spent mushroom compost were carried out according to the standard methods given by A.O.A.C (2012) and presented in Table 2.

Method for preparation of vermiwash:

Plastic drums of 200 litre capacity along with open/close (on/off) tap fitted at 4 inch from bottom (for harvesting of vermiwash) were used for vermiwash preparation (Figure 3). The ten plastic drums were filled with the layering adopted as stated in table 3. Two vermiwash drums were kept for one treatment and quadruplicate sampling of vermiwash from each drum was carried out for assessing characterization and nutrient composition. The treatment wise rain tree litter and paddy straw spent mushroom compost were allowed to partially degrade for 45 days and thereafter used for vermicomposting. Vermicompost prepared from various proportions of rain tree litter and paddy straw spent mushroom compost was used for extracting vermiwash. Bricks pieces, gravel, coarse and fine sand, plastic net, cow dung, partially decomposed compost and vermicompost of respective treatment, earthworms and gunny bags were used for filling the vermiwash drum.

The vermiwash drums were filled layer wise (Table 3). After filling vermiwash drums, they were allowed for incubation upto 15 days (Figure 2). The moisture content was maintained 50-55 percent in the vermiwash drums. After 15 days of incubation, 10 litres of water added in each drum and allowed to saturate for 48 to 50 hours for incubation and then treatment wise vermiwash harvested. Harvested vermiwash was analysed for characterization and nutrient composition by following standard methods. (A.O.A.C 2012)

Table 1 Treatment wise quantity of organic matter used in each bed

Treatment no.	Proportion of organic matter	Quantity of organic matter on dry weight basis (kg)	
		Raintree litter	Paddy straw spent mushroom compost
T ₁	25% RTL+75% PSSMC	1000	3000
T ₂	50% RTL+50% PSSMC	2000	2000
T ₃	75% RTL+25% PSSMC	3000	1000
T ₄	100% RTL	4000	-
T ₅	100% PSSMC	-	4000

Table 2 Characterization of raintree litter and paddy straw spent mushroom compost

Sr. no.	Parameter	Raintree litter	Paddy straw spent mushroom compost
1	pH(1:10)	7.6	7.3
2	EC dSm ⁻¹ (1:10)	1.22	0.44
3	Organic carbon (%)	118	41
4	N (%)	2.08	0.66
5	P (%)	0.98	0.45
6	K (%)	0.79	0.38
7	Fe (mg kg ⁻¹)	186	54
8	Mn (mg kg ⁻¹)	78	27
9	Zn (mg kg ⁻¹)	69	22
10	Cu (mg kg ⁻¹)	29	21
11	C:N ratio	56.73	62.21
12	C:P ratio	120.40	91.11

Table 3 Layering in the vermiwash drum

First Layer (from bottom) (15-20cm Thick)	Brick pieces 75-100 nos.
Second Layer (10-15cm Thick)	Coarse sand 25kg
Third Layer (5-10cm)	Fine Sand (size 2-3cm) 25kg
Fourth Layer (15-25cm)	Partially decomposed compost (100 to 150kg) mixed with cow dung (15-20 days old) 50 to 60 kg
Fifth Layer (5 To 10cm)	Vermicompost approximately 40 to 80 kg
Sixth Layer	Earthworms of species (<i>Eisenia fetida</i>) 4-5 kg or 1000 to 1500 numbers.
Seventh Layer	Vermicompost + cow dung (15-20 days old) in 50:50 proportion 50 kg
Eighth Layer	Partially decomposed compost (100 to 150kg) mixed with cow dung (15-20 days old) 50 to 60 kg
Ninth Layer	Vermicompost (40 to 80kg)
Tenth Layer	Wet gunny bags



Figure1 Earthwormsofspecies*Eiseniafetida*



Figure2HDPE vermibeds(12X4X2)



Figure 3 Vermivash unit with 200-liter plastic drums

[plastic drums](#)

RESULT AND DISCUSSION

Nutrient enrichment in vermicompost as influenced by rain tree litter waste

The nutrient enrichment and characterization of vermicompost as influenced by using rain tree litter and paddy straw spent mushroom compost in different proportions was presented. (Table 4 and 5 and Figure 4 and 5). The chemical properties like EC, organic matter and C: N ratio of vermicompost was found significantly influenced by the rain tree litter and paddy straw spent mushroom compost. Non-significant results were reported for 'days required for vermicompost' by using different combinations of rain tree litter and paddy straw spent mushroom compost. Almost similar period were required for the production of vermicompost by using 100% rain tree litter (55 days) and 100% paddy straw spent mushroom compost (54 days). Use of rain tree litter and paddy straw spent mushroom compost in different proportion reported non-significant results for the pH for vermicompost. Numerically lowest pH (6.65) was reported in the vermicompost prepared by using 100% paddy straw spent mushroom compost while higher pH (7.17) was recorded with 50% rain tree litter (RTL) and 50% paddy straw spent mushroom compost (PSSMC). The EC of vermicompost was ranged between 1.47 to 2.81 dSm^{-1} . Vermicompost prepared from 100% rain tree litter reported significantly higher EC (2.81 dSm^{-1}) which was closely followed by 50% rain tree litter and 50% paddy straw spent mushroom compost. Lower EC (1.47 dSm^{-1}) was reported with 100% paddy straw spent mushroom compost. Organic matter content in vermicompost prepared by using rain tree litter and PSSMC was ranged from 17.77 to 18.98%.

Significantly lower organic matter (17.77%) in vermicompost was reported by using 100% paddy straw spent mushroom compost which was found to be at par with 50% rain tree litter and 50% paddy straw spent mushroom compost (18.98%). Lower organic matter in paddy straw spent mushroom compost might be due to already the straw was decomposed by oyster mushroom (*Pleurotus sajorajju*). The C: N ratio of these vermicompost prepared by using rain tree litter and paddy straw spent mushroom compost was ranged between 9.02 and 14.26. The 50% rain tree litter and 50% paddy straw spent mushroom compost combination was reported significantly lower C: N ratio 8.83 which was closely and statistically at par with 100% rain tree litter (9.02) and 75% rain tree litter and 25% paddy straw spent mushroom compost (11.72).

Rate of decomposition of any organic matter depends upon total carbon and total nitrogen ratio. The carbon to nitrogen ratio is an important parameter, which will relate the composting reactions to the relative concentrations of essential chemical constituents required for the growth and metabolic reactions of the microbial populations. As organic matter with lower C: N ratio at early stage of decomposition shows more microbial activity and more CO_2 evolution thereby rate of decomposition beco

Formatted: Indent: Left: 0", First line: 0"

Comment [U6]: Have statistical studies been done?

Comment [U7]: With equal particle size?

mes faster. However higher C:N ratio organic matter at later stage releases higher CO₂ and CH₃ causes slower rate of decomposition. Compounds such as carbohydrates, in addition to being sources of carbon for the microbial biomass, will generate energy required for the microbial metabolic activity. Nitrogen is an essential component of proteins and amino acids required for the growth of

Comment [U8]: Reference?

UNDER PEER REVIEW

the microbial biomass. Generally, it is recommended that, to maintain an active microbial population during composting, the available carbon to nitrogen ratios should be kept at appropriate levels. Lower ratios will result in losses of nitrogenous compound, while higher ratios will reduce the rate of composting process. So in case of rain tree litter, the nitrogen content was higher than that of paddy straw spent mushroom compost that has resulted in lower days required for rain tree litter vermicompost than rest of the treatment. Further the C:N ratio can be regulated by selecting the most suitable combination of organic matter by using rain tree litter and paddy straw spent mushroom compost. In these experiment vermicomposts prepared by using various combination of organic matter were reported to have less than 30 C: N ratio which indicates good quality of compost and after application in soil rate of mineralization will be high. ~~However~~ However, lower the C: N ratio, the more rapidly nitrogen will be released into the soil for crop use (Martin., 2007).

Nitrogen, phosphorus and potassium content in vermicompost prepared from various combination of rain tree litter and paddy straw spent mushroom compost were ranged from 1 to 2.23%, 0.383 to 1.135% and 0.303 to 0.832% respectively (Table 5). Vermicompost prepared from 100% rain tree litter was reported significantly high nitrogen (2.23%), phosphorus (1.135%) and potassium (0.823%) content. However, lower nutrient content was reported in vermicompost prepared from 25% rain tree litter + 75% paddy straw spent mushroom compost (N:1%, P:0.383% and K:0.303%). It could be observed from the data that as the proportion of rain tree litter increase with paddy straw spent mushroom compost, the nutrient composition in vermicompost also increases. Further magnitude of increase in the enrichment of nutrient was also higher with rain tree litter than that of paddy straw spent mushroom compost.

Metallic micronutrients (viz., Fe, Mn, Zn and Cu) content in vermicompost also affected significantly with different substrates and their proportions. The Fe, Mn, Zn and Cu concentration in vermicompost was ranged between 47.2 to 1105 mg kg⁻¹, 150.25 to 276 mg kg⁻¹, 79 to 276 mg kg⁻¹ and 33.5 to 77.25 mg kg⁻¹, respectively. It could be noticed from the data that significantly higher Fe (1105 mg kg⁻¹), Mn (276 mg kg⁻¹), Zn (276 mg kg⁻¹) and Cu (77.25 mg kg⁻¹) concentration was reported in the vermicompost prepared by using 100% rain tree litter. However lower Fe (47.2 mg kg⁻¹), Mn (150.25 mg kg⁻¹), Zn (79 mg kg⁻¹), and Cu (33.50 mg kg⁻¹) content was observed in vermicompost prepared by using paddy straw spent mushroom compost. Higher concentration of nitrogen, phosphorus, potassium, iron, manganese, zinc and copper was reported in the vermicompost prepared by using 100% rain tree litter which might be due to higher content of these nutrients in the rain tree litter (Table no. 5). However lower nutrient concentration in the vermicompost prepared from paddy straw spent mushroom compost might be due to the absorption / extraction of nutrients by mushroom. Similar results were also reported by Chaudhuri *et al.*, (2016), Ritu Nagar *et al.*, (2017), Klomklang *et al.*, (2021). Gaur and Singh (1993) reported that enrichment of final compost with phosphatesolubilizers, nitrogen fixers and microbe capable of cellulose degradation is promising method.

The reduction of carbon in vermicomposting resulted from respiration and mineralization of organic matter produced by microorganisms and earthworms. Earthworms through their fragmentation action modify the substrate conditions which increases the surface area for microbial action (Ansari and Sukhraj, 2010). Further nutrient enrichment was found higher in vermicompost prepared from 100% rain tree litter which might be due to higher nutrient concentration in litter or leaves of rain tree. Further, increment of nitrogen in vermicompost might be resulted due to the addition of mucus, nitrogenase casts which facilitates microbial mediated mineralization through decomposition of earthworm tissues. Similar results were also reported by Jaikishun *et al* 2014.

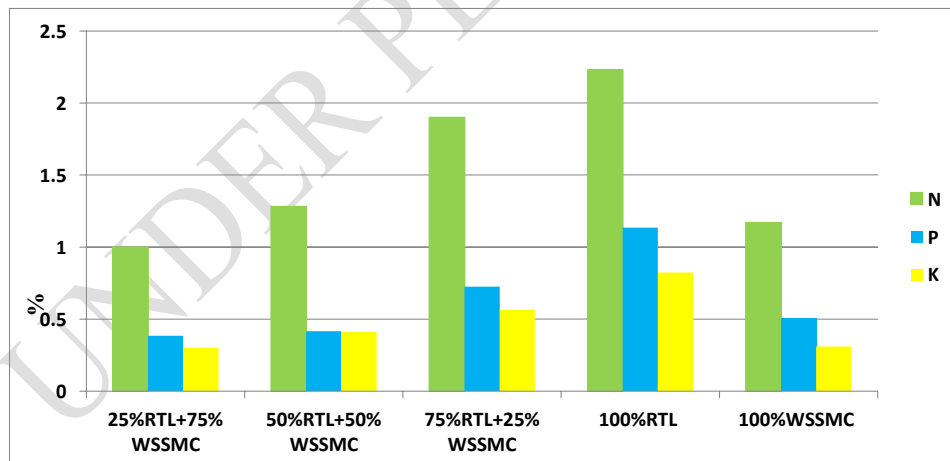
Comment [U9]: The measurement method is not mentioned

Table4.Characteristicsofvermicompost

Treatment	Daysrequiredfor vermicompost	pH	EC (dSm ⁻¹)	Organic matter(%)	C:N ratio
25%RTL+75%PSSMC	64	6.77	1.56	24.31	14.26
50%RTL+50%PSSMC	58	7.17	2.10	18.98	8.83
75%RTL+25%PSSMC	60	7.10	1.97	30.86	9.68
100%RTL	55	7.02	2.81	28.90	11.72
100%PSSMC	54	6.65	1.47	17.77	9.02
S.E. _± (m)	3.77	0.190	0.174	2.471	1.010
C.D.at5%	N.S.	N.S.	0.542	7.697	3.140

**Table5.Nutrientcontentinvermicompostasinfluencedbyraintree litterwasteandpaddystraws
pent mushroomcompost**

Treatment	Macronutrients(%)			Micronutrients (mgkg ⁻¹)			
	N	P	K	Fe	Mn	Zn	Cu
25%RTL+75%PSSMC	1.00	0.383	0.303	472	150.25	79	33.50
50%RTL+50%PSSMC	1.28	0.415	0.410	592	175.25	135	35.75
75%RTL+25%PSSMC	1.90	0.725	0.565	654	204.18	201	44.25
100%RTL	2.23	1.135	0.823	1105	276.50	276	73.25
100%PSSMC	1.17	0.505	0.310	673	197.00	163	53.50
S.E. _± (m)	0.104	0.086	0.082	75.230	18.824	12.314	5.436
C.D.at5%	0.323	0.269	0.256	234.37	58.645	38.362	16.936

**Figure4Totalnitrogen,phosphorusand potassiumcontentinvermicompost**

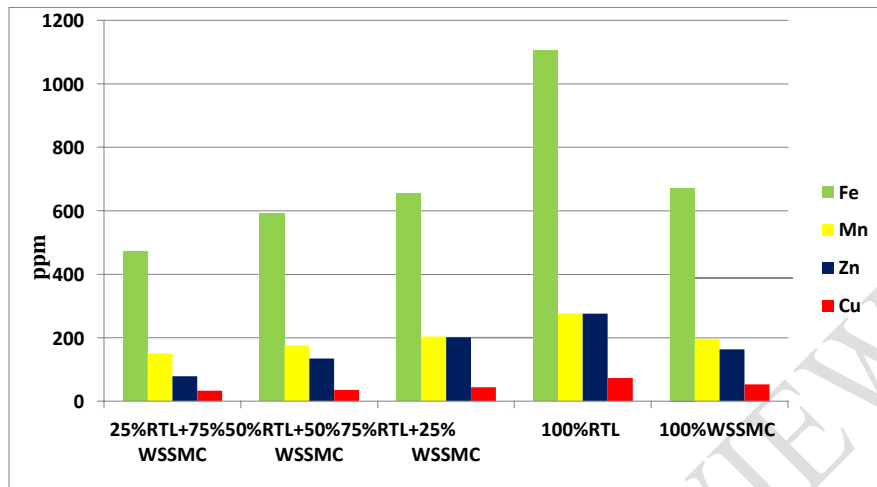


Figure 5 Total iron, manganese, zinc and copper content in vermicompost

Nutrient enrichment in vermiwash as influenced by rain tree litter waste

The colour of vermiwash influenced drastically by using different types of vermicompost used for the preparation of vermiwash. Vermiwash prepared for 100% rain tree litter vermicompost 75% RTL+25% spent mushroom was observed dark in colour than rest of treatments (Figure 6). The pH, electrical conductivity, nitrogen, phosphorus, potassium, iron, manganese and zinc content in vermiwash influenced significantly by different proportions of rain tree litter and paddy straw spent mushroom compost (Table 6, 7 and 8). However, pH of vermiwash at both harvesting was found non-significant. Numerically vermiwash pH was ranged between 6.73 to 7.50 and 6.40 to 7.75 at first and second harvest. Electrical conductivity of vermiwash was ranged from 3.43 to 7.20 dSm^{-1} for first harvest and 2.43 to 5.58 dSm^{-1} for second harvest. Electrical conductivity of first harvested vermiwash was found higher in all the treatments than second harvest. Significantly higher EC of vermiwash was observed at first (7.20 dSm^{-1}) and second (5.58 dSm^{-1}) harvest when it was prepared by using 100% rain tree litter vermicompost than rest of the treatments. It could be observed from the data that as the proportion of rain tree litter for the preparation of vermicompost increases, the EC also increases. The content of nitrogen, phosphorus and potassium in vermiwash at both the harvesting stage was also significantly affected by the different combinations of rain tree litter and paddy straw spent mushroom compost used for vermicompost. Nitrogen, phosphorus and potassium content in vermiwash were ranged from 0.21 to 0.65 and 0.20 to 0.33 %, 0.14 to 0.33 and 0.10 to 0.27 % and 0.06 to 0.27 and 0.05 to 0.23 % at first and second harvest respectively. Vermiwash by using 100% rain tree litter reported significantly higher nitrogen (0.65 and 0.51 %), phosphorus (0.33 and 0.27 %) and potassium (0.27 and 0.23 %) content at both harvest but higher content was in first harvest. While lower content of nitrogen (0.21 and 0.20 %), phosphorus (0.14 and 0.10 %) and potassium (0.06 and 0.05 %) was observed when 25% RTL +75% PSSMC was used for vermiwash preparation.

Decomposition rate of rain tree litter and paddy straw spent mushroom compost by microbial activity resulting in the production of CO_2 and organic acids which reflected in the reduction of pH. The reduction in pH of vermiwash and vermicompost might be resulted in the high rate of nitrogen and phosphorus into nitrite/nitrate and phosphorus mineralization. Nutrient enrichment in vermiwash was higher when it was prepared from 100% rain tree litter/leaves which might be due to the high nutrient content in rain

tree leaves and litter. Further feeding of *Eisenia fetida* on partially decomposed compost and vermicompost prepared from rain tree litter might have released more mucus

UNDER PEER REVIEW

nitrogenous excretory substances, growth hormones and enzymes from the gut of earthworms might have contributed for nitrogen, phosphorus and potassium enrichment in vermiwash. Similar results were also reported by Hand *et al* (2008) and Durga and Ramasubramanian (2015). Higher nutrient content in rain tree litter or leaves might have released nutrients elements in vermiwash as well as vermicompost during decomposition.

It could be evident from the data presented in table 8 that, iron, manganese, zinc and copper concentration in vermiwash was noticed more in first harvest than second. Among the micronutrients, the concentration of iron in vermiwash at both harvest was found higher followed by manganese, zinc and copper. Vermiwash prepared by using 100% rain tree litter reported significantly higher iron (16.73 and 12.66 mg kg⁻¹), manganese (3.18 and 1.76 mg kg⁻¹) and zinc (3.06 and 2.08 mg kg⁻¹) content than rest of the treatments. Vermiwash prepared from the vermicompost of 100% rain tree litter/leaves reported significantly higher iron content (16.73 and 12.34 mg kg⁻¹) at first and second harvest but vermiwash prepared from 75%RTL+25%PSSMC (12.66 mg kg⁻¹) was found statistically at par only at first harvest. Lower concentration of iron, manganese, and zinc was reported in vermiwash prepared from using 25%RTL+75%PSSMC and 100%PSSMC.

Comment [U10]: ???

Conclusions

Data revealed that rain tree litter waste/leaves was found suitable organic matter for nutrient enrichment in vermicompost by using earthworm species *Eisenia fetida* than that of paddy straw spent mushroom compost. Further the vermicompost prepared by using rain tree litter waste was also found superior for getting nutrient rich vermiwash. It could be concluded from this experiment that rain tree litter/leaves could be a good nutrient source enriching vermicompost and vermiwash rather than burning in open air. This study can be converted into a start-up with HDPE vermibeds and plastic drums of 200 liter for the in-situ production of nutrient rich vermicompost and vermiwash.

Table 6. Characteristics of vermiwash as influenced by tree litter and paddy straw spent mushroom compost

Treatments	pH		EC (dSm ⁻¹)	
	First Harvest	Second harvest	First Harvest	Second harvest
25%RTL+75%PSSMC	6.73	6.40	3.93	2.43
50%RTL+50%PSSMC	6.98	7.05	3.75	3.00
75%RTL+25%PSSMC	7.28	7.08	5.30	3.73
100%RTL	7.50	6.78	7.20	5.58
100%PSSMC	7.00	7.75	3.43	2.53
S.E.±(m)	0.14	0.14	0.33	0.24
C.D.at5%	N.S.	N.S.	0.98	0.70

Table 7. Macronutrient content in vermiwash as influenced by tree litter waste and paddystraw spent mushroomcompost

Treatments	Nitrogen		Phosphorus		Potassium	
	First Harvest	Second harvest	First Harvest	Second harvest	First Harvest	Second harvest
25%RTL+75% PSSMC	0.21	0.20	0.14	0.10	0.06	0.05
50%RTL+50%PSSMC	0.45	0.39	0.20	0.12	0.11	0.11
75%RTL+25%PSSMC	0.49	0.38	0.21	0.15	0.14	0.12
100%RTL	0.65	0.51	0.33	0.27	0.27	0.23
100%PSSMC	0.36	0.34	0.21	0.14	0.16	0.13
S.E.+(m)	0.08	0.08	0.02	0.01	0.02	0.02
C.D.at5%	0.15	0.29	0.08	0.05	0.08	0.07

Table 8. Micronutrient content in vermiwash as influenced by tree litter and paddy strawspentmushroomcompost

Treatments	Fe(mgkg ⁻¹)		Manganese (mgkg ⁻¹)		Zinc (mgkg ⁻¹)		Copper (mgkg ⁻¹)	
	First Harvest	Second harvest	First Harvest	Second harvest	First Harvest	Second harvest	First Harvest	Second harvest
25%RTL +75%PSSMC	6.27	4.31	0.55	0.27	0.33	0.16	Trace	Trace
50%RTL +50%PSSMC	7.88	4.77	0.94	0.29	1.17	0.33	Trace	Trace
75%RTL +25%PSSMC	12.66	8.81	2.07	0.89	1.76	0.98	0.45	0.17
100%RTL	16.73	12.34	3.18	1.76	3.06	2.08	1.05	0.45
100%PSSMC	5.65	4.05	0.54	1.02	1.82	1.09	0.13	Trace
S.E.+(m)	1.39	1.11	0.27	0.14	0.24	0.22	--	--
C.D.at5%	4.11	3.30	0.79	0.42	0.72	0.65	--	--



Figure 6 Vermivash (first harvest) from different treatments.

References

AOAC (2012) Official Method of Analysis: Association of Analytical Chemists. 19th Edition, Washington DC, 121-130.

Ansari, AA, Sukhraj K (2010) Effect of vermivash and vermicompost on soil parameters and productivity of okra (*Abelmoschus esculentus*) in Guyana. African Journal Agriculture Research 5: 1794-1798. <http://www.academicjournals.org/AJAR>, <https://doi.org/10.5897/ajar09.107>

Atiyeh RM, Lee Edwards CA, Arancon NQ, Metzger JD (2002). The influence of humic acids derived from earthworm-processed organic wastes on plant growth. *Bioresource Technology* 84: 7-14

Cegarra J, Famandez FM, Tercero A, Roig A (1992) Effects of vermicomposting of some components of organic wastes. Preliminary results. *Mitteilungen aus dem hamburgischen zoologischen museum und-Institute* 89: 159-167.

Gaur AC, Singh G (1993) Role of IPNS in sustainable and environmentally sound agricultural development in India. *PAO/RAPA Bull.*, pp 199-313

Durga, S. and Ramasubramanian, V. 2015. Quantification of micro and macronutrients from different types of vermivashes. *Indian Journal of Science*. 15: 50-58

- C. A. Edwards and J. R. Lofty, "Biology of Earthworms," Chapman & Hall, London, 1972, p.283.
- Gaur, A.C. and Singh, G (1993). Role of IPNS in sustainable and environmentally sound agricultural developments in India. PAO/RAPA/Bulletin, pp199-313.
- Hand, P., Hayes, W.A., Frankland, J.C., Satchell, J.E. (1988) Vermicomposting of cow slurry. *Pedobiologia* 31, 199–209. [https://doi.org/10.1078/S0031-4056\(04\)70084-0](https://doi.org/10.1078/S0031-4056(04)70084-0)
- Haque MA, Ali, MI and Khan MK (1999). Quantifying N availability from legume tree prunings for rice and wheat rotation. *Thai Journal of Agricultural Science*, 32(1): 41-47.
- Jaikishun S, Hunte N, Ansari AA, Gomathinayagam S (2014) Effect of vermiwash from different sources (Bagasse, Neem, Paddy Straw in different combinations) in controlling fungal diseases and growth of tomato (*Lycopersicon esculentum*) Fruits in Guyana. *Journal of Biological Sciences* 14(8):501–507. <https://doi.org/10.3923/jbs.2014.501.507>
- N. Kansai, N. Chaisuwan, and N. Supakata (2018) Characteristics of carbonized briquettes from rain tree (*Samanea saman*) residues and coffee ground/tea waste for domestic household cooking. *Engineering Journal*, (22) pp. 47–63, 2018.
- Ritu Nagar, Anurag Titov, Praveesh Bhati. Government Madhav Science PG College, Ujjain, (MP), India Vermicomposting of Leaf litters: Way to convert waste in to Best International Journal of Current Science 2017; 20(4): E25-30 Research Article ISSN 2250-1770.
- Suntararak S. (2014) The utilization of mixed food scraps and rain tree (*Samanea saman*) leaves compost in rice (*Oryza sativa* L.) varieties RD 6 growing," Department of Environmental Science, Faculty of Science Rajabhat Buriram University, 2014.
- Talukdar NC. 2008. Soil-plant microbe interaction for sustainable productivity and soil quality. In: Compendium of the National Seminar on Soil Health and Food Security with Special Reference to North East Region of India; 2008 March 12–14; Imphal, India p.111–126.
- Thakur SK, Sharma CR. 1998. Effect of rock phosphate enrichment and Azotobacter inoculation on the transformation of nitrogen and phosphorus during composting. *Journal of Indian Society of Soil Science* 46:228 – 231.
- Tiwari SC, Tiwari BK, Mishra RR. 1989. Microbial populations, enzymatic activities, nitrogen—phosphorus—potash enrichment in earthworm casts and in the surrounding soil of a pineapple plantation. *Biology and Fertility of Soils*. 8:178–182
- Unchalika Klomklang, Nisachol Kulsirilak, Nuttakorn Intaravicha, Nuta Supakata. *Engineering Journal*. 2021, 25(4) DOI:10.4186/ej.2021.25.4.1

UNDER PEER REVIEW

