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Nutrient content in Fresh substrata, partial Decomposed Matter and Vermicompost under different Treatments

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ABSTRACT: The object of the study was to convert biomass into in enriched vermicompost with the use of various additives like Trichoderma, PSB, cow dung and rock phosphate alone and in combination with each other. Treatments consisted of two substrata, soybean and paddy straw and six additives. Hence, twelve treatment combinations were arranged in a randomized block design (RBD) with three replications. Substrata along with additives as per treatments were allowed for partial decomposition i.e. 21 days followed by digestion by earthworm. The 200 gram of earthworms were released in each treatment. Observations with respect to duration required for vermicomposting change in composition of nitrogen, phosphorus and potassium in partially decompose matter and varmicompost over fresh substrata. Results reveal that the treatment combination of soybean stover amended with cow dung and inoculated with PSB and required only 59 days to complete the process of vermicomposting. The content of nitrogen, phosphorus and potassium increases over fresh substrata in the partially decomposition as well as in vermicomposting. The higher content of 0.76, 2.10% nitrogen, 0.36 and 0.89% phosphorus and 0.83 and 1.04% potassium with soybean straw+cow dung+PSB in partially decomposed matter and vermicompost respectively.

Keywords: vermicompost, earthworm, soybean stover, paddy straw, cow dung, bio waste, partial decomposition.

INTRODUCTION

Both farmers and scientists are concerned about the deterioration in soil productivity due to decreasing application of organics. The judicious and heavy use of chemical fertilizers also negatively affects the quality of feed and food. This is due to simple reason that the agricultural products are largely transported to urban areas without counter flow of organic matter to the farms Agrawal *et al.* (2000). Therefore, it is essential to recycle organic wastes back into farmlands using bio-terminators. Modern agricultural practices have had detrimental effects on both local ecosystems and the global biosphere. At the same time, a significant amount of bio-waste is generated, either being burned or used as landfill. In India, it is estimated that organic wastes can provide approximately 7.1 million tonnes of nitrogen, 3.0 million tonnes of phosphorus, and 7.6 million tonnes of potassium (Anonymous, 2014). With these considerations in mind, the current study aimed to assess the chemical changes that occur during the process of vermicomposting. Trichoderma spp. are frequently encountered soil fungi that have gained recognition for their effectiveness in combating various plant pathogens across diverse soil conditions. These fungi serve multiple roles, functioning as bio-pesticides to control pests, bio-fertilizers to enhance nutrient availability, and soil amendments that contribute to the improvement of organic matter quality in the soil. Additionally, they play a crucial role in safeguarding plants from diseases and promoting overall soil health. *Trichoderma viride*, in particular, enhances the humification of organic matter, making it an excellent soil amendment. Therefore, converting different agricultural wastes into vermicasts not only addresses the issue of crop residue burning in fields but also reduces the need for chemical fertilizers, conserving natural resources Tomar (1995). Recycling crop residues and organic wastes with the help of bio-terminators is a key technology for waste disposal and organic manure production, contributing to a reduction in environmental pollution. In this context, the earthworm species *Eisenia fetida* has been found effective in converting bio-waste into high-quality compost at a rapid rate, rich in plant nutrients and containing a high number of microorganisms responsible for the decomposition process (Yami and Cole 2003). The use of earthworms as bio-terminators can facilitate the conversion of biodegradable waste into valuable compost. Earthworms are invertebrates known as humus formers, capable of digesting bio-wastes and transforming them into enriched manures. Earthworms have the remarkable ability to consume food equal to their own body weight daily. After utilizing about 5-10 percent of the ingested material for their own growth and metabolic processes, they excrete a substance called worm casts. These worm casts are composed of organic matter and are covered in a mucus layer. Within the earthworm's digestive system, these worm casts undergo a series of physical and chemical transformations, facilitated by the action of their muscular gizzard, as documented by Ndegwa *et al.* (2000). Given these considerations, the current experiment focused on fortifying organic manures through the addition of substances such as cow dung, rock phosphate, and microbial cultures before processing. This approach is a viable option for enhancing the decomposition process and simultaneously supplementing nutrients in vermicompost.

MATERIAL AND METHODS

A Pot experiment consisted of twelve treatment combinations (two substrata × six additives as given in Table 1) was carried out during 2015-16 and 2016-17 at Krishi Vigyan Kendra Jabalpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP). These 12 treatments were arranged in a randomized complete block design (RCBD) replicated thrice. The bio wastes of soybean and paddy were obtained from seed production research farm as well as cow dung from dairy farm Nanaji Deshmukh Pashu chikitsa Vigyan Vishwa Vidyalaya Jabalpur (MP). While the trichoderma, PSB as well as rock phosphate taken from Department of Soil Science and Agriculture chemistry college of Agriculture, Jabalpur. The bio wastes and cow dung were mixed in a proportion of 1:1 in each treatment. Prior to inoculation of bio agents, rock phosphate, the bio wastes were partially decomposed for three weeks. After partial decomposition earthworm (*Eisenia fetida*) was release @ 200 gram in each treatments. The various observations in relation to duration for partiality decomposition, duration for completion of vermicomposting process changes in chemical composition of treatment during partial decomposition and vermicomposting with respect to content of nitrogen, phosphorus as well as potassium.

RESULTS AND DISCUSSION

Duration for vermicomposting Process as influenced by different treatments. The data presented in Table 1. In general, when comparing soybean substrates to paddy straw, it was observed that soybean substrates required less time for vermicomposting, regardless of whether additives were used or not. Statistical analysis revealed significant variations in the time required for vermicomposting across various treatment combinations. The shortest duration, significantly at 59 days (21 days of partial decomposition + 38 days of vermicomposting), was recorded for soybean stover combined with cow dung, Trichoderma, and PSB. This combination performed significantly better in terms of speed than all other combinations, except for soybean stover with cow dung and Trichoderma, as well as soybean stover with rock phosphate and PSB, and soybean stover with rock phosphate, PSB, and Trichoderma. On the other hand, paddy straw without any additives took significantly longer, requiring 109 days for decomposition and digestion. This duration was notably longer compared to all other treatment combinations. Additionally, it was observed that paddy straw without cow dung or rock phosphate also took more time than soybean stover without additives, but it was similar in duration to soybean stover without additives. For treatments involving paddy straw combined with cow dung and Trichoderma, cow dung, Trichoderma, and PSB, rock phosphate and PSB, rock phosphate, PSB, and Trichoderma, and soybean stover with Trichoderma and PSB, there were no statistically significant differences in the duration required for substrate digestion by the earthworms. The findings indicate that soybean stover completed the vermicomposting process 17-22 days earlier than paddy straw, regardless of the presence or absence of additives. These results along with the findings of Saleem *et al.* (2000).

Content of nitrogen in vermicompost. The data presented in Table 2 clearly indicate that when the decomposed matter (after the introduction of earthworms) is converted into vermicompost, the nitrogen content increases threefold compared to partially decomposed matter. The analysis of the data reveals significant variations due to various treatments, and the highest nitrogen content of 2.10 percent, closely followed by 2.04 percent, was recorded in treatments T_4 and T_3. These two treatments were significantly superior to all the other treatments. Treatment T_2, T_5, and T_6 also showed significant superiority over the other treatments, although they were statistically similar to each other. Treatment T_9 and T_{10} were statistically similar to each other and found to be significantly superior to T_7 and T_8. A similar trend was observed in the partially decomposed matter. In conclusion, it can be inferred that vermicompost derived from soybean substrates amended with cow dung or rock phosphate contains significantly higher levels of nitrogen compared to vermicompost derived from paddy straw. These results along with the findings of Agrawal *et al.* (2000); Bansal and Kapoor (2000).

Phosphorus content in vermicompost. The various combinations of soybean stover and paddy straw, along with amendments of cow dung and rock phosphate, and inoculation with PSB and Trichoderma, were assessed for their phosphorus content at different stages: in fresh substrates, prior to decomposition, after partial decomposition for 21 days, and in the final vermicompost product. The data presented in Table 3 revealed significant differences among the treatments at these various stages. In terms of fresh substrates, both soybean stover and paddy straw, when partially decomposed for 21 days, showed a significant increase in phosphorus content in treatments that were amended with cow dung and inoculated with PSB and Trichoderma. The vermicompost obtained from soybean stover and paddy straw, which were amended with cow dung and inoculated with PSB and Trichoderma, exhibited the highest phosphorus content at 0.89%, closely followed by 0.86% in treatment T_5. This particular treatment was significantly superior to the other treatment combinations, although it was on par with T_5 and T_{11}. Additionally, it was observed that paddy straw combined with cow dung and inoculated with Trichoderma and PSB was statistically similar to T_{11} and T_{12}, where paddy straw was amended with rock phosphate and also inoculated with PSB and Trichoderma. This increase in nutrient content with the inoculation of microbes aligns with findings reported by Singh and Sharma (2002).

Content of Potassium in vermicompost. The data presented in Table 4. The process of partial decomposition had a positive effect on increasing the potassium (K) content in both substrates. Additionally, the digestion of partially decomposed matter by earthworms further enhanced the K content. The data clearly show that soybean stover amended with cow dung and inoculated with PSB and Trichoderma (T_4) had significantly higher potassium content compared to T_1 and T_7, although it was similar to the other treatments. It can be concluded from these findings that both the process of partial decomposition and vermicompost production contribute to an improvement in potassium content. The higher levels of nitrogen and potassium observed in soybean stover may be attributed to the fact that soybean stover, being a leguminous plant, inherently possesses higher nitrogen content. Additionally, the physical breakdown of waste materials due to the action of Trichoderma, coupled with the presence of dung, may have played a role in this increase. Furthermore, the earthworms contribute to the availability of nitrogen, phosphorus, and potassium by facilitating their release from decomposed waste through digestion in the earthworm gut, as reported by Agarwal *et al.* (2010).

Table 1: Duration for vermicomposting process as influenced by various treatments (data pooled over 2015-16 and 2016-17.

Sr. No.	Treatment	Duration for partial decomposition (days)	Duration required for complete the vermicompost process after release of warms	Total duration required (days)
T_1	Soybean stover + without additive	21	66	87
T_2	Soybean stover + Tricho + PSB	21	49	70
T_3	Soybean stover + Cd+Tricho	21	43	64
T_4	Soybean stover +Cd+ Tricho +PSB	21	38	59
T_5	Soybean stover +RP+PSB	21	45	66
T_6	Soybean stover +RP+ PSB+ Tricho	21	40	61
T_7	Paddy straw + without additive	21	88	109
T_8	Paddy straw + Tricho + PSB	21	68	89
T_9	Paddy straw+ Cd+ Tricho	21	58	79
T_{10}	Paddy straw+Cd + Tricho +PSB	21	57	78
T_{11}	Paddy straw + RP + PSB	21	55	76
T_{12}	Paddy straw +RP+ PSB+ Tricho	21	55	76
SEm±			0.3	5.3
CD (P=0.05)			1.0	15.8

Table 2: Nitrogen (%) content in fresh substrata, partial decomposed matter and vermicompost under different treatments.

Sr. No.	Treatment	Fresh substrata	Partial decomposition	Vermicompost
T_1	Soybean stover + without additive	0.52	0.62	1.46
T_2	Soybean stover + Tricho + PSB	0.52	0.65	1.82
T_3	Soybean stover + Cd+Tricho	0.47	0.71	2.04
T_4	Soybean stover +Cd+ Tricho +PSB	0.47	0.76	2.10
T_5	Soybean stover +RP+PSB	0.52	0.66	1.79
T_6	Soybean stover +RP+ PSB+ Tricho	0.52	0.69	1.85
T_7	Paddy straw + without additive	0.38	0.43	0.64
T_8	Paddy straw + Tricho + PSB	0.38	0.47	0.82
T_9	Paddy straw+ Cd+ Tricho	0.40	0.49	1.12
T_{10}	Paddy straw+Cd + Tricho +PSB	0.40	0.53	1.20
T_{11}	Paddy straw + RP + PSB	0.38	0.45	0.92
T_{12}	Paddy straw +RP+ PSB+ Tricho	0.38	0.51	0.96
SEm±			0.03	0.07
CD (P=0.05)			0.11	0.24

Table 3: Phosphorus content (%) in fresh substrata, partial decomposed matter and vermicompost under different treatments.

Sr. No.	Treatment	Fresh substrata	Partial decomposition	Vermicompost
T_1	Soybean stover + without additive	0.18	0.21	0.55
T_2	Soybean stover + Tricho + PSB	0.18	0.23	0.72
T_3	Soybean stover + Cd+Tricho	0.25	0.31	0.68
T_4	Soybean stover +Cd+ Tricho +PSB	0.25	0.36	0.89
T_5	Soybean stover +RP+PSB	0.18	0.30	0.86
T_6	Soybean stover +RP+ PSB+ Tricho	0.18	0.29	0.73
T_7	Paddy straw + without additive	0.08	0.17	0.41
T_8	Paddy straw + Tricho + PSB	0.08	0.20	0.53
T_9	Paddy straw+ Cd+ Tricho	0.20	0.28	0.59
T_{10}	Paddy straw+Cd + Tricho +PSB	0.20	0.30	0.66
T_{11}	Paddy straw + RP + PSB	0.08	0.23	0.76
T_{12}	Paddy straw +RP+ PSB+ Tricho	0.08	0.25	0.78
SEm±			0.02	0.03
CD (P=0.05)			0.07	0.10

Table 4: Content (%) of Potassium in partially decomposed matter after partial decomposition.

Sr. No.	Treatment	Fresh (Pre-decomposition)	Partial decomposition	Vermicompost
T_1	Soybean stover + without additive	0.35	0.83	0.75
T_2	Soybean stover + Tricho + PSB	0.37	0.83	0.85
T_3	Soybean stover + Cd+Tricho	0.48	0.83+0.45	0.98
T_4	Soybean stover +Cd+ Tricho +PSB	0.55	0.83+0.45	1.04
T_5	Soybean stover +RP+PSB	0.41	0.83	0.88
T_6	Soybean stover +RP+ PSB+ Tricho	0.45	0.83	0.82
T_7	Paddy straw + without additive	0.64	0.71	1.08
T_8	Paddy straw + Tricho + PSB	0.66	0.71	1.11
T_9	Paddy straw+ Cd+ Tricho	0.68	0.71+0.45	1.29
T_{10}	Paddy straw+Cd + Tricho +PSB	0.68	0.71+0.45	1.30
T_{11}	Paddy straw + RP + PSB	0.75	0.71	1.18
T_{12}	Paddy straw +RP+ PSB+ Tricho	0.77	0.71	1.19
SEm±		0.03	0.02	0.03
CD (P=0.05)		0.09	0.06	0.09

CONCLUSION

On the basis of findings, it is concluded that, among the substrates, soybean straw amended with cow dung and inoculated trichoderma and PSB takes least duration of 59 days (including 21 days of partial decomposition) for completion of vermicomposting process. The nutrient content with respect to nitrogen, phosphorus as well as potassium increased over fresh and partial decomposed matter in vermicompost. Thus, it could be concluded that the process of vermicomposting is advantageous for enhancing matter nutrient content in final product of vermicomposting.

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Conflict of Interest. None.

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