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IMPACT OF VERMICOMPOSTS GENERATED THROUGH VARIOUS RESOURCES IN IMPROVING MULBERRY (*Morus alba* L.) CROP PRODUCTION

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ABSTRACT

A field experiment was carried out at Regional Sericultural Research Station, Kodathi, Bangalore during 2014-16 to evaluate the impact of vermicomposts generated through the use of various resource materials such as silkworm rearing residue (SRR), seri-farm residue (SFR), avenue tree debris (ATD) and municipal corporation waste (MCW) in combination with recommended dose of NPK and FYM in mulberry. A total of 10 mulberry leaf harvests data revealed that 5mt/ha/yr vermicompost of SRR in combination with 50% reduced dose of FYM (10mt/ha/yr) along with NPK (@350:140:140kg/ha/yr) yielded increased leaf (T3-10,877.9kg/ha/cr) followed by the vermicompost of MCW (T5-10,345.2kg/ha/cr), vermicompost of ATD (T4-9,657.9) and SFR (T2-9,638.6), respectively compared with the control (T1-8,969.7kg/ha/cr) where recommended $N_{350}P_{140}K_{140}$+20MT FYM/ha/yr incorporated. Similar trend was noticed in case of plant growth and leaf yield parameters. Chemo assay of mulberry leaves *viz.* leaf moisture, total chlorophylls and leaf protein further supported the above results recording improved levels in the above treatments compared to control. Encouraging results were also noticed in case of soil nutrient status after experimentation in the vermicompost imparted plots compared to the control plots indicating that vermicompost combination under 50% reduced level of FYM and recommended NPK has an ability of improving sustainable mulberry crop production thereby appropriate utilization of various non-renewable wastes in to renewable nutrient rich composts minimizing the ever-growing landfills, preventing environmental pollution and helping appropriate utilization for the serifarming enrichment. From the results it is imperative that popularization of vermicomposting technologies for the appropriate management of all the resourceful wastes for suitable utilization in their farming not only contributes in appropriate utilization of these non-renewable wastes but also promotes environmental free farming.

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INTRODUCTION

Waste management is all about how to dispose all the things you don't want on the farm. Increase in solid waste generation not only results in environmental degradation but also involves huge loss of natural resources, which remains unaccounted for (Parikh and Parikh, 1997).

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The most important reason for waste collection is the protection of the environment and the health of the population. Rubbish and waste can cause air and water pollution. Rotting garbage is also known produce harmful gases that mix with the air and can cause breathing problems in people. Because of these problems there are active campaigns against waste incineration. Now there is a growing realization that the adoptions of ecological and sustainable farming practices can be only reverse the declining trend in the global productivity and environment protection (Wani and Lee, 1992; Wani *et al*., 1995; Nagavellamma *et al.,* 2004; Parikh and Parikh, 1997).

On one hand tropical soils are deficient in all necessary plant nutrients and on the other hand large quantities of such nutrients contained in domestic wastes and agricultural byproducts are wasted. It is estimated that in cities and rural areas of India large quantity of organic waste of 700 mil.ton/yr is generated annually which is either burned or land filled posing a problem of safe disposal (Bhiday, 1994). Composting is a sustainable waste management practice that converts any volume of accumulated organic waste into a usable product. When organic wastes are broken down by microorganisms in a heat-generating environment, waste volume is reduced, many harmful organisms are destroyed, and a useful, potentially marketable, product is produced. Organic wastes may include manure from livestock operations, animal bedding, and yard wastes, such as leaves and grass clippings, and even kitchen scraps. To mitigate this problem all the waste can be converted in to highly valuable nutrient-rich compost in an environment friendly manner. Composting is a process by which organic wastes are broken down by microorganisms, generally bacteria and fungi, into simpler forms. The microorganisms use the carbon in the waste as an energy source. The degradation of the nitrogen- containing materials results in the breakdown of the original materials into a much more uniform product which can be used as a soil amendment. Heat generated during the process kills many unwanted organisms such as weed seeds and pathogens.

Advantages of composting include reduction of waste volume, elimination of heat-killed pests, and the generation of a beneficial and marketable material. Adding compost to soil increases organic matter content. This, in turn, improves many soil characteristics and allows for the slow release of nutrients for crop use in subsequent years. Vermicomposting is a simple biotechnological process of composting in which certain species of earthworms are used to enhance the process of waste conversion and produce a better nutrient rich end product. Vermicomposting differs from other composting methods as because it is a mesophilic process which is faster than composting because the material passes through the earthworm gut a significant transformation thereby resulting the earthworm castings (worm manure) are rich in microbial activity an plant growth regulators, fortified with pest repellence attributes as well a type of biological alchemy are capable of transforming garbage into 'gold' (Vermi Co., 2001; Tara Crescent, 2008; Lin Lin *et al.,* 2014; Karmakar *et al*., 2015). Mulberry (*Morus alba* L.) perennial in habit raised as low bush crop for foliage to feed silkworm for the production for enhanced raw silk demands high quantities of organic and inorganic manures (NPK@ 350:140:140kg & 20MT per hectare/year) (Dandin *et al*., 2003). Imparting of such high doses of organic and inorganic manures is not only becoming unaffordable and posing economic burden to the marginal sericulturists.

Further, depletion of non-renewable source of energy, escalating fertilizer prices, deterioration of environmental quality aspects, reduction of agricultural land due to speeding urbanization, agricultural brain drain towards urbanized life style, decline of bovine population compelled the farming community in search of alternative organic manure resources (Acharya, 1992; Gaur, 1992; Shivashankara, 1996). One hectare of mulberry cultivation has the potentiality of generating more than 50mt/ha/yr organic residues in the farm of mulberry farm, silkworm rearing residue including avenue tree foliage and debris having tremendous manure value of nitrogen (280-300kg), phosphorus (90-100kg) and potash (150-200kg) as well as possessing of several micronutrients like Fe, Zn and Co (Dandin *et al.,* 2006). Sufficient information is available on the effective utilization of organic resource and manures and their impact on agriculture crop (Gaur and Sadasivam, 1993; Juwarkar, 1992; Palaniappan and Natarajan, 1993). Attempts were made for appropriate utilization of Sericultural residue in to viable organic manures (Bhogesha *et al*., 1994; 1997; Chowdhuri *et al*., 2001). However, generation of nutritionally rich compost using various raw materials from various sources such as municipal waste, farm residue and avenue tree debris and its utilization for mulberry development is remained as un-attempted field of research. Hence, through this study an attempt was made to evaluate the benefit of various vermicomposts generated through the use of varied residues and their impact on mulberry crop production and soil improvement.

MATERIALS AND METHODS

The study was undertaken at the Regional Sericultural Research Station, Kodathi, Bangalore where the standing established mulberry farm and vermicomposting technologies are actively imparted for the prolific recycling of various residues in to viable vermicompost generation during 2014-16. The raw materials such as silkworm rearing residue (SRR), Seri farm residue (SFR), avenue tree dry leaf debris (ATD) and the municipal corporation waste (MCW) available in the vicinity of the Campus were used for vermicomposting processes. All the residues as detailed above were arranged in layer by layer in concealed cemented pits of with at least 1-2 feet height and each layer was coated with raw cow dung slurry in every 15-20 days interval for fastening the composting process. In addition to the above the composting accelerators such as *Phanerochaete chrysosporium, Pleurotus ostreatus* and *Trichoderma viride* were mixed with cowdung slurry coat @ 1kg/ton material were released for quick decomposition. Rest of the composting processes was followed as described by the earlier workers (Bhogesha *et al*., 1997; Dandin *et al*., 2006; Eriksson *et al.,* 1990; Sudhakar *et al., 2012*). Depending upon the maturity the vermicompost of 90 days duration was subjected for quality assessment along with FYM for their nutritive status before incorporation in the field. The efficacy of all the vermicomposts generated through the use of various resource materials in combination with FYM and FYM lone (as recommended) were broadcasted along with recommended doses of chemical fertilizers (NPK) were tested on mulberry leaf yield and soil nutrient status under field conditions.

For the above study an experimental lay out was made with 5 treatments T1 (NPK @ 350:140:140kg+FYM @20MT/ha/yr as (Control)), T2 (NPK@350:140:140kg+10MT FYM+5MT vermicompost (use of farm residue)/ha/yr), T3 (NPK@ 350:140:140kg+10MT FYM+5MT vermicompost (use of rearing residue)/ha/yr), T4 (NPK@350:140:140kg+10MT FYM+5MT vermicompost (use of avenue tree debris)/ha/yr) and T5 (NPK@350:140:140kg+10MT FYM+5MT vermicompost (use of municipal waste)/ha/yr), respectively in 3 replications distributed in a randomized block design (RBD) in an established V1 mulberry garden planted with paired row spacing [(60+90)x150cm]. Each replicated plot with 84.8 m^2 net area with 120 no. plants. All the treatment replicated plots were maintained throughout the study period following recommended package of practices for irrigated mulberry

Fig. 1. Prolific recycling of diverse resource materials in to viable vermicomposts generation

(Dandin *et al*., 2003). Each crop was harvested on 70th day after pruning. The experimental plots were maintained in irrigated conditions by giving 1.5 acre inch of water/irrigation in 3-4 days. All the plant growth and leaf yield parameters were recorded 70 days after pruning of every crop i.e. for 5 crops in year. For leaf area, 10 healthy leaves were taken from 10 plants selected at random in each replicated plot and the area was calculated through the regression equation area=-2.12+0.68 (LxB) (Satpathy *et al*., 1992). Moisture and chlorophylls contents were estimated from 5th/6th leaf from the top (Rao *et al*., 1991). Soil chemical analysis of the experimental plots before and after experimentation was analyzed for pH, electrical conductivity, organic carbon, available nitrogen (N) phosphorous (P) and potassium (K) kg/ha by standard methods (Chopra and Kanwar, 1976; Jackson, 1973). Initial nutrient status was recorded as neutral pH (6.94), ideal electrical conductivity (EC-0.154 dS/m^2), low level of organic carbon (OC-0.428%), low in available nitrogen (N-195.6kg), desired level of available phosphorous (P-24.10kg) and medium level of available potassium

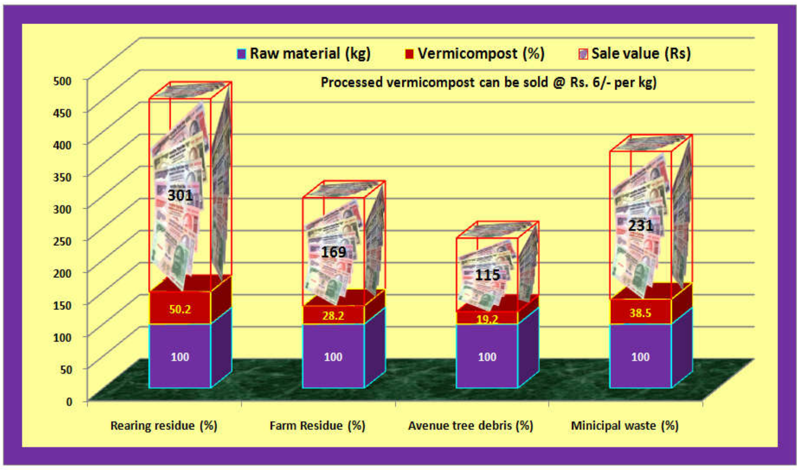

Fig. 2. Vermicompost realization from 1 ton of raw materials of various kinds incorporated

Table 1. Impact of vermicomposts generated from various resources on mulberry plant growth and leaf yield

Treatments	Plant height (cm)	No. of branch/ plant	No. of leaves/ plant	Leaf area/ cm^2	L:S Ratio (%)	Leaf yield (kg/ha/ crop)
T1 = FYM @ 20MT/ha/yr (Control)*	144.8	7.20	171.2	164.2	60.45	8,969.7
T2 = FYM @ 10MT+5MT Vermicompost (SFR)/ha/yr*	145.2	7.42	188.4	159.2	59.94	9,638.6
T3= FYM @ 10MT+5MT vermicompost (SRR)/ha/yr*	151.0	8.13	199.4	172.2	62.65	10,877.9
T4= FYM @ 10MT+5MT vermicompost (ATD)/ha/yr*	132.6	7.29	171.5	166.9	59.93	9,657.9
T5=.FYM @10MT+5MT vermicompost (MCW)/ha/yr*	156.1	8.43	203.9	178.5	61.70	10,345.2
CD at 5%	2.60	0.50	1.05	5.80	N.S.	499.2

*NPK @ 350:140:140 kg/ha/yr applied uniformly in all treatments

Table 2. Impact of vermicomposts generated through various resources on leaf nutrient status of mulberry

Treatment	Biochemical status of mulberry leaves				
	Leaf moisture (%)	Chloro-phyll-a (mg/g)	Chloro-phyll-b (mg/g)	Total Chlorophylls (a+b) (mg/g)	Leaf protein (%)
T1 =FYM @ 20MT/ha/yr (Control)	75.27	2.46	0.64	3.10	17.45
T2 =FYM @ 10MT+5MT Vermicompost (SFR)/ha/yr	74.63	2.35	0.59	2.94	17.65
T3=FYM @ 10MT+5MT vermicompost (SRR)/ha/yr	76.50	2.49	0.71	3.20	18.05
T4=FYM @ 10MT+5MT vermicompost (ATD)/ha/yr	75.06	2.55	0.69	3.24	17.85
T5=FYM @10MT+5MT vermicompost (MCW)/ha/yr	76.45	2.69	0.86	3.55	17.05
CD at 5%	0.82	0.09	0.02	--	5.45

(K-161.3kg/ha) respectively. Soil analysis status was assessed after two years of experimentation to observe the impact of various vermicomposts. Finally, pooled data of ten (10) crops were statistically analyzed using ANOVA with factorial analysis and presented.

RESULTS AND DISCUSSION

During the period under the experimentation 2014-16, 10 crops plant growth, leaf yield, leaf and soil biochemical analysis as influenced by the vermicomposts generated through the use of various raw materials recorded was compiled, pooled data was subjected to ANOVA and presented. Generation of vermicomposts incorporating various resource materials for experimentation was revealed that silkworm rearing residue (SRR) was found easily available in large quantities because of hectic silkworm rearing schedules generate >50MT of SRR per annum. The other dissipate large scale resource is municipal corporation waste (MCW), however limited quantities of wastes can be realized from seri-farm residue (SFR) and avenue tree debris (ATD). When one ton of each waste subjected, 50.2% vermicompost was realized from SRR followed by MCW (38.5%) whereas only 28.2% and 19.2% was realized from SFR and ATD, respectively.

Therefore, the farming community can avail the nutrient rich vermicompost for their farm use or else marketed for economic benefit considering as an economically viable venture (Fig. 2). Further, the perusal of the farm level experimental results revealed that mulberry plant growth and leaf yield was responded significantly well to the varied treatments. Increased leaf yield was noticed in T3 (10,877.9kg/ha/cr) where $N_{350}P_{140}K_{140}$+10MT/ha/yr supplemented with vermicompost (@ 5MT/ha/yr) made of rearing residue followed by T5 (10,345.2kg/ha/cr) supplemented with 5MT/ha/yr vermicompost of municipal waste, T4 (9,657.9) and T2 (9,638.6) where the recommended NPK+10MT FYM supplemented with 5MT vermicomposts generated through the use of Avenue tree debris and Serifarm residue, respectively. However, T1 recorded comparatively lower yield (8,969.7kg/ha/cr) out of the all treatments where recommended $N_{350}P_{140}K_{140}$+20MT FYM/ha/yr incorporated (Table 1).Similar trend was noticed in case of plant growth parameters such as plant height, no. of branches, no. of leaves, leaf area and L:S ratio confirming that the cumulative effect of plant growth parameters was result in recording the enhanced leaf yield in the T3, T5, T4 and T2 and also indicating the nutritious impact of vermicomposts of various kind in combination with recommended NPK and 50% FYM combination (Table 1).

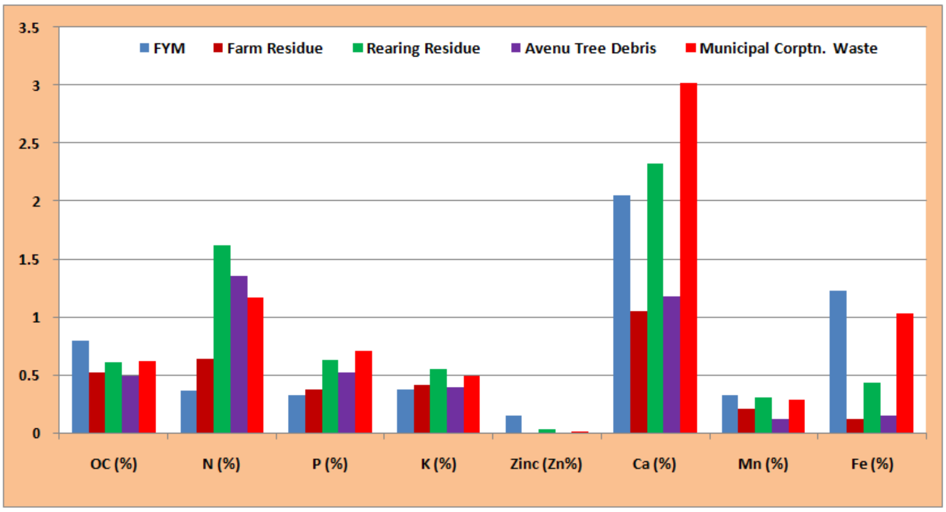

Fig. 3. Nutrient status of FYM and vermicompost generated through the use of various residues

Table 3. Impact of vermicomposts generated through various resources on the soil nutrient status of mulberry

Treatments	Soil analysis parameters					
	pH	EC (dS/m^2)	OC %	Avl. N (kg/ha)	Avl. P (kg/ha)	Avl. K (kg/ha)
Initial status	*7.01*	*0.25*	*0.39*	*175.60*	*24.10*	*161.30*
T1 = FYM @ 20MT/ha/yr (Control)	7.15	0.12	0.40	*225.30*	36.15	225.02
T2 = FYM @ 10MT+5MT Vermicompost (SFR)/ha/yr	7.05	0.16	0.41	205.25	35.05	165.55
T3= FYM @ 10MT+5MT vermicompost (SRR)/ha/yr	7.28	0.15	0.45	255.23	37.10	185.01
T4= FYM @ 10MT+5MT vermicompost (ATD)/ha/yr	7.12	0.22	0.44	225.85	36.10	192.25
T5=.FYM @10MT+5MT vermicompost (MCW)/ha/yr	7.34	0.28	0.49	275.72	39.26	205.03

The results were in conformity with earlier workers (Sudhakar *et al*., 2012; Bhogesha *et al.* 1997) in mulberry as well as in other cultivations (Kale, 1997; Vadiraj *et al.,* 1998). Improved leaf quality *viz*. increased leaf moisture, total chlorophylls and leaf proteins was noticed in all the treatments incorporated the vermicomposts generated through the incorporation of various residues (Table 2). However, vermicomposts generated using rearing residue and municipal corporation wastes (T3 & T5) have shown an edge among all the treatments. The improvement in plant growth, leaf yield and leaf quality parameters of mulberry in various treatments compared to control may due to the superior nutrient status of vermicomposts generated through the incorporation of various organic wastes (Fig. 3). The efficiency of vermicompost in improving plant growth and yield of different field crops like vegetables, flower and fruit crops was evaluated by several workers (Karmegam and Daniel, 2000; Patil and Sheelavantar, 2000; Nagavellamma *et al.,* 2014; Wu *et al*., 2014). From the earlier studies it is also evident that vermicompost provides all nutrients in readily available form and also enhances uptake of nutrients by plants. Sreenivas *et al*. (2000) studied the integrated effect of application of fertilizer and vermicompost on soil available nitrogen (N) and uptake of ridge guard. Soil available N increased significantly with increasing levels of vermicompost and higher N uptake was obtained at 50% of the recommended fertilizer rate plus 10MT vermicompost/ha. Similarly, the uptake of N, phosphorous (P), potassium (K) and magnesium (Mg) by rice (*Oryza sativa*) plant was highest when fertilizer was applied in combination with vermicompost (Jadhav *et al*., 1997). Chemical analysis of soil reaction (pH & EC), nutrient parameters like organic carbon (OC%), available N, P & K have shown marked improvement in all the. treatments after the two years experimentation compared to the initial of the experimental plot soils. Enhanced levels of soil nutrient status was noticed in the treatment where municipal corporation waste (T5) followed by T3 (silkworm rearing residue) and T1 (FYM alone) incorporated (Table 3). Thus from the present study it can be concluded that production of nutrient rich vermicomposts through the prolific recycling of non-renewable waste in to renewable form and their utilization for the sustainable mulberry crop production is righteous act. Sericulture being the largest and widely spread cottage industry in India recycling of its byproducts is not only economizes the sericulture practice but also leads to the appropriate utilization for their benefits thereby preventing the un hygienic atmosphere, restricting silkworm rearing diseases, averting atmospheric pollution and offering value addition. Further, Serifarm residue and other easily available wastes recycling in to viable nutrient rich compost is the only devise to overcome with the non availability of farmyard manure (FYM). Their application in mulberry cultivation is highly beneficial and much effective with multifaceted benefits than conventional use of FYM. Therefore, efforts are to be made for intensive popularization of the sericultural composting technologies among the sericulturists for their benefit and upliftment of socioeconomic conditions.

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