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Enriching Organic Wastes with Humus Substances thru Vermicomposting

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Abstract

Enriching organic wastes with humus substances through the bioactivity of earth worms is deliberated. Earth worms' activity enriches composts with 30 to 50% humus substances, besides many simple organic compounds, in a period of 20 to 30 days. Nature takes several years to build such level of humus substances in soil profile

Keywords

Vermicompoting; Humus Enrichment; Analysis and Trials.

Introduction

Vermiculture is as old as agriculture and it deals with the role of earthworms in maintaining soil fertility. The faeces of earth worms contain simple organic compounds formed by break down of organic wastes ingested by them by the proteolytic, cellulolytic, and lignolytic enzymes present in their guts. They also harbour symbiotic bacteria and actinomycetes which mineralizes and polymerizes these chemicals particularly that of lignin materials into humus substances. Importance of humus substances in building soil structure and stabilizing soil profile characteristics are well known. Earth worms' activity enriches composts with 30 to 50% humus substances besides many simple organic compounds in a period of 20 to 30 days. In nature, it takes hundreds of years to build such level of humus substances

Production of vermicompost

Large scale vermicompost production was undertaken to study its effects on yield and quality of agricultural products in farmers' fields besides developing chemical methods to assess their composition and compare with international standards.

The earth worms require partially decomposed composts for efficient feeding. They are produced by aerobic high temperature composting method using available 1) post harvest farm wastes from ground nut, banana and sugar cane fields 2) fallen leaves from gardens 3) municipal wastes and 4) animal and domestic wastes from the neighbourhood in open heaps of 10m long, 1 m wide and about 1m height, each capable of handling 8 to 10 tons of wastes. It takes 20 to 22 days to get the desired state of decomposition fit for feeding the earth worms.

Brick walled beds for vermicomposting are 10m long 1m wide and 1m high under 6m high shed with coconut fronts roof and sides covered partially with plastic sheets. A thin film (3 to 5 cm) of sand and dust from stone quarries and (or) road works is spread at the bottom of beds and treated for termites. All around the beds, a narrow trench is dug and filled with cow dung slurry to prevent escape of worms. Then the partially decomposed compost is spread to a depth of about 90 cm. It works out one bed per composting heap. Above that earth worm culture (Eudrilus eugeniae) is spread and covered with a thin layer of partially decomposed material. The main enemies of the earth worms are bandicoot, rats, birds and termites. Bandicoot and rats are kept away by lighting the area with 40 watts bulbs during the night, birds by keeping scarecrow and termites by initial treating of bed bottoms. Sprinkling water over the beds is done regularly to keep the beds moist.

After 20 to 22 days small earth worms could be seen crawling on the surface. At this stage,

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the vermicomposted materials from the bed are heaped in the form of a cone. Earth worms move down to the base in about an hour or two. Top layers of the cone leaving a 2cm layer at the bottom are removed, sieved thru 8 to 10 mm sieve ,air dried and stored. The bottom layer is returned to the beds as earth worm cultures for the next batch and the beds filled with partially decomposed material and the cycle of operations starts.

The air dried compost is dark grey to black, free flowing, and odourless with a density around 0.8. Overall recovery as vermi-compost (13% moisture) is about 50 to 60 % of original material composted. Four to five tons of vermicompost per bed could be obtained In 20 to 22 days.

Structural analysis of Vermicompost

The fractionation analysis of humus is done by the principles detailed by Kim H.Tan (1982) In 'Principles of Soil Chemistry'. Analyses were done at 1) R & D division of M/s RBT Ltd., Vandiperiyar, Kerala 2) Soil Science Division AC & RI, TNAU, Madurai,3) Rallis Agro-Research station, Bangalore and 4) Modern Analytical Laboratory and Consultancy Services, Kirkee, Pune. The pure commercial humus substances have a CEC of 500 to 600 meq% while soil humus substances have a CEC ranging 250 to 300 meq % (Wayne R. Kussow 2002). Assuming CEC of soil humus as 300 meq%, the content of humus substances in soil organic matter and composts is roughly about 30 % of their cation exchange capacity in meq%. The compiled analytical results are given in Table 1.

Field trials

1. Farmers' Field: The cost per kg of vermicompost is about 2 to 3 times the cost of raw materials. Increase in cost is due to 1) Vermicompost is air dried to moisture content of about 13 % while the moisture content of raw materials used varied from 20 to 40% 2) Recovery % which is in between 50 to 60 % and 3) operating costs. In the trials in farmers' fields, the total cost of fertilizers were kept at the same level by reducing the rates of other fertilizes to balance the increase in costs due to substitution of part of the fertilizes with the application of 1300 to 1500 kg vermicomostst per KUZHI (80 cents) whose cost is about 3.5 times the costs of ordinary compost. The ordinary composts were used at the rate 6 tons/acre. As a result of improved soil structural properties in the root zone due to vermicompst application, there was an increase in yield up to 25% and enhancement in quality of end products with prolonged storage time (Shelf life). The yield increase is due to better utilization of soil inherent and added nutrients. All these factors contributed to increase the volume of profit per unit area. Trials were conducted in grapes, banana and other orchard crops in CUMBUM valley. Data were collected from the farmers of grapes and banana gardens and from R & D division of M/s Ram Bahadur Thakur Ltd. Vandiperiyar for plantation crops (Cardamom and Pepper). Results are given in Table 2 and 3:

Table 1: Analytical Report-Vermicompost

1. Structural Analysis		**2. Available Nutrient Content**		
Carbon (C %)	40 to 57	N	0.85 to 1.50 %	0.84 %
Hydrogen (H %)	4 to 8	P	0.03 to 0.09 %	0.07 %
Oxygen (0%)	33 to 54	K	0.06 to 0.80 %	0.64 %
Sulphur (S %)	0.5 to 0.7	Ca	0.15 to 0.30 %	0.22 %
Nitrogen (N %)	2.0 to 5.0	Mg	0.19 to 0.25 %	0.20 %
Phosphorus (P %)	0.25 to 0.35	Zn	30 to 100 ppm	54 ppm
Acidity meq/g	5.7 to 12.4	Cu	10 to 150 ppm	71 ppm
Carboxyl (-COOH)meq/g	1.5 to 9.0	Mn	10 to 150 ppm	73 ppm
Phenolic Hydroxyl (-OH) meq/g	1.4 to 6.0	Fe	70 to 3000 ppm	1740 ppm
Carbonyl (-CO) meq/g	0.9 to 3.1	B	50 to150 ppm	60 ppm
Alcoholic Hydroxyl meq/g	2.0 to 4.0	**3. Physicochemical properties**		
Tentative Recommendations		pH	4.0 to 9.0	6.8
pH 1 % suspension	4.0 to 9.0	OC	40 to 57 %	47 %
EC 1% suspension mmho/cm minimum	0.10	CEC	100 to 120 meq %	110 meq %
Organic Carbon (OC) minimum	35 %	-COOH	20 to 80 meq %	48 meq %
Total CEC meq% - minimum	100	-OH	50 to 100 meq %	70 meq %
C/N ratio, maximum	20			

American standard ; Min 30% Humic substances

RBT LTD. Vandiperiyar : 30 to 40 % Humic substances

Table 2: Fertilizers applied and their costs

	Crop /particlars	Fertilizers applied per Kuzhi		costs of fertilizers ₹	
		A	B	A	B
1.Grapes	vermicompost	nil	1300 kg	xxxx	4550
	compost	6 loads	xxxxxx	2400	xxxx
	oilcakes ground nut	6 bags	2 bags	2100	700
	oilcakes NEEm	4 bags	2 bags	720	360
	GRAPES standard Fertlizer mixture	20 bags	15 bags	2200	1650
	cost of feltilizers ₹			7420	7260
2. Bananaa	Oil cakes-Groundnut	7 bags	xxx	4200	xxxx
	Neem cakes	5bags	xxxxx	1800	xxxx
	Comlex fertilizer	3 bags	3 bags	1740	1740
	DAP	2bags	2 bags	680	680
	Ammonium sulphate	2 bags	2 bags	216	216
	BORATES	1kg	1 kg	40	40
	Potash	6 bags	6 bags	1158	1158
	vermicompost	1600kg	xxxxx	xxxx	5600
	cost of feltilizers ₹			9834	9434

as provided by farmers (1993-1995);

KUZHI =80 cents land mesurement system in vogue in Southern Districts of Tamil Nadu

A- Farmers schedule of application

B -substituting Vermicompost and equalizing the increased cost by adjusting the rates of application of other fertlizer inputs

Table 3: Yield obtained and impact of vermicompost

			A	B
Grapes	1	vines/er KUZHI	260	260
	2	Cost of fertilizers ₹	7420	7260
	3	yield kg	5400	7000
	4	Cost of fertilizers in a kg grapes - ₹	1.37	1.04
Banana	1	plants/kuzhi	800	800
	2	Cost of fertilizers ₹	9834	9434
	3	number of bunches	750	750
	4	no. of banana/bunch	125	160
	5	no. of banana fruits , total	93750	120000
	6	Cost of fertilizers in one banana- ₹	0.11	0.08

2 Cardamom and Pepper in Vandiperiyar Area (M/s RBT Ltd.,); As the soils contained high organic matter, the trials were limited to study the effect of application of 0.5 kg Vermicompost /plant in the root zone around the collar. There were no increase in yield in both the crops.There was marked improvement in appearance of finished (marketable) end products in both the crops. The Shelf life increased to more than a year in both cases

Discussions

There are two nutrient recycling pathways in nature for sustaining soil fertility; 1) weather dependent Inherent mineralogical fertility 2) biological one- mineralization through bioactivity of soil fauna. Earthworms are one of soil macro fauna playing the most important role in humus cycling which is important for sustaining soil porosity, necessary for movement of air, nutrients and water in the root zone. Besides that, they contribute substantially to cation exchange capacity of the soil medium. The importance of soil structure in the retention and release of nutrients and water in the root zone is well documented. Time and money spent on vermicomposting is worth the trouble as it pays back with dividends several times more than the investments made. In the farmers trails, the increase in profit per unit end products due to partial vermicompost substitution ("X" per Kg in grapes and per fruit in banana) is the difference in cost component of fertilizer input in 'no vermicompost' and 'vermicompost' plots when other costs of cultivation were the same. Therefore, the total additional gains is the product of yield and "X" (as defined above) It worked out to 2310 for grapes and 3154 for banana peer kuzhi (80 cents) for the same investment on fertilizer.

In Indonesia, the orchards are improved by rearing earthworms in situ by taking trenches around the base of the trees. Their population dynamics is largely dependent on sustained availability of decomposing organic matter and hence regular addition of organic matter is necessary to maintain their population density either in composting beds or in situ culture. The population dynamics of earth worms is largely dependent on availability of food materials and the extent of vulnerability to predators.

To sum up:

The earthworms play an important role in Humus recycling and sustaining soil structure for successful soil based agriculture. Vermicomposting techniques help to exploit the bio activity of earth worms to hasten the process of improving soil fertility in intensive target based production programs seeking both yield and quality. It happens with ease thru enriching the compost with humus substances.

Conclusion

To sum up the earthworms play an important role in Humus recycling and sustaining soil structure for successful soil based agriculture. Vermicomposting techniques help to exploit the bio activity of earth worms to hasten the process of improving soil fertility in intensive target based production programs seeking both yield and quality. It happens with ease thru enriching the compost with humus substances.

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