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Analysis of Vermicompost of Vegetable Market Waste and its Effect on the Growth and Yield of Black Gram

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Abstract

Soil parameters such as pH, EC, macro (N, P, K, Ca, Mg and organic carbon) and micronutrients (Zn, Fe, Cu and Mn) present in different per cent substrate ratios (PSR) (50, 25, 20, 10, 5 and 0) of vegetable market wastes (VMW) after vermicomposting with *Lampito mauritii* were analyzed. The pH values of all the samples obtained before and after vermicomposting practice showed slightly basic in nature except 50 PSR sample. The EC values observed in the raw samples showed relatively more when compared to samples obtained after vermicomposting practice which indicate that the soluble salts present in raw samples were reduced during vermicomposting. On the contrary the earthworm during composting, drastically increased the levels of macro and micronutrients in all the PSR media over raw samples. The black gram, *Vigna mungo* raised in pots with 50, 25, 20, 10 and 5 PSR media revealed a differential growth and yield in accordance with the levels of PSR. However, the plants raised in higher PSR (25 and 50), though showed improved growth, but are severely affected with insect pest of saprophytic type due to their soft nature as a direct effect of higher nitrogen and organic carbon present in them. This study proved that VMW serve as a best raw materials for the production of nutrients rich organic fertilizer, namely vermicompost.
Key words : Macro and micro nutrients, Vermicompost, Vegetable market waste, Black gram.

The continuous use of large quantities of chemical fertilizers, pesticides and weedicides to increase the yield of crop varieties cause several hazards to soil such as heavy withdrawal of macronutrients (Prasad and Singh 1981), deficiency of micronutrients (Kanwar and Randhawa 1978), nutrient imbalance (Singh et al. 1989) and reduction in organic matter content (Padmaja et al. 1996) leads to reduction of plant growth and yield. All these problems have motivated scientists to evolve organic farming practices which could maintain higher crop yield, fertility and productivity of soil. Organic farming is attributed to the use of organic manure and biofertilizers. Production of organic manure through vermicomposting and the use of vermicompost is a break through in the field of agriculture in the era of sustainable organic farming. Vermicomposts have all macro and micronutrients, humus, organic carbon, growth regulators, enzymes, vitamins, antibiotics and microflora (Bhawakar 1991, Bangar and Jatgar 1995). Many have reported that the worm cast has created and maintained soil structure and physical properties through its polysaccharides (Tomati and Galli 1995); increased content of available mineral nutrients (Mackey et al. 1983), enhanced nutrient uptake and increased protein content (Tomati et al. 1988); stimulated plant root initiation and development and increased root biomass (Grappelli et al. 1985) and enhanced plant growth, improved crop qualities, increased crop yield and plant productivity (Edwards and Lofty 1978, Edwards 1983, Vasanthi and Kumaraswamy 1996). Evaluation and the effects of vermicomposts obtained from specific organic waste on plant growth and yield are the important prerequisites to recommend these vermicomposts as an effective organic fertilizer for sustainable development in the era of organic farming. To establish the quality of vermicompost obtained from the organic wastes collected from vegetable market after using them by earthworm, *Lampito mauritii*, a pot study was undertaken to assess the quality and nutrients status of the same using a short term pulse crop, black gram, *Vigna mungo.*

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Methods

Methods for collection, selection and introduc-

Table 1. Values showing the levels of pH, electrical conductivity (EC) (ds/m), macro and micro nutrients obtained in the samples of different per cent substrate ratios (PSR) of partly decomposed westes of vegetable market (VMW) before and after vermicomposting practice with *Lampito mauritii* for one month. Upper row indicates value obtained from samples before vermicomposting; Lower row indicates value obtained from samples after vermicomposting.

PSR	pH	EC	Macro nutrients (%) N	P	K	Ca	Mg	Organic carbon	Micro nutrients (ppm) Zn	Fe	Cu	Mn
50	6.9	0.55	1.49	0.05	0.56	1.68	0.539	0.058	81.0	2236	26	162
	7.0	0.47	1.55	0.07	0.86	1.72	0.542	0.450	84.0	2247	29	184
25	7.4	0.53	1.45	0.04	0.54	1.63	0.536	0.052	79.0	2239	26	158
	7.3	0.47	1.55	0.08	0.82	1.68	0.550	0.450	81.0	2241	27	172
20	7.5	0.55	1.14	0.04	0.56	1.63	0.536	0.042	77.0	2242	24	161
	7.3	0.49	1.23	0.05	0.84	1.69	0.548	0.380	84.0	2249	26	174
10	7.5	0.59	0.89	0.04	0.56	1.58	0.529	0.046	77.0	2187	24	145
	7.5	0.49	0.98	0.05	0.86	1.64	0.542	0.380	81.0	2298	26	168
5	7.5	0.62	1.18	0.02	0.52	1.56	0.527	0.042	73.0	2168	21	139
	7.5	0.49	1.24	0.04	0.82	1.62	0.536	0.340	76.0	2274	26	152
0	8.2	0.68	0.78	0.02	0.52	0.81	0.431	0.041	71.0	1146	18	121
	7.8	0.53	0.93	0.04	0.80	0.96	0.486	0.340	73.0	1156	21	126

tion of earthworm, partial decomposition of vegetable market waste (VMW) and the preparation of different per cent substrate ratios (PSR) for vermicomposting were followed as described by Bakthavathsalam and Uthayakumar (2007).

Analysis of Macro and Micronutrients in Vermicompost

The levels of pH and electrical conductivity (EC) of different PSR samples (50, 25, 20, 10 and 5) of VMW obtained before and after vermicomposting practice with *Lampito mauritii* for one month were measured. Macronutrients such as nitrogen, phosphorus, potassium, calcium, magnesium and organic carbon and micronutrients such as zinc, iron, copper and manganese were also estimated in the above samples at Soil Testing Laboratory, Soil Research Institute, Aduthurai, Thanjavur district, Tamil Nadu. The contents of macro and micronutrients were expressed as percent and ppm respectively.

Cultivation of Black Gram Using Vermicompost

At the end of 30 days of cocoon production study (Bakthavathsalam and Uthayakumar 2007), the substrate medium (each PSR) used by earthworms was collected as vermicompost and stored in polythene bag. Five liters of vermicompost collected from each PSR (50, 25, 20, 10, 5 and 0) were transferred separately into six circular pots of size 25 cm diameter and 24 cm height. Another five liters of same vermicompost obtained from these PSR media was also transferred separately into another six circular pots for duplicating the experiments under identical conditions. Certified black gram seeds were obtained from the Regional Research Rice Institute, Tamil Nadu Agriculture University, Aduthurai, Thanjavur district, Tamil Nadu. Four seeds were placed in each pot at 2.5 cm depth and sufficient water was poured in all the pots for proper germination. The experimental pots were kept at open terrace for direct sun light and were regularly poured with sufficient water to ensure proper growth until the plants get harvested (60 days). Care was taken to see that the plants growing in the pots must be protected from predation, if any.

After 20 days of cultivation, all plants in the pots were measured, their stem and petiole length were taken, and counted the leaves. The same measurements were also made in all the plants after 30, 40, 50 and 60 days of growth. Parameters such as number of flowers, number of pods and total number of seeds per plant were also recorded in all the plants during the course of study.

Results and Discussion

Macro and Micronutrients Analysis of Vermicompost

The levels of soil parameters such as pH, electri-

Table 2. Mean values of leaves, stem and petiole length (cm) of black gram, *Vigna mungo* cultivated in pots using different PSR of vermicompost obtained from VMW after using them by earthworm, *Lampito mauritii.* Upper, middle and lower row values indicate mean ± SD of stem length, number of leaves and petiole length of eight plants respectively ; [a] Significant (P<0.01) over 0–PSR value ; [b] Significant (P<0.05) over 0–PSR value ; [c] Not significant (P>0.05) over 0–PSR value.

PSR	20 day	30 day	40 day	50 day	60 day
	9.13 ± 0.89[a]	12.67 ± 1.73[a]	19.62 ± 1.22[a]	21.62 ± 1.21[a]	23.87 ± 1.51[a]
50	9.75 ± 1.56[a]	24.50 ± 2.12[a]	30.87 ± 3.95[a]	34.62 ± 4.09[a]	32.25 ± 3.49[a]
	6.52 ± 0.22[a]	10.37 ± 0.99[a]	14.12 ± 1.05[a]	15.12 ± 1.05[a]	16.25 ± 1.02[a]
	8.75 ± 0.96[b]	12.12 ± 1.05[a]	18.12 ± 1.88[a]	20.25 ± 1.47[a]	22.87 ± 1.38[a]
25	9.12 ± 1.96[a]	22.00 ± 1.32[a]	26.37 ± 2.34[a]	30.50 ± 2.12[a]	28.75 ± 1.85[a]
	6.18 ± 0.22[a]	9.37 ± 1.31[a]	13.31 ± 1.34[a]	14.31 ± 1.24[a]	15.08 ± 1.05[a]
	8.43 ± 0.84[c]	11.43 ± 0.98[a]	17.37 ± 1.31[a]	19.35 ± 1.22[a]	21.37 ± 0.86[a]
20	8.75 ± 0.96[a]	20.12 ± 4.25[a]	25.25 ± 7.31[b]	29.37 ± 6.61[b]	27.62 ± 6.28[a]
	6.08 ± 0.18[a]	8.25 ± 1.09[a]	12.87 ± 1.69[a]	13.83 ± 1.71[a]	14.43 ± 1.70[a]
	8.22 ± 1.40[c]	10.68 ± 0.83[a]	16.50 ± 1.22[a]	17.75 ± 1.07[a]	19.87 ± 1.05[a]
10	8.25 ± 0.96[c]	17.00 ± 2.59[a]	23.00 ± 3.96[b]	27.12 ± 2.97[a]	25.12 ± 2.97[a]
	5.90 ± 0.14[a]	6.83 ± 0.52[a]	10.06 ± 0.38[b]	11.13 ± 0.59[b]	12.16 ± 0.75[b]
	8.16 ± 0.60[c]	10.37 ± 1.22[b]	15.00 ± 0.50[a]	16.63 ± 0.90[b]	18.18 ± 1.11[b]
5	7.37 ± 1.41[c]	12.87 ± 2.08[c]	20.75 ± 2.90[c]	25.62 ± 2.34[b]	23.87 ± 2.14[a]
	4.82 ± 0.23[a]	6.06 ± 0.95[c]	9.56 ± 1.35[c]	10.75 ± 1.37[c]	11.25 ± 1.67[c]
	7.98 ± 0.63	9.05 ± 0.69	12.87 ± 1.61	14.88 ± 1.63	16.87 ± 1.50
0	6.50 ± 1.5	11.00 ± 2.12	18.12 ± 3.33	22.25 ± 3.26	19.62 ± 3.03
	3.97 ± 0.39	5.37 ± 1.11	8.93 ± 1.59	9.81 ± 1.73	10.62 ± 1.78

cal conductivity, macronutrients (nitrogen, phosphorus, potassium, calcium, magnesium and organic carbon) and micronutrients (zinc, iron, copper and manganese) present in the PSR samples (50, 25, 20, 10 and 5) collected from the substrate media of earthworm before and after vermicomposting practice with *Lampito mauritii* for one month are given in Table 1. The pH values measured in all the PSR samples of raw VMW obtained before vermicomposting practice showed slightly basic in nature except 50 PSR sample where a slightly acidic pH was noticed. But the samples obtained after one month of vermicomposting showed somewhat basic or neutral pH. However, the levels of pH were not changed in the PSR of 10 and 5. The levels of electrical conductivity (as a measure of soluble salts level) measured in all the PSR samples obtained before vermicomposting showed relatively more values than the samples obtained after vermicomposting practice which indicate that the soluble salts level was reduced during vermicomposting. The availability of several plant nutrients and the levels of other elements present in any soil depends upon the pH value of the organic manure. The pH value at neutral level should be considered important in retaining nitrogen since it is lost as volatile ammonia at high pH (Haimi and Huhta 1987) and the pH range 6—7 seems to promote the availability of plant nutrients (Brady 1988). In the present analysis though there are changes in pH during vermicomposting in 20, 25 and 50 PSR but their pH levels were maintained in the safe range around 7 as suggested by Brady (1988). Hence it could be concluded that the observed pH in the vermicompost obtained from VMW after digesting by earthworm is an optimum level for the plants to get available free nutrients for their better growth as it was also revealed in the pot culture experiment with black gram using the same vermicompost (Tables 2 and 3). Of the six macronutrients (N, P, K, Ca, Mg and C) and four micronutrients (Zn, Fe, Cu and Mn) analyzed in the raw and vermicompost samples, the levels of calcium and iron were relatively high when compared to other

Table 3. Mean values showing the total number of flowers, pods and seeds produced by black gram, *Vigna mungo* raised in pots using different PSR of vermicompost obtained from VMW after using them by earthworm, *Lampito mauritii*. Values are mean ± SD of eight plants; [a] Significant (P<0.01) over 0–PSR value; [b] Significant (P<0.05) over 0–PSR value; [c] Not significant (P>0.05) over 0–PSR value.

PSR	Total flowers	Total pods	Total seeds
50	13.50 ± 4.92[b]	12.50 ± 4.92[a]	83.00 ± 27.87[a]
25	12.00 ± 1.58[a]	11.12 ± 2.10[a]	72.37 ± 14.10[a]
20	11.12 ± 2.71[b]	9.75 ± 3.45[b]	62.75 ± 23.63[a]
10	10.12 ± 1.45[c]	8.50 ± 1.65[b]	50.50 ± 7.27[a]
5	9.25 ± 1.39[c]	7.50 ± 1.73[c]	41.75 ± 8.67[c]
0	8.50 ± 2.23	6.37 ± 2.44	31.50 ± 13.91

macro and micronutrients. It is important to note that while vermicomposting, the earthworm *Lampito mauritii* drastically increased the levels of all macro and micronutrients in all the PSR media over the levels in raw samples. This result was similar to the results of Edwards et al. (1995) where they found increased levels of N, P, K and Mg due to the effective action of earthworms through enhanced microbial activity on waste materials during vermicomposting. Kale (1988) also reported a significant increase in the available NPK in worm worked cow dung and sheep dung. Bano and Suseela Devi (1996) have also reported increased levels of macro and micronutrients in the vermicompost prepared from different organic wastes. Similarly Ramalingam (1997) has also noticed increased levels of macronutrients such as N, P, K, Ca and Mg in the vermicomposts obtained from individually and in combination of different organic wastes such as coir waste, pressmud, water hyacinth, farm wastes, farm yard manure and biogas slurry of pressmud and cattle dung after using them by *Lampito mauritii* and *Eudrilus eugeniae* individually. From the chemical analysis of vermicompost obtained from VMW after using them by earthworm it could be inferred that the above wastes at lower PSR levels were accepted and processed by earthworms resulting in the production of nutrient rich organic manure. Hence it can be concluded that the quality of vermicompost depends upon the quality of organic wastes used and upon the rates of degradation of organic wastes by the combined action of earthworm and microbes present in them. The present study proved that VMW serve as best raw materials for the production of nutrients rich organic fertilizer namely vermicompost.

Effects of Vermicompost on the Growth of Black Gram

Mean values of leaves, stem and petiole length and total number of flowers, pods and seeds produced by the black gram, *Vigna mungo* cultivated in pots using different PSR (50, 25, 20, 10, 5 and 0) of vermicompost obtained from VMW after using them by earthworm, *Lampito mauritii* are presented in Tables 2 and 3. The plants raised in soil alone showed poor growth and lower yield over the plants raised in other PSR media. The results observed in different vermicompost media revealed a differential growth and yield and followed the trend in accordance with PSR. One important observation noted in the growth study of black gram with vermicompost was that the plants raised in higher PSR (25 and 50) though showed improved growth but are severely affected with insect pest of saprophytic type due to their soft nature. This adversed effect may be attributed with more nitrogen and organic carbon present in the vermicompost (Table 1). This result proved that the application of vermicompost has a positive role on the growth and yield of black gram and also falls in line with many reports already made in other plants with vermicomposts obtained from different sources. There are experiments in which plants grown in pots with earthworms or their casts or vermicompost showed increased growth and yield. Kale and Bano (1986) found that the vegetative growth of plants was influenced by *Eudrilus eugeniae* worm cast in a better way than chemical fertilizers. Kale (1994) has recorded excellent growth and yield of cereals, pulses, oil seeds, spices, vegetables, fruits, ornamental plants, cash crops and plantation crops raised in vermicompost. Arulmurugan (1996) has also studied the effect of vermicompost and recorded an increase in plant height, root length, root volume, number of seeds per plant, protein and oil content of seeds together with increased uptake of NPK by soybean. Ramalingam (1997) has studied the differential effect of organic manures (cattle dung, farm yard manure and pressmud) and vermicomposts (obtained from farm waste + pressmud, water hyacinth + pressmud and water hyacinth + pressmud slurry) on the growth of tomato for 60 days from transplantation and found a many fold increase in the growth parameters of plants raised in soil with vermicompost over plants raised in soil with organic manure. Recently Bakthavathsalam and Deivanayaki (2007) have also noticed a significance influence of vermicompost with or without rhizobium on the growth and yield of black gram raised in pots. The mechanism whereby plant growth is stimulated by vermicompost or worm cast are not clear. However, it is believed that the stimulating effect observed in the growth and yield of black gram could be due to synergic action of several factors such as presence of polysaccharides (Tomati and Galli 1995), growth regulators (Tomati et al. 1988), enrichment of organic carbon, NPK, micro and macro nutrients, vitamins, enzymes, antibiotics and micro flora (Bakthavathsalam and Geetha 2004) and humic acid and humic substances (Phoung and Tichy 1976).

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