Dynamic Soil, Dynamic Plant ©2012 Global Science Books

Biomanagement of Sugar Factory Pressmud through Vermitechnology for the Growth and Yield of a Pulse Crop, Black Gram (*Vigna mungo*)

Muthukaruppan Gobi* • Paramasamy Gunasekaran

Department of Genetics, School of Biological Sciences, Madurai Kamaraj University, Madurai 625 021, Tamilnadu, India

***Corresponding author*: * gobic2001@yahoo.com, pguna@eth.net**

ABSTRACT

Vermicompost (VC) of sugar factory pressmud (PM) using two different species of earthworms, *Eudrilus eugeniae* and *Lampito mauritii* was prepared. Plant nutrient contents of these VC and their effects on black gram (*Vigna mungo* L) growth in relation to the effects of sole soil were investigated. VC produced by the two species of earthworms differed in their nutrient concentrations. But possessed higher concentration of total N and Ca than that of the control. The results showed that effects of VC are more efficient for the vigorous production of black gram. VC had significant positive effects on flower number, leaf growth, shoot length, root length, number of leaves, leaf area index, wet weights and dry weights compared to control. It is also suggested that PM compost is more favorable for vigorous production of black gram and maintenance of soil environment.

Keywords: *Eudrilus eugeniae*, *Lampito mauritii*, pressmud, pot culture

Abbreviations: EC, electrical conductivity; **PM**, pressmud; **VC**, vermicompost; **LAI**, leaf area index

INTRODUCTION

Human and animal activities generate large quantities of organic residuals. In India a large fraction of these residuals is wasted and dumped into the environment, thus causing overloading on land or in water bodies. Overloading, in turn leads to environmental pollution. It is estimated that about 60 billion tons of organics are produced globally every year. Much of this is wastefully respired in manmade processes as well as in the litter respiration in nature. The value of these organics is about 10 times the fossil energy consumed in 1995 (Meili 1995).

Agriculture provides employment for about 60% of the population (Onayemi 1981), However there is a wide gap between food production and need of the population. FAO projection shows that there is going to be an additional 2.6 billion mouths to feed by 2025. The demand for basic staple food is expected to increase at an annual rate of 2.6% over 20-30 years. Shrinking sources of available farmland compounds the problem. It is mainly through sustainable farming we can solve this global problem.

Sugarcane is one of the most important commercial crops of India producing more than 300 mt of cane every year (Patil 2001). It is to be mentioned that the total available pressmud (PM) in India is about 35,000 tones/day (Programme Objective Series: PROBES/111/2006-2007, CPCB 2007). It is a vast storehouse of macro and micronutrients besides being an effective soil ameliorant. Usually, PM that is produced is about 3% of the cane weight crushed. A factory of 2000 T.C.D produces 60-70 tones of PM/day. There are about 22 sugar factories in Tamilnadu, which will give about 5 lakh tones of PM. The factories have the problem of handling and storing and it is usually about Rs.4501/ton in wet conditions. As it dries in the stocking point, it is given to self-combustion, which virtually adds fuel to fire.

The management of industrial wastes is relatively easy compared to the management of municipal or urban wastes as the generation of industrial wastes is mostly from point of sources and that too of a known and less complex composition. The management of solid wastes from agro-based industries has even further advantage in the sense that the characterization of these wastes do not vary much from unit to unit within same agro-based industrial sector. This implies that the wastes generated from agro-based industries need to be studied on priority from the point of possible energy recovery. Composting of such materials in a methodical manner will turn the organic waste into bio-resources. There is needed to make use of environmental resources for development instead of creating pollution by their mismanagement (Prapurna and Shashikanth 2002).

Applications of biotechnology for conversion of PM into a useful biomass would not only solve the waste disposal problem but would also indirectly meet the growing energy crisis of developing countries (Vijayakumari *et al*. 1988). PM has previously been shown to be a substrate for vermicomposting (Parthasarathi and Ranganthan 2002) and give a product rich in chelating and phytohormonal elements with a high microbial content and stabilized humic substances (Atiyeh *et al*. 2001). Further, combining vermicomposting with composting also accelerates the composting process thus reducing the time required for composting (Frederickson *et al*., 1997; Ndegwa and Thompson 2001). Hence this material here was subjected to biological treatment. The present work was undertaken for proper management of sugar factory PM, treat through vermitechnology by employing an exotic earthworm *Eudrilus eugeniae*, and an indigenous earthworm *Lampito mauritii*.

MATERIALS AND METHODS

The sugar factory PM was collected from the Dharani Sugars and Chemicals Ltd, Vasudevanallur. The bulking agent saw dust; was collected from nearby sawmills. The sugar factory PM freshly obtained had high water content. To reduce the excess heat and volatile matter, the heaped PM was well spread and sun dried.

Received: 20 February, 2011. Accepted: 29 August, 2011.

Original Research Paper

Vermicomposting

The freshly collected and dried industrial waste material PM was mixed with bulking agent (saw dust) at 2:1 ratio, in which 2 kg of saw dust mixed with 4 kg of PM, and PM alone was used as control. The above mixed waste materials were placed in 125 × 62.5 × 25 cm size vermipits in the ground. The exotic earthworm, *E. eugeniae* and *L. mauritii* were inoculated separately, in which 4 earthworms/kg were inoculated and the whole setup was replicated.

Pot culture studies for black gram

The present study was carried out to determine the impact of vermicompost (VC) prepared from PM on the morphological and yield characteristic of black gram in earthen pots. Pots of 23.5 cm height and 20.5 cm inner diameter each with 5 kg of mixture, sole agricultural field soil mixed with VC were used. The pot experiment with three treatments each with five replicates was set up in a randomized block design.

The plants were cultivated in the medium designed with the following permutation and combinations. The certified seeds of the pulse crop *Vigna mungo* variety CO-1 was selected for the study were procured from the regulated market. The selected seeds were washed with deionised water and surface sterilized with 0.1 mercuric chloride solution to keep off from spores of fungi and was sown in pots. The experiment was run for a period of 60 days. Plants cultivated in the pots were watered regularly and from the wet medium five plants were removed gently from each treatment. The plants were washed in clean water to remove the adhered soil particles and the excess water was removed with the help of filter paper and the following morphological characteristics were measured every fortnight. The following morphological parameters were measured: root length, shoot length, number of leaves, number of nodules, fresh weight, dry weight, number of pods, number of seeds/pod and weight of seeds (Puttaswamy *et al.* 1976):

$$LAI = K (L \times W)$$

where, LAI = leaf area index, K = correlation factor, L = length of the terminal leaflet (cm), W = maximum width of the terminal leaflet (cm).

The data on various physico-chemical and field data of the samples were fed into the computer and mean values with standard deviation were obtained. Statistical significance on the basis of the *F*-test (analysis of variance) was determined by using Microsoft Excel.

RESULTS AND DISCUSSION

The nutrient status of VC of PM made with two different species of earthworms presented in **Table 1** showed that the PM VC processed by *Eudrilu*s possessed a slightly higher nutrient content than the PM VC composted by *Lampito* and the control.

The pH of initial PM value was 7.01 ± 0.05. The pH of PM compost showed significant variation when compared to others. The overall increase of pH may be attributed to the decomposition of nitrogenous substrates resulting in the production of ammonia. The pH of the PM was slightly acidic range from 7.01 ± 0.05 before composting and after composting the values changed towards alkali. The pH of the composts after composting was 7.92 ± 0.08 for *Eudrilus* compost and 8.06 ± 0.02 for *Lampito* compost. High solubility of nutrients in earthworm casts increase the pH of cast (Barley 1961; Khwairakpam and Bhargava 2009). One possible reason for this may be the neutralization of soil as it passes through the earthworms gut, through secretion of the calciferous glands. The observed pH 7.92 ± 0.08, 8.06 ± 0.02 in the present study was found to be at par with above results, supporting increase in biomass, fecundity and cast production of the earthworms.

The mean electrical conductivity (EC) of the initial PM was 1.15 ± 0.02 mS/cm. The gradual increase of EC was observed in all experiments including control from its initial value. The final EC recorded was 1.201 ± 0.01 mS/cm and 1.091 ± 0.28 mS/cm for *Eudrilus* and *Lampito* compost, respectively. The increase in EC might have been due to the decomposition of organic matter and release of different mineral salts in available forms (Kaviraj and Sharma 2003). The increase of EC in VC when compared to the control might be due to the presence of exchangeable calcium, magnesium and potassium in worm cast as reported by other researchers (Balamurugan 2002). However, the amount of N, P, K and micronutrients in PM VC were higher than in control. The amounts of minerals differed in treatment groups; this could be attributed to variations in growth and multiplication rate of the earthworms in the PM, which resulted in a differential pattern of uptake of the nutrient for their body synthesis and subsequent release of the remaining minerals in a mineralized form (Loh *et al.* 2005; Karmegam and Daniel 2009; Sangwan *et al*. 2010).

Table 1 Physico-chemical and microbial parameters were analyzed in raw pressmud.

Parameters	Pressmud	*Eudrilus* compost	*Lampito* compost
pH	7.01 ± 0.05	7.25 ± 0.08	6.94 ± 0.02
EC (m.mhos/cm)	1.15 ± 0.02	1.201 ± 0.01	1.091 ± 0.28
Nitrogen (%)	1.18 ± 0.250	1.67 ± 0.34	1.82 ± 0.06
Phosphorous (%)	1.02 ± 0.12	3.09 ± 0.06	3.28 ± 0.05
Potassium (%)	0.42 ± 0.07	0.72 ± 0.26	0.76 ± 0.17
Calcium (%)	4.530 ± 0.23	5.164 ± 0.02	4.935 ± 0.16
Magnesium (%)	0.81 ± 0.05	1.12 ± 0.31	1.24 ± 0.31
Iron (%)	0.25 ± 0.12	0.37 ± 0.02	0.41 ± 0.42
Copper (mg/l)	110 ± 0.24	129 ± 0.02	118 ± 0.06
Zinc (mg/l)	200 ± 0.31	249 ± 0.34	240 ± 0.18
Manganese (mg/l)	213 ± 0.41	273 ± 0.05	249 ± 0.67
Organic carbon (%)	34.86 ± 1.29	19.53 ± 0.92	23.38 ± 1.11

After composting, the nitrogen values significantly increased over control in both VCs. The increasing trend in nitrogen in the vermibeds was also reported by Ramalingam (1997) and Balamurugan (2002). Of the total nitrogen excreted by worms, about another half is secreted as mucoproteins by gland cells found in the epidermis and half in the form of ammonia, urea and possibly uric acid as allantoin in a fluid execrated from nephridiopores. Earthworm might increase nitrogen availability by reducing microbial immobilization. Therefore the variation in increased percentage of nitrogen over control in compost with each different species of could have been due to the varying number of microorganisms present in the different concentration of the substrates and the palatability of the substances by earthworms.

Increase in phosphorus during vermicomposting is complex organic combination such as phospholipids, nucleo protein and calcium phosphate. The initial and final values of potassium in different concentrations PM compost revealed that potassium increased progressively more than control. The presence of large number of microflora in the gut of earthworm might play an important role in increase P and K content in the process of vermicomposting (Kaviraj and Sharma 2003). The value of calcium at the end of compost formation was more than the control. There are two possible reasons for increase of calcium content in compost. One is the soil particles in the worm intestine are found to be cemented by calcium humate formed from the intestine organic matter and calcite excreted by the calciferous glands (Satchell 1967). The Ca level was high due to the addition of lime during the clarification of cane juice.

The initial and final values of the micronutrients such as magnesium, manganese, copper, iron and zinc revealed that the main reason for the increase in the micronutrients in the VC. Several investigators reported that increased amounts of micronutrients in VC (Parthasarathi and Ranganathan 1999, 2000; Bansal and Kapoor 2000; Kaushik and Garg 2003). Increase in Mg, Cu, Mn, Zn and Fe in the PM VC seems to be due to effective decomposition of PM while passing through the gut of earthworms leading to an en-

Table 2 Morphological parameters of black gram.

Parameters	Treatment	Days			
		15th day	30th day	45th day	60th day
Root length	Control	3.04 ± 0.25	3.16 ± 0.40	5.52 ± 1.02	3.2 ± 0.51
	Eudrilus compost	2.64 ± 0.26	2.78 ± 0.23	4.22 ± 0.50	3.9 ± 0.36
	Lampito compost	2.76 ± 0.18	3.96 ± 0.16	5.12 ± 0.56	5.36 ± 0.46
	F- test	0.7532NS	4.360*	0.8203NS	5.938*
Shoot length	Control	19.66 ± 0.72	17.7 ± 0.37	17.5 ± 1.46	18.96 ± 1.31
	Eudrilus compost	24.28 ± 1.03	18.88 ± 1.34	17.56 ± 1.22	19.72 ± 0.52
	Lampito compost	23.72 ± 0.81	18.8 ± 0.37	21 ± 1.15	20.42 ± 1.08
	F- test	8.4857*	0.6239NS	2.4307NS	0.5067NS
Leaf area index	Control	2.07 ± 0.67	10.29 ± 0.12	17.94 ± 2.36	16.25 ± 1.00
	Eudrilus compost	4.63 ± 1.19	13.44 ± 3.24	25.49 ± 1.64	26.04 ± 1.79
	Lampito compost	4.743 ± 1.18	12.21 ± 0.03	18.97 ± 2.57	18.06 ± 1.26
	F- test	2.094NS	1.576NS	3.062NS	0.2539NS
Number of root nodules	Control	26 ± 3.21	27.6 ± 1.94	30 ± 2.19	12.4 ± 2.04
	Eudrilus compost	31.2 ± 1.99	30.8 ± 3.83	20.8 ± 1.02	25.3 ± 1.20
	Lampito compost	37.4 ± 7.10	28.4 ± 3.06	37.2 ± 2.87	18.0 ± 3.23
	F- test	1.5150NS	0.2997NS	14.39*	3.43NS
Number of leaves	Control	5.0 ± 0.00	8.2 ± 0.37	11.2 ± 1.91	12.6 ± 1.12
	Eudrilus compost	7.4 ± 0.60	10.2 ± 0.73	9.2 ± 0.37	12.6 ± 1.60
	Lampito compost	8.0 ± 0.00	11 ± 0.54	16.8 ± 1.53	16.2 ± 0.80
	F- test	21.00*	6.3673*	7.607*	2.905NS
Inter-nodal length	Control	2.58 ± 0.37	1.86 ± 0.08	3.24 ± 0.27	2.32 ± 0.29
	Eudrilus compost	4.06 ± 0.16	3.88 ± 0.33	4 ± 0.59	2.18 ± 0.13
	Lampito compost	4.78 ± 0.29	3.5 ± 0.25	5.88 ± 0.52	2.84 ± 0.34
	F- test	14.95*	18.68*	7.825*	1.623NS
Fresh weight	Control	0.62 ± 0.08	1.21 ± 0.15	2.97 ± 0.30	3.28 ± 0.37
	Eudrilus compost	1.07 ± 0.08	1.80 ± 0.18	2.73 ± 0.40	5.44 ± 0.87
	Lampito compost	1.04 ± 0.03	1.75 ± 0.18	4.74 ± 0.49	5.67 ± 0.26
	F- test	11.17*	3.4881NS	7.283*	5.347*
Dry weight	Control	0.39 ± 0.03	0.15 ± 0.02	2.02 ± 0.21	2.29 ± 0.41
	Eudrilus compost	0.51 ± 0.02	0.54 ± 0.07	1.88 ± 0.33	3.81 ± 0.72
	Lampito compost	0.58 ± 0.02	0.226 ± 0.04	3.22 ± 0.38	4.35 ± 0.24
	F- test	12.10*	36.39*	5.301*	4.540*

Mean ± SE; NS- Not significant; *- Significant at $P < 0.05$

hanced mineralization rate, higher microbial and enzymatic activities in the gut as well as in the VC; mucus contribution from the gut of earthworm and incorporation of dead earthworm biomass into the compost (Domínguez 2004; Suthar 2007).

Pot culture studies of black gram

Effects of the VC produced by *E. eugeniae* and *L. mauritii* on black gram (*V. mungo*), in relation to that of sole soil, soil mixed with VCs presented in **Table 2**. Quality of the compost was tested using them as organic fertilizer for black gram. A pot culture experiment was carried out for determining the growth studies.

1. Root length

The average root length (cm) of the plants grown in pot applied with three different treatments is given in **Table 2**. In general the root length of the plant grown is three different composts have increased gradually from the first day to 60th days and it was more than that of control. The maximum root length of 5.36 ± 0.46 was recorded in *L. mauritii* compost and followed by *E. eugeniae* compost (3.9 ± 0.36) and control (3.2 ± 0.51), respectively.

2. Shoot length

The average shoot length (cm) of the plants was recorded once in every fortnight and present in **Table 2**. Application of different treatments performed significantly and varied widely over the control. The shoot length was found to increase gradually in all experiments. The maximum shoot length of the plants grown in the *Eudrilus* compost was recorded on 15th, 30th and 60th day and it was 24.28 ± 1.03, 18.88 ± 1.34 and 19.72 ± 0.52. Plants grown in *Lampito* compost showed maximum shoot length on the 30th, 45th and 60th day.

3. Number of leaves

The number of leaves/plant is important yield contribution parameters of black gram. The number of leaves/plant showed variations by the applications of treatment. The number of leaves was increased gradually with time and reached its peak at harvest in respect of all treatment. At 15th day the number of leaves per plant ranged from 5 to 8. The maximum number of leaves/plant 8.0 was observed in *Lampito* compost and the minimum number of leaves per plant was found in the control. At harvest, the number of leaves per plant was more than previous growth period. Application of two different vermicompost markedly influenced the number of leaves per plant and maximum number of leaves (16.2) was produced by *Lampito* compost applied black gram.

4. Leaf area index

LAI (cm^2) of black gram was significantly influenced by treatments at different growth period. The LAI was gradually increased up to harvest of the crop. At 15th day, the LAI varied significantly by the application of two different vermicompost. The application of *Lampito* compost produced maximum LAI (4.743) and followed by *Eudrilus* compost treated of 4.63. The smallest LAI (2.07) was found in control. At 60th day, the largest LAI of black gram remarkable influenced due to the application of vermicompost. The *Eudrilus* compost caused the maximum LAI (26.04) which was statistically non significant and it was 18.06 in *Lampito* compost.

5. Number of nodules

The number of root nodules was significantly influenced by different treatments. The root nodules ranged from 37.4 to 26 in different treated pots. The maximum number of root nodules (20.8 ± 2.68) was found by the application of *Eudrilus* compost followed by *Lampito* compost (18.0 ± 3.23) on 60th day. It was found to gradually decrease from the first day. All the treatments shows similar trend of decrease.

6. Internode length

The mean internodal length of the plants in each treatment is given in **Table 2**. The internodal length of all the plants was higher on 45th day. But it was gradually reduced at 60th day.

7. Fresh weight

The fresh weight (g) of each treatment plant has increased gradually during the growth in respect of the root length and shoot length. Plants grown in *Eudrilus* compost showed increased fresh weight in (5.44 ± 0.87) on the 60th day. Likewise plants grown in *Lampito* compost exhibited more fresh weight in (5.67 ± 0.26) on the 60th day.

8. Dry weight

The dry weight (g) was significantly increased in different treatments over control (**Table 2**). The total dry weight of black gram ranged from 0.39 to 4.35. The maximum dry weight (4.35 ± 0.24) was observed in *Lampito* compost on the 60th day. The data on dry weight revealed that as in fresh weight, the maximum dry weight (3.22 ± 0.38) was recorded in *Eudrilus* compost on the 60th day.

9. Number of pods/plant

The number of pods/plant showed significant variations by the application of treatments at different vermicompost. On the 60th day the number of pods per plant was found to be similar in both *Eudrilus* compost (2.6 ± 1.25) and *Lampito* compost (2.6 ± 0.40). The number of pods was found to be minimum in the control pots.

10. Total weight of yield

Application of different VC influenced the fresh yield (g) of black gram (**Table 3**). The *Eudrilus* compost applied pots showed a maximum yield (17.59) which was 93.72% yield increase over the control. Application of *Lampito* compost produced the yield increase (13.86) by 52.64% over the control.

The length of the root increased steadily during the growth of plants. The maximum root length was recorded in *Lampito* compost over control and other experiments. The growth of shoot length also was found to increase gradually in all the experiments. The maximum length of shoot among treatments was recorded in (20.42 ± 1.08) *Lampito* compost on the 60th day. Control plants had minimum growth in all experiments during all the stages of growth. Significant difference was observed in control. Nijhawan and Kanwar (1952) have observed similar results of increased root length than the control on application of earthworm compost to wheat. A similar effect in Salvia and Aster grow in the pots was observed by Grappelli *et al.* (1985). Increase in crop growth due to the transport of minerals and other compounds from deep down to the surface soil by the earthworms were found by Sharma (1986). Maximum number of root nodules was found on the 60th day in *Lampito* compost and it was found that the root nodules gradually increased from the first fortnight. The minimum number of nodules was found in roots of control plants.

Kale *et al.* (1992) have also reported that the significant increase in the colonization of the microbes (total microbes, nitrogen fixers, actinomyces and spores formers) in the experimental plots, which received half the recommended dose of fertilizers and the VC over control. The presence of increased number of bacterial population in the present study is in accordance with the above result. The soil nutrients and physical properties may be another reason for the maximum number of root nodules, Haimi and Huhta (1987) inferred that the VC could be considered superior to conventional compost especially with regard to its physical make up. Improvement of physical properties cardinal to soil health result in better oxygen and waste supply to root system (Aina 1984). The plant roots could grow well coupled with increased microbial population and the number of nodules also enhanced significantly over the control due to the improved physical structure of VC.

Table 3 Average total weight of yield (g) of *V. mungo* in different treatments.

Days	Control	*Eudrilus* compost	*Lampito* compost
Total weight of yield (g)	9.08	17.59	13.86
% of yield increase over control	0	93.72	52.64

The data on dry weight reduced that as in fresh weight the maximum dry weight was recorded in all the two composts. Plants in *Eudrilus* and *Lampito* composts showed in increase dry weight in 3.81 ± 0.72 and 4.35 ± 0.24, respectively on the 60th day. This may be one of the reasons for an increased weight of the plant on fresh and dry weight basis. Shuxin *et al.* (1991), who studied the dry weight of the plant by applying worm cast in soybeans found that 40-70% increase due to the nutrient absorption by the plant and the nitrogen absorbed by the plants from soil was increased by 30-50%. Hence it is clear that the worm cast can boost the yield of the vegetative growth as well as the yield.

Several studies have examined the effect of VC on growth and yield of vegetables in container growth media. These studies showed that increases in growth and yield at low amounts of VC in the potting medium could probably be due to improvement in the physicochemical properties of the container medium, increase in enzymatic activity, increases in microbial diversity and activity, nutritional factors and plant growth regulators (Tomati and Galli 1995; Atiyeh *et al.* 2000; Arancon *et al.* 2004).

Results obtained from this experiment revealed that growth and yield parameters such as leaf area, dry shoot weights and weight of fruits were significantly affected by applying VC. The LAI is an important factor in black gram growth. Since it is related to photosynthesis and dry matter accumulation, an appropriate LAI should be maintained by planting at optimal density and avoiding excessive pruning. Increasing the soil fertility will promote better growth and higher leaf area and hence increase the LAI. More foliage indicates better light interception and increase photosynthesis.

Results of similar trends i.e. maximum record on applying VC alone with recommended dose of chemical fertilizer in various crops were observed by various researchers, which agree with the present findings. Bawa (1995) found that application of VC at 10 tons/hectare along with recommended dose of nitrogen and phosphorus resulted in 55% increase in dry pod yield over the treatments receiving only recommended dose of nitrogen and phosphorus. Soya bean seeds pelleted with VC at 50 g/Kg resulted in increase of pod yield by 16% (Dharmalingam 1996). Palanisamy (1996) found 40% increase in yield of wheat when he applied the cast in soil.

Mishra *et al.* (2005) showed that VC had beneficial effects on growth and yield of rice, especially caused significant increase of many growth parameters, seed germination, chlorophyll concentration and yield. Similar results were noted by Maynard (1995), who reported that tomato yields in field soils amended with compost were significantly greater than those in the untreated plots. Arancon *et* *al.* (2004) reported positive effects of VC on the growth and yield in strawberry, especially increases leaf area, shoot dry weight and fruit weight in field conditions. The results of this experiment showed that the increase in growth and yield of black gram with addition of VC is associated with greater uptake element nutrients such as P, K, Fe and Zn. The available nutrient status of soil was greatly enhanced by the application of VC as an organic source (Prabha *et al.* 2007).

Norman *et al*. (2005) found out an increasing growth and yield of pepper may be to the application of VCs to soils which increased the microbial biomass, humic materials and plant growth influencing substances. Similarly strawberry (*Fragaria ananassa*) growth and yield increased significantly, including increases of up to 37% in leaf area, 37% plant shoot biomass, 40% number of flowers, 36% in number of plant runners and 35%in marketable fruit weight (Arancon 2004). Higher growth, yield, quality of turmeric (Sanwal *et al*. 2007) and tomato and okra were also reported when VC was applied (Premshekhar and Rajashree 2009a, 2009b). Prabha *et al*. (2007a) showed that growth parameters (root length, shoot length, number of leaves) of vegetables *Hibiscus esculentus* and *Salanum melongena* and medicinal plants (*Adhatoda vasica* and *Solanum trilobatum*) showed higher values in VC applied after 90days.

CONCLUSION

In the present study, black gram showed significantly higher growth in plant root length, shoot length, leaf number, leaf area index, wet weight and dry weight in the mixture of VC and control plants. The plants showed maximum growth in the aforementioned characteristic in the mixture of VC produced by *E. eugeniae*, which indicated its superiority over the VC produced by other species of earthworms and even the control. The higher growth of various plant characteristic in VC compared to control was not only because of the presence of greater amounts most of the plant nutrients but also due to the presence of microbial metabolites, the plant growth promoting hormones like substances. The earthworm cast and VC influenced the development of the plants and promoted stem elongation, root initiation and root biomass, which suggest the linkage between biological effects of VC and microbial metabolites that influence the plant growth and development. However the quality of VC and its effects on plant growth may depend on a variety of factors on plant growth may depend on a variety of factors, which needs further investigations.

REFERENCES

Aina PO (1984) Contribution of earthworms to porosity and water infiltration in a tropical soil under forest and long-term cultivation. *Pedobiologia* **26**, 131-136

Arancon NQ, Edwards CA, Atiyeh RM, Metzger TD (2004) Effect of vermicomposts produced from food waste on the growth and yields of green house peppers. *Bioresource Technology* **93**, 139-144

Arancon NQ, Edwards CA, Bierman P, Welch C, Metzger JD (2004) Influences of vermicomposts on field strawberries: 1. Effects on growth and yields. *Bioresource Technology* **93**, 145-153

Atiyeh RM, Arancon N, Edwards CA, Metzger TD (2000) Influence of earthworm processed pig manure on the growth and yield of greenhouse tomatoes. *Science Digest* **75**, 175-180

Atiyeh RM, Arancon NQ, Edwards CA, Metzger JD (2001) The influence of earthworm processed pig manure on the growth and productivity of marigolds. *Bioresource Technology* **81**, 103-108

Balamurugan V (2002) Physico-chemical and microbial perspectives of vermicompost produced by *Eisenia fetida* (Savigny), *Eudrilus eugeniae* (Kinberg) and *Lampito mauritii* (Kinberg) with note on their fecundity and growth studies in ten different organic wastes. PhD thesis, Manonmaniam Sundarnar University, Tirunelveli, India, 88 pp

Bansal S, Kapoor KK (2000) Vermicomposting of crop residues and cattle dung with *Eisenia fetida*. *Bioresource Technology* **73**, 95-98

Barley KP (1961) Abundance of earthworms in agricultural land and their possible significance in agriculture. *Advances in Agronomy* **13**, 249-268

Bawa JN (1995) Studies on the effect of different organic manures, chemical fertilizers and growth promoter on growth, yield and quality of rabi hot weather groundnut (*Arachis hypogea* L.) under Later Tic Sols of Kongen Region. MSc thesis, Konkan Agricultural University, Dapoli, 19 pp

Dharmalingam C (1996) *Vermicompost Pelleting Enhances Productivity in Soybean.* In*: Notes on National Training on Vermiculture Prepared by Directorate of Extension Education*, Tamilnadu Agricultural University, Coimbatore, 50 pp

Domínguez J (2004) State-of-the art and new perspectives on vermicomposting research. In: Edwards CA (Ed), *Earthworm Ecology*, Second Ed. CRC Press, pp 401-424

Frederickson J, Butt KR, Morris RM, Daniel C (1997) Combining vermiculture with traditional green waste composting systems. *Soil Biology and Biochemistry* **29 (3-4)**, 725-730

Grappelli A, Tomati V, Galli E (1985) Earthworm casting in plant propagation. *Horticulture Science* **20**, 874-876

Haimi J, Huhta V (1987) Comparison of composts produced from identical wastes by vermistabilization and convential composting. *Pedobiologia* **30**, 137-144

Kale RD, Mallesh BC, Bano K, Bagyaraj DJ (1992) Influence of vermicompost application on the available macro-nutrients and selected microbial populations in a paddy field. *Soil Biology and Biochemistry* **24 (12)**, 1317-1320

Karmegam N, Daniel T (2009) Investigating efficiency of *Lampito mauritii* (Kinberg) and *Perionyx ceylanensis* Mich. for vermicomposting of different types of organic substrates. *Environmentalist* **29**, 287-300

Kaushik P, Garg VK (2003) Vermicomposting of mixed solid textile mill sludge and cow dung with the epigeic earthworm, *Eisenia fetida*. *Bioresource Technology* **90**, 311-316

Kaviraj B, Sharma S (2003) Municipal solid waste management through vermicomposting employing exotic and local species of earthworms. *Bioresource Technology* **90**, 169-173

Khwairakpam M, Bhargava R (2009) Bioconversion of filter mud using vermicomposting employing two exotic and one local earthworm species. *Bioresource Technology* **100**, 5846-5852

Loh TC, Lee YC, Liang JB, Tan D (2005) Vermicomposting of cattle and goat manures by *Eisenia foetida* and their growth and reproduction performance. *Bioresource Technology* **96**, 111-114

Lui S, Xiang D-H, Wu D-B (1991) *Studies on the Effect of Earthworms on the Fertility of Red Arid Soil.* In: Veeresh GK, Rajagopal D, Viraktamath CA (Eds) *Advances in Management and Conservation of Soil Fauna*, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, pp 543-546

Maynard AA (1995) Cumulative effect of annual additions of MSW compost on the yield of field growth tomatoes. *Compost Science and Utilization* **3**, 47-54

Meili M (1995) *Biogeochemical Cycles, in Encyclopedia of Environmental Biology* (Vol 1), Academic Press, New York, pp 235-248

Mishra MS, Rajani K, Sahu-Sanjat K, Padhy-Rabindra N (2005) Effect of vermicomposted municipal solid wastes on growth, yield and heavy metal contents of rice (*Oryza sativa*). *Fresenius Environmental Bulletin* **14**, 584-590

Ndegwa PM, Thompson SA (2001) Integrating composting and vermicomposting in treatment and bioconversion of biosolids. *Bioresource Technology* **76**, 107-112

Nijhawan SD, Kanwar JS (1952) Physico-chemical properties of earthworm casting and their effect on the productivity of soil. *Journal of Indian Society of Soil Science* **22**, 357-372

Norman QA, Edwards CA, Bierman P, Metzger JD, Lucht C (2005) Effects of vermicomposts produced from cattle manure, food waste and paper waste on the growth and yield of peppers in the field. *Pedobiologia* **49**, 297-306

Onayemi O (1981) Post-harvest of loss management in Nigeria. *Industrial Environment* **Jan/Feb**, 5-7

Palanisamy S (1996) Earthworms and plant interactions. In*: Notes on National Training on Vermiculture Prepared by Directorate of Extension Education*, Tamilnadu Agricultural University, Coimbatore, pp 42-46

Parthasarathi K, Ranganathan LS (1999) Longevity of microbial and enzyme activity in and their influence on NPK content in pressmud vermicasts. *European Journal of Soil Biology* **35 (3)**, 107-113

Parthasarathi K, Ranganathan LS (2000) Aging effect on enzyme activities in pressmud vermicasts of *Lampito mauritii* (Kinberg) and *Eudrilus eugeniae* (Kinberg). *Biology and Fertility of Soils* **30**, 347-350

Parthasarathi K, Ranganathan LS (2002) Supplementation of pressmud vermicasts with NPK enhances growth and yield in leguminous crops (*Vigna mungo* and *Arachis hypogaea*). *Journal of Current Science* **2**, 35-41

Patil RH (2001) Enriched preparation using sugarcane trash. *Kisan World* **28 (8)**, 19-20

Prabha ML, Indira AJ, Jayaraj R, Srinivas Rao D (2007) Effect of vermicompost and compost on growth parameters of selected vegetable and medicinal plants. *Asian Journal of Microbiology, Biotechnology and Environmental Science* **9 (2)**, 321-326

Pranha KP, Loretta YL, Usha RK (2007) An experimental study of verminbiowaste composting for agricultural soil improvement. *Bioresource Technology* **99**, 1672-1681

Prapurna N, Shashikanth K (2002) Pollution level in Hussain Sagar Lake of Hyderabad - a case study. *Journal of Pollution Research* **21**, 187-190

Premsekhar M, Rajashree V (2009a) Influence of organic manures on growth yield and quality of tomato and the residual performance of cowpea. *Green Farming* **2 (5)**, 272-274

Premsekhar M, Rajashree V (2009b) Influence of organic manures on growth yield and quality of okra. *American-Eurasian Journal of Sustainable Agriculture* **3 (1)**, 6-8

Programme Objective Series: PROBES/111/2006-2007 (2007) *Bio-Methanation Potential of solid Wastes from Agro-Based Industries*, Centre Pollution Control Board, New Delhi, 2 pp

Puttasamy S, Thinmagowda S, Krishnamoorthy K (1976) Determination of leaf area in pulses. *Current Research* **5 (3)**, 48-57

Ramalingam R (1997) Studies on the lifecycle, growth and population dynamics of *Lampito mauritii* (Kinberg) and *Eudrilus eugeniae* (Kinberg) cultured in different organic wastes and analysis of nutrient and microbes of vermicompost. PhD thesis, Annamalai University, India, 94 pp

Sangwan P, Kaushik CP, Garg VK (2010) Vermicomposting of sugar industry waste (press mud) mixed with cowdung employing an epigeic earthworm *Eisenia fetida*. *Waste Management Research* **28**, 71-75

Sanwal SK, Laxminarayan K, Yadav RK, Rai N, Yadav DS, Mousumi B (2007) Effect of organic manures on soil fertility, growth, physiology, yield and quality of turmeric. *Indian Journal of Horticulture* **64 (4)**, 444-449

Satchell JE (1967) Lumbricidae. In: Burgess A, Raw F (Eds) *Soil Biology*, Academic Press, London, pp 259-322

Sharma N (1986) Recycling of organic wastes through earthworms for crop growth. PhD thesis, Indian Institute of Technology, New Delhi, 102 pp

Suthar S (2007) Vermicomposting potential of *Perionyx sansibaricus* (Perrier) in different waste materials. *Bioresource Technology* **98**, 1231-1237

Tomati U, Galli E (1995) Earthworm, soil fertility and plant productivity. *Acta Zoologica Fennica* **196**, 11-14

Vijayakumari J, Nirmala KM, Usha K (1988) Biodegradation of coir pith. *Indian Journal of Agricultural Science* **59**, 316-318