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Effect of Vermicompost and Chemical Fertilizer on Growth and Yield of Hyacinth Bean, *Lablab purpureus* (L.) Sweet.

Natchimuthu Karmegam[1*] • Thilagavathy Daniel[2]

[1] Department of Biotechnology, V.M.K.V. Engineering College, Vinayaka Missions University, Periya Seeragapadi, Salem-636 308, Tamil Nadu, India
[2] Department of Biology, Gandhigram Rural University, Gandhigram-624 302, Dindigul District, Tamil Nadu, India

Corresponding author: * **kanishkarmegam@gmail.com**

ABSTRACT

A 180-day field trial (Randomized Block Design) was carried out with 14 different treatments, using vermicomposts of *Polyalthia longifolia* leaf litter + cowdung (1:1, VC-PL), pearl millet cobs + cowdung (1:1, VC-PT) and a weed, *Rottboellia exaltata* + cowdung (1:1, VC-RE), chemical fertilizer and combination of vermicompost and chemical fertilizer with *Lablab purpureus* (L.) Sweet. The results of the study showed that all the growth and yield parameters i.e. leaf area index, total chlorophyll content of leaves, dry matter production, number of primary branches per plant, day of first flower appearance, length of fruits, dry weight of 100 seeds, yield (fruit) per plant, yield per plot and yield per hectare were significantly higher in the plots which received vermicompost, chemical fertilizer and vermicompost + chemical fertilizer mixture than in the control plots ($P<0.05$). The highest fruit yield (fresh weight) of 109 tonnes ha^{-1} was recorded in the treatment which received 2.5 tonnes of vermicompost (VC-RE prepared using *Perionyx ceylanensis*) + ½ dose of recommended NPK ha^{-1}, while it was 61.9 tonnes ha^{-1} in control plots without vermicompost and/or chemical fertilizer. The available soil nutrients (nitrogen, phosphorus and potassium) were higher in the plots which received vermicompost than in the plots that received chemical fertilizer and those that received chemical fertilizer + vermicompost mixture. The uptake of nutrients by the plants was high in the plots which received chemical fertilizer + vermicompost mixture over the plots which received chemical fertilizer and vermicompost. The available NPK after harvest in soil collected from the plots treated with chemical fertilizers were 244, 32.9 and 100 kg ha^{-1} which were higher than in the control plots and lower than in the plots that received chemical fertilizer + vermicompost mixture. The available NPK values in soil which received VC-RE prepared using *P. ceylanensis* + ½ dose of recommended NPK ha^{-1} were 262, 45.2 and 110 kg ha^{-1}, respectively.

Keywords: organic wastes, plant growth, soil available NPK
Abbreviations: DAS, day after sowing; **DMP**, dry matter production; **LAI**, leaf area index; **LM**, *Lampito mauritii*; **NPK**, nitrogen, phosphorus and potassium; **PC**, *Perionyx ceylanensis*; **PL**, leaf litter of *Polyalthia longifolia*; **PT**, *Pennisetum typhoides* cobs; **RBD**, Randomized Block Design; **RE**, *Rottboellia exaltata*; **VC**, vermicompost

INTRODUCTION

Organic composts, in general, are beneficial to soil fertility when applied continuously. They improve the physico-chemical, enzymatic and microbiological status and in due course result in the well-defined improvement of crop growth and yield (Wang *et al.* 2004; Chang *et al.* 2007; Okur *et al.* 2008). The production and use of vermicompost in agriculture is economical with regard to food production and more ecofriendly with regard to environment and soil protection. Through the process of vermicomposting, many different kinds of organic wastes can be made into valuable vermicompost. Recent works related to the vermicomposting of different organic wastes, ranging from leaf litters (Karmegam *et al.* 2003), aquaculture effluent solids (Marsh *et al.* 2005), paper mill sludge (Garg and Kaushik 2005), plants growing as wild weeds like Taro (Kurien and Ramasamy 2006), municipal solid wastes (Tognetti *et al.* 2007), sewage sludge (Clarke *et al.* 2007) and others highlighted the vermicomposting potential of different earthworms, physico-chemical changes during the process of vermiconversion and nutrient status of the vermicompost.

Vermicompost application has shown to increase the germination efficiency, growth and yield of plants (Atiyeh *et al.* 2000a, 2001, 2002a). Significantly higher chlorophyll, sugar and protein contents were observed in vermicompost + NPK application than in plants treated with press mud or vermicompost or NPK alone and in the control (Parthasarathi and Ranganathan 2001). The effects of the application of different types and rates of vermicomposts, on the growth and yields of field-grown strawberries, under field conditions independent of nutrients were reported by Arancon *et al.* (2004). The works related to the preparation and standardization of vermicomposting of leaf litters using the earthworms, *Lampito mauritii* (Kinb.) and *Perionyx ceylanensis* Mich. have been well documented (Karmegam *et al.* 2003). The present study reports the application of the vermicomposts produced by these two native earthworm species with leaf litters of *Polyalthia longifolia*, pearl millet (*Pennisetum typhoides*) cobs, and a weed *Rottboellia exaltata* mixed with cowdung (1:1). The influence of the vermicomposts individually and in combination with chemical fertilizers on the growth and yield parameters of the vegetable crop, *Lablab purpureus* (L.) Sweet. and also the nutrient uptakes by the plant and available soil NPK have been investigated.

MATERIALS AND METHODS

Experimental design

Field trials were carried out with *Lablab purpureus* (L.) Sweet. (Family: Fabaceae) using vermicomposts, recommended dose of chemical fertilizer and combination of vermicompost and chemical fertilizer in a private farm owned by Mr. A. James of Vellodu, near Gandhigram Rural University, Dindigul District, Tamil Nadu, India. The experiment was laid out in Randomized Block Design (RBD) technique comprising of 14 treatments with four replica-

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Table 1 Physico-chemical characteristics of the vermicomposts of the three different substrates (treatment with *P. ceylanensis* for 90 days; treatment with *L. mauritii* for 120 days)

Parameters	Vermicompost					
	Leaf litter of *P. longifolia* + cowdung		*P. typhoides* cobs + cowdung		*R. exaltata* + cowdung	
	P. ceylanensis	*L. mauritii*	*P. ceylanensis*	*L. mauritii*	*P. ceylanensis*	*L. mauritii*
pH	7.00	6.89	6.99	6.86	7.07	7.12
E.C. (dS m^{-1})	1.44	1.67	1.22	1.33	0.89	0.97
O.C. (%)	25.95	22.99	32.13	27.29	31.99	30.47
N_2 (%)	1.48	1.68	1.05	1.37	0.93	0.99
P (%)	0.92	1.19	0.96	1.21	0.62	0.74
K (%)	0.32	0.55	0.46	0.62	0.55	0.65
O.M. (%)	44.73	39.64	55.40	46.57	55.15	52.54
C:N ratio	17.48	13.73	30.59	19.97	34.40	30.91
C:P ratio	28.15	19.28	33.42	22.56	51.67	41.20

tions (180 days trial) as listed next:

T_0 - Control
T_1 - 5 tonnes VC LM-PL ha^{-1}
T_2 - 5 tonnes VC LM-PT ha^{-1}
T_3 - 5 tonnes VC LM-RE ha^{-1}
T_4 - 5 tonnes VC PC-PL ha^{-1}
T_5 - 5 tonnes VC PC-PT ha^{-1}
T_6 - 5 tonnes VC PC-RE ha^{-1}
T_7 - Recommended dose of NPK (120 Kg N ha^{-1} + 40 Kg P ha^{-1} + 30 Kg K ha^{-1})
T_8 - 2.5 tonnes VC LM-PL + ½ dose of recommended NPK ha^{-1}
T_9 - 2.5 tonnes VC LM-PT + ½ dose of recommended NPK ha^{-1}
T_{10} - 2.5 tonnes VC LM-RE + ½ dose of recommended NPK ha^{-1}
T_{11} - 2.5 tonnes VC PC-PL + ½ dose of recommended NPK ha^{-1}
T_{12} - 2.5 tonnes VC PC-PT + ½ dose of recommended NPK ha^{-1}
T_{13} - 2.5 tonnes VC PC-RE + ½ dose of recommended NPK ha^{-1}

where, VC LM-PL, VC LM-PT and VC LM-RE are the vermicomposts prepared from *P. longifolia* leaf litter, *P. typhoides* cobs and *R. exaltata* in combination with cowdung (1:1) respectively using *L. mauritii*; VC PC-PL, VC PC-PT and VC PC-RE are the vermicomposts prepared from *P. longifolia* leaf litter, *P. typhoides* cobs and *R. exaltata* in combination with cowdung (1:1) respectively using *P. ceylanensis*.

Preparation of field and dosage of vermicompost and inorganic fertilizer

The field was ploughed three times and brought to a fine tilth. Plots were marked for each treatment with an area of 6 m^2 per plot (2 m × 3 m). The plots were applied with vermicompost and inorganic fertilizer as given in the experimental design. The nutritional status of the vermicompost is shown in **Table 1**. Vermicompost was applied at the rate of 5 tonnes ha^{-1}. The recommended dose of NPK fertilizers at the rate of 120: 80: 30 kg ha^{-1} in the form of urea (SPIC), single super phosphate (Kothari Industrial Co. Ltd.) and muriate of potash (EID Parry India Ltd.,) were applied as straight fertilizer. From the recommended N (120 kg ha^{-1}), 60 kg ha^{-1} was applied as basal dose with P and K fertilizers in the soil and the remaining N was top dressed on 60th day after sowing (DAS) as per the experimental setup. The vermicompost was applied at the rate of 2.5 tonnes ha^{-1} along with 50% of the recommended dose of chemical fertilizer given in the experimental design. From the total application of nitrogen (i.e. 60 kg ha^{-1}), 30 kg ha^{-1} was given as basal dose along with vermicompost and remaining 30 kg ha^{-1} was top dressed at 60th day.

Sowing of seeds

The certified seeds of *L. purpureus* were procured from local market and washed with distilled water then with 0.1% mercuric chloride. The seeds were sown in rows leaving 0.3 m space in soil and covered by the top soil. The distance between each row was 1.0 m. The beds were watered and along the edges, Lindane dust (10%) was applied to prevent ants from damaging the seeds. The entire field was laid with rows of stones fixed with iron wires to spread the branches of the plants. After 20 days the seedlings were given support to grow straight over the iron wires. After the 40th day the terminal buds were removed in all the plants to get sprouting of branches as per the traditional agricultural practices.

Plant growth and yield parameters

The day of the appearance of first flower in 50% of the crop from the date of sowing was recorded in each treatment. Number of primary branches was counted on the 60th, 120th and 180th day in each plot and the mean values were expressed in numbers. The leaf area index (LAI) was calculated on the 60th, 120th and 180th day. The total chlorophyll content of the leaves on the 60th, 120th and 180th day was measured using the method of Arnon (1949) and expressed as mg g^{-1} of fresh tissue. The length of the fruit for 10 randomly selected fruits from each plot of the treatments was taken and the mean was calculated and expressed in centimeter (cm). The dry weight of fruits was taken after drying the fruits in hot air oven at 80°C for 24 h and expressed in grams $fruit^{-1}$. The seeds were collected from matured fruits and oven dried at 80°C for 24 h and a lot of 100 seeds were weighed and expressed in grams (g). The weight of fruits per plant, per plot was recorded at each harvest and the total of all the harvests made was calculated and expressed as yield of fruits per plant (g) and per plot (kg) and the yield per hectare was calculated and expressed in tones ha^{-1}.

Uptake of nutrients by plants

The chopped plant samples were dried in hot air oven at 60°C and ground in a Wiley mill and used for the analysis of nutrients i.e. nitrogen, phosphorus and potassium by adopting standard procedures (Piper 1966; Jackson 1973) and the nutrients were expressed as kg ha^{-1} of plants.

Analysis of soil samples

Soil samples were collected from the experimental plots at a depth of 15-30 cm after harvest of the crop, dried under shade, powdered and sieved through a 2 mm sieve for analysis of available N, P and K contents. The soil available N content (alkaline permanganate method; Subbiah and Asija 1956), available P content (calorimetric method; Olsen *et al.* 1954) and available K content (flame photometric method; Stanfold and English 1949) were analyzed and were expressed in kg ha^{-1}.

Statistical analysis

The results of the experiments were statistically analysed by one-way ANOVA (with blocks) with the help of SPSS statistical software (version 9.05 for Windows). The analyses were carried out at the 0.05 significance level.

RESULTS

The leaf area index (LAI) was significantly ($P<0.05$) higher in all the vermicompost applied plots, chemical fertilizer applied plots and vermicompost + chemical fertilizer applied plots on the 60th day after sowing (DAS) over the control plots (**Table 2**). The highest LAI was recorded in the

Table 2 Effect of vermicompost, chemical fertilizer and combination of vermicompost + chemical fertilizer on the leaf area index, total chlorophyll content of leaves, number of primary branches and total dry matter production of *L. purpureus* on the 60th day after sowing

Treatment	Leaf area index (cm^2)	Total chlorophyll in leaf (mg g^{-1} of fresh tissue)	Primary branches (no. $plant^{-1}$)	Total dry matter production (g $plant^{-1}$)
Control (T_0)	0.72	0.96	8.76	262.19
VCLM-PL (T_1)	0.82	1.29	13.74	316.00
VCLM-PT (T_2)	0.90	1.41	14.73	312.09
VCLM-RE (T_3)	0.83	1.36	15.71	327.74
VCPC-PL (T_4)	0.84	1.26	12.76	332.63
VCPC-PT (T_5)	0.86	1.31	14.73	312.09
VCPC-RE (T_6)	0.91	1.34	13.74	318.94
NPK (T_7)	0.93	1.43	16.69	329.70
VCLM-PL+NPK (T_8)	0.89	1.42	14.73	346.33
VCLM-PT+NPK (T_9)	0.91	1.33	15.71	340.46
VCLM-RE+NPK (T_{10})	0.94	1.34	17.67	342.42
VCPC-PL+NPK (T_{11})	0.95	1.41	16.69	331.66
VCPC-PT+NPK (T_{12})	0.90	1.36	15.71	334.59
VCPC-RE+NPK (T_{13})	0.92	1.40	16.49	345.35
C.D. (0.05)	0.23	0.465	16.46	45.67

C.D. = Critical Difference. VC – vermicompost; LM – *L. mauritii*; PC – *P. ceylanensis*; PL – leaf litter of *P. longifolia* + cow dung; PT – *P. typhoides* cobs + cow dung; RE – *R. exaltata* + cow dung;

Table 3 Effect of vermicompost, chemical fertilizer and combination of vermicompost + chemical fertilizer on leaf area index, total chlorophyll content of leaves, number of primary branches and total dry matter production of *L. purpureus* on the 120th day after sowing. For abbreviations see legend of **Table 2**.

Treatment	Leaf area index (cm^2)	Total chlorophyll in leaf (mg g^{-1} of fresh tissue)	Primary branches (no. $plant^{-1}$)	Total dry matter production (g $plant^{-1}$)
Control (T_0)	1.11	1.21	20.44	1554.57
VCLM-PL (T_1)	1.60	1.68	37.30	2583.78
VCLM-PT (T_2)	1.68	1.66	39.27	2409.64
VCLM-RE (T_3)	1.62	1.70	41.23	2335.28
VCPC-PL (T_4)	1.59	1.72	38.29	2196.36
VCPC-PT (T_5)	1.64	1.75	44.18	2282.45
VCPC-RE (T_6)	1.62	1.78	43.19	2205.16
NPK (T_7)	1.77	1.76	39.27	2457.57
VCLM-PL+NPK (T_8)	1.68	1.79	38.29	2622.91
VCLM-PT+NPK (T_9)	1.63	1.75	36.32	2522.14
VCLM-RE+NPK (T_{10})	1.65	1.80	41.23	2723.68
VCPC-PL+NPK (T_{11})	1.59	1.83	45.16	2640.52
VCPC-PT+NPK (T_{12})	1.62	1.73	37.30	2524.10
VCPC-RE+NPK (T_{13})	1.64	1.81	40.25	2641.50
C.D. (0.05)	0.70	0.62	44.87	1170.12

Table 4 Effect of vermicompost, chemical fertilizer and combination of vermicompost + chemical fertilizer on leaf area index, total chlorophyll content of leaves, number of primary branches and total dry matter production of *L. purpureus* on the 180th day after sowing. For abbreviations see legend of **Table 2**.

Treatment	Leaf area index (cm^2)	Total chlorophyll in leaf (mg g^{-1} of fresh tissue)	Primary branches (no. $plant^{-1}$)	Total dry matter production (g $plant^{-1}$)
Control (T_0)	1.38	1.39	34.07	2543.67
VCLM-PL (T_1)	2.11	1.98	57.92	3130.67
VCLM-PT (T_2)	2.14	2.07	54.97	3315.57
VCLM-RE (T_3)	2.27	2.11	56.94	3392.86
VCPC-PL (T_4)	2.12	2.01	53.01	3281.33
VCPC-PT (T_5)	2.21	2.15	59.88	3216.76
VCPC-RE (T_6)	2.18	2.09	55.96	3326.33
NPK (T_7)	2.16	2.07	57.92	3316.55
VCLM-PL+NPK (T_8)	2.26	2.12	63.81	3435.91
VCLM-PT+NPK (T_9)	2.25	2.15	59.88	3447.65
VCLM-RE+NPK (T_{10})	2.20	2.16	65.77	3395.80
VCPC-PL+NPK (T_{11})	2.17	2.11	61.85	3435.91
VCPC-PT+NPK (T_{12})	2.14	2.14	61.85	3423.19
VCPC-RE+NPK (T_{13})	2.25	2.20	57.92	3315.57
C.D. (0.05)	1.16	0.92	49.47	522.95

T_{11} treatment than all the other treatments. However, the difference in LAI within the treatments was not significant ($P>0.05$). The total chlorophyll content of leaves, number of branches per plant and total dry matter production (DMP) of *L. purpureus* were significantly higher in vermicompost applied plots and vermicompost + chemical fertilizer applied plots ($P<0.05$) than in the control. Total chlorophyll content of the leaves was high in T_7, i.e. 1.4 mg g^{-1} of fresh tissue. The number of primary branches was high in T_{10} i.e. 17.7 $plant^{-1}$. The DMP was high in T_8 i.e. 346 g $plant^{-1}$ on the 60th DAS.

LAI of 1.8 cm^2, total chlorophyll content of leaves of 1.8 mg g^{-1} of fresh tissue, number of primary branches of 45.2 $plant^{-1}$ and total DMP of 2724 g $plant^{-1}$ were the highest recorded values in the treatments T_7, T_{11}, T_{11} and T_{10}, respectively over the other treatments but the values did not differ significantly between treatments except in T_0 (**Table 3**). The LAI, total chlorophyll content of leaves, number of primary branches per plant and total DMP on the 180th day after sowing was higher in the treatments T_1 to T_{13} and the

Table 5 Effect of vermicompost, chemical fertilizer and combination of vermicompost +chemical fertilizer on day of first flowering, length of fruit, dry weight of fruit and weight of 100 seeds of *L. purpureus*. For abbreviations see legend of **Table 2**.

Treatment	Day of first flower appearance	Fruit length (cm fruit $^{-1}$)	Dry weight (g fruit^{-1})	Weight of 100 seeds (dry wt., g)
Control (T_0)	84.42	7.08	3.74	61.91
VCLM-PL (T_1)	68.72	9.05	5.03	70.98
VCLM-PT (T_2)	71.66	8.75	5.53	72.26
VCLM-RE (T_3)	73.63	9.44	5.73	69.69
VCPC-PL (T_4)	67.74	8.65	5.45	73.19
VCPC-PT (T_5)	69.70	8.95	5.18	73.73
VCPC-RE (T_6)	74.61	9.15	5.57	72.50
NPK (T_7)	73.13	8.85	5.66	74.49
VCLM-PL+NPK (T_8)	71.66	9.24	5.38	76.19
VCLM-PT+NPK (T_9)	69.69	8.95	5.29	72.97
VCLM-RE+NPK (T_{10})	76.57	8.75	5.46	71.79
VCPC-PL+NPK (T_{11})	73.63	8.46	5.20	74.29
VCPC-PT+NPK (T_{12})	68.72	9.15	5.51	75.33
VCPC-RE+NPK (T_{13})	71.66	9.01	5.32	72.50
C.D. (0.05)	12.69	1.65	2.24	8.14

Table 6 Effect of vermicompost, chemical fertilizer and combination of vermicompost + chemical fertilizer on the available nutrient content in the soil after crop harvest and nutrient uptake by *L. purpureus*. For abbreviations see legend of **Table 2**.

Treatment	Available nutrient content in soil (kg ha^{-1})			Nutrient uptake by plants (kg ha^{-1})		
	N	P	K	N	P	K
Control (T_0)	204.68	20.62	87.86	64.30	8.78	32.02
VCLM-PL (T_1)	245.42	35.34	100.43	85.31	13.35	45.65
VCLM-PT (T_2)	250.33	32.40	95.03	80.71	12.66	43.68
VCLM-RE (T_3)	240.51	37.30	103.76	90.95	14.38	41.73
VCPC-PL (T_4)	263.09	40.25	98.76	85.85	13.73	47.78
VCPC-PT (T_5)	252.29	36.32	96.20	88.56	13.99	42.80
VCPC-RE (T_6)	255.23	33.38	101.50	91.84	12.87	44.64
NPK (T_7)	244.44	32.89	100.43	87.27	14.01	49.10
VCLM-PL+NPK (T_8)	258.18	46.14	116.43	96.79	14.38	52.67
VCLM-PT+NPK (T_9)	252.29	43.19	110.44	99.44	15.04	48.74
VCLM-RE+NPK (T_{10})	260.14	39.27	107.20	103.37	14.74	51.58
VCPC-PL +NPK (T_{11})	256.22	37.30	117.90	100.72	14.59	49.63
VCPC-PT+NPK (T_{12})	251.31	49.08	112.60	102.68	15.02	50.92
VCPC-RE +NPK (T_{13})	262.11	45.16	109.75	106.90	15.27	51.56
C.D. (0.05)	43.25	33.95	36.26	69.21	75.63	32.64

difference was significant at 5% level over the control (**Table 4**). LAI of 2.1 cm^2, total chlorophyll content of the leaves of 2 mg g^{-1} of fresh tissue, number of primary branches of 53 branches plant^{-1} and total DMP of 31301 g plant^{-1} were the lowest values recorded on the 180th DAS in the treatments T_1, T_1, T_4 and T_1, respectively than in the other experimental treatments and the difference in these parameters between treatments was not significant at 5% level except in T_0. The treatments in vermicompost application, i.e. T_1 to T_6 did not show significant difference in these parameters from the chemical fertilizer application and also from the application of vermicompost + chemical fertilizer.

The first flower appearance was noticed on the 84th day after sowing in the control plot and the difference in the first flower appearance was significantly higher ($P<0.05$) than in exclusive vermicompost application, chemical fertilizer application and vermicompost + chemical fertilizer application (**Table 5**). The day of first flower appearance did not differ significantly ($P>0.05$) among the vermicompost application (T_1-T_6), chemical fertilizer application (T_7) and vermicompost + chemical fertilizer application (T_8-T_{13}). The length per fruit, dry weight of the fruit and dry weight of 100 seeds were higher in the treatments T_1 to T_{13} than in T_0 (control) and the differences in these parameters between T_1-T_{13} and T_0 were significant at 5% level. These parameters did not differ at $P<0.05$, within the treatments T_1 to T_{13}.

The available nutrient contents N, P and K in the soil showed an increase in the plots which received chemical fertilizer (T_1) and the plots which received vermicompost + chemical fertilizer mixture (T_8-T_{13}) over the control (T_0). The available N content in the plots which received chemical fertilizer was lower than that in the plots which received vermicompost, except T_3. The available P content in the soil of the plots received chemical fertilizer (T_7) was lower than the soil which received the vermicomposts of T_1, T_3, T_4, T_5 and T_6, but the difference in available P content within treatments was not significant (**Table 6**).

The nutrient uptake by the plants grown in T_1 to T_{12} was higher than those in T_0 and the difference in nutrient uptake between T_1-T_{12} and T_0 was statistically significant ($P<0.01$). The plots which received vermicompost + chemical fertilizer showed an increase in the uptake of nutrients over the plants which were grown in the plots which received chemical fertilizer (**Table 6**). However, the difference in the val-

Table 7 Effect of vermicompost, chemical fertilizer and combination of vermicompost + chemical fertilizer on the yield of *L. purpureus*. For abbreviations see legend of **Table 2**.

Treatment	Fruit yield (fresh weight)		
	g plant^{-1}	Kg plot^{-1}	Tonnes ha^{-1}
Control (T_0)	1459.74	34.39	61.87
VCLM-PL (T_1)	2258.82	53.22	95.74
VCLM-PT (T_2)	2072.30	48.82	87.84
VCLM-RE (T_3)	2183.23	51.44	92.54
VCPC-PL (T_4)	2149.85	50.65	91.13
VCPC-PT (T_5)	2102.73	49.54	89.13
VCPC-RE (T_6)	2256.85	53.17	95.66
NPK (T_7)	2212.68	52.13	93.79
VCLM-PL+NPK (T_8)	2370.73	55.85	100.48
VCLM-PT+NPK (T_9)	2343.24	55.21	99.32
VCLM-RE+NPK (T_{10})	2158.69	50.86	91.50
VCPC-PL +NPK (T_{11})	2216.60	52.22	93.95
VCPC-PT+NPK (T_{12})	2310.84	54.44	97.95
VCPC-RE +NPK (T_{13})	2566.08	60.46	108.77
C.D. (0.05)	1387.48	32.69	58.81

ues of nutrient uptake by plants was not significantly different (C.D. at 5%) between chemical fertilizer and vermicompost + chemical fertilizer application. The fruit yield was high in certain vermicompost + chemical fertilizer applied plots when compared to the plots which received chemical fertilizer, but the difference was not significant at 5% level (**Table 7**). The highest yield of 109 tonnes ha^{-1} was recorded in the treatment T_{13}, i.e. 2.5 tonnes ha^{-1} vermicompost of *R. exaltata* + cow dung mixture produced using *P. ceylanensis* + ½ the recommended dose of chemical fertilizer.

DISCUSSION

The field trial has shown that vermicompost either alone or in combination with 50 percent of the recommended dose of chemical fertilizer is able to produce results constantly equal to an exclusive application of chemical fertilizer as observed through certain growth parameters (**Tables 2-5**). All these observations showed that vermicompost can form a replacement for chemical fertilizer, thereby reducing the cost of crop production, improving soil fertility (**Table 6**) and saving the environment from the ill-effects of chemical compounds. The nutrient uptake (NPK) by plants and fruit yield was higher with vermicompost application and equivalent to chemical fertilizer application. Similar results for *A. hypogea* and *V. mungo* were reported by Parthasarathi and Ranganathan (2001).

Ghosh *et al*. (1999) observed that integration of vermincompost with inorganic fertilization tended to increase the yield of potato, rape seed, mulberry and marigold over that with traditional compost prepared from the same material. Bhattacharjee *et al.* (2001) reported that the increased yield was due to uptake of nutrients in paddy and the application of vermicompost reduced the dosage of NPK. Increased yield owing to the application of vermicompost along with chemical fertilizer might be due to increased uptake of nutrients. This may indicate that vermicompost reduces the loss of nutrients through leeching from the soil by changing the physico-chemical properties of the soil. Other factors, such as the presence of beneficial microorganisms or biologically active plant growth influencing substances or phytohormones released by beneficial microorganisms including humates in the vermicompost might be also involved (Krishnamoorthy and Vajranabhaiah 1986; Tomati *et al.* 1990; Subler *et al.* 1998; Atiyeh *et al.* 2002b). Nitrogen encourages the vegetative growth and is a regulator that governs to a considerable degree of the uptake of phosphorus and potassium, which are important for seed production. Muscolo *et al.* (1999) reported that the effects of these substances on plant growth have been shown to be very similar to the effects of soil-applied plant growth regulators or hormones. Vermicompost contains most nutrients in forms that are available for plants such as nitrates, phosphates, and exchangeable calcium and soluble potassium. Usually, the vermicompost contains most of the essential minerals. Vermicomposts are rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes (Edwards 1998).

CONCLUSION

The good evidence produced through plant growth experiments carried out in the present study shows that vermicompost can promote plant growth and retain major nutrients in soil. The study clearly indicates that the vermicompost in respect of organic wastes and earthworm species utilized had equal effects to that of chemical fertilizer alone or partially substituted with vermicompost. The long-run effect of similar application trials are required to completely justify the improvement of soil fertility status.

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