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Effect of vermicomposts on the growth of amaranthus plants and soil fertility

S. Priya and S. Santhi

Department of Zoology, Queen Mary's College (Autonomous), Mylapore, Chennai, Tamil Nadu, India

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ABSTRACT

The present investigation cultured the two species of earthworms, namely Eudrilus eugeniae (epigeic) and Lampito mauritii (anecic) for vermicomposting. The effect of these two types of vermicompost were studied by growing three different amaranthus plants- Hibiscus cannabinus, Trigonella Foenum graecum and Solanum nigrum with respect to control soil. Comparative studies on growth (shoot length, wet weight, leaf area and root length) of the plants with relation to different types of vermicomposts and control soil were examined till the flowering period. The results revealed that the macro nutrients (N, P and K) and micro nutrients (Fe, Mn, Zn and Cu) were more or less higher in the vermicomposts in comparison to the control soil. The plants grown in Eudriluseugeniae compost showed a better result compared to Lampito mauritii with respect to control soil. Findings of the study confirm that Eudrilus eugeniae can be easily used for soil fertility improvement and vermicomposting.

Key words: *Eudriluseugeniae, Lampitomauritii, Hibiscus cannabinus, Trigonella Foenum graecum, Solanum nigrum*

INTRODUCTION

Earthworms are invertebrates belonging to the phylum Annelida and class Oligochaeta. Earthworms contribute to soil fertility improvement, plant growth and play a key role in converting organic matter and composting garbage. Charles Darwin and numerous scientists before and after him have described earthworms as a great benefactor of soil and agriculture [1]. There are about 3627 species of terrestrial earthworms in the world [2]. Earthworms are long, thread-like, elongated, cylindrical, soft bodied animals with uniform ring like structures all along the length of their body [3]. Earthworms are most important soil dwelling organisms involved in the process of soil formation and organic matter decomposition [4].

In India-as also many other parts of the world-vermicasts are believed to have several components, which improve the soil to which they are applied. Vermicast generated from animal dung is universally believed to be beneficial to soil and plants. Lumbricid earthworms from temperate regions are capable of stimulating plant growth in grasslands [5]. Further, small scale experiments using non lumbricid tropical geophageous earthworms have shown similar trends and indicated species specific responses of plants to earthworm activity. Moreover, their findings showed that optimum yield enhancement is achieved when the correct species of earthworms are inoculated [6, 7].

Vermicompost significantly stimulate the growth of a wide range of plant species including several horticultural crops such as tomato, pepper, garlic, aubergine, strawberry, sweet corn and green gram [8]. Moreover, in comparison with mineral fertilizers, compost produces significantly greater increases in soil organic carbon and some plant nutrients [9, 10, 11, and 12]. Vermicompost an organic source of plant nutrients contains a higher percentage of nutrients necessary for plant growth in readily available forms [13].Diluted vermiwash and

vermicomposting leachate when used as nutrient solution for *Plectranthus ambionicus*, chlorophyll and carotenoids content were higher if compared to control [14].

However, information on the effect of vermicompost on different families of amaranthus plants is very meager. The aim of this present investigation is focused on the impact of vermicompost on the growth of two different short duration amaranthus plants and soil fertility.

MATERIALS AND METHODS

L. mauritii used in this study was collected from the college campus by manual method. Another species used, i.e. *E. eugeniae*, was obtained from stock culture maintained in animal room laboratory, Department of Zoology, Queen Mary's College, Chennai. Species of earthworms were identified by Prof. Sultan Ahmed Ismail (Head, Department of Biotechnology, New College, Chennai). Vermicomposting was prepared by means of monoculture method.

Each experimental tray was 7.5 cm long and 20 cm wide with 2kg capacity. The control trays were filled up with 1500g of garden soil and the experimental trays were filled up with 750g of garden soil and 750g of vermicompost (1:1). The seeds of 3 different amaranthus varieties namely-

- *Hibiscus cannabinus* (called as "Pulicha Keerai" in Tamil, is an annual or biennial herbaceous plant and belongs to the family Malvaceae).
- *Trigonella Foenum graecum* (called as Fenugreek is an annual plant in the family Fabaceaeand is a common ingredient in dishes.
- *Solanum nigrum* (also known as Black Nightshade is a fairly common herb or short-lived perennial shrub, in the family Solanaceaewere directly sown by hand into the trays at a rate of 1 tablespoon to a depth of 2 cm.

Data were recorded for the plant height every week. Six plants were randomly selected from each tray and the observations were recorded. At the beginning of flowering period, the plants are harvested and the average plant height was measured from base to tip of the plant for each tray using a ruler (±0.5 cm) [15, 16]. The Leaf area and root length was also measured using the ruler (±0.5 cm). For evaluating the total weight, plants are harvested and the roots are washed with water to remove the soil particles. The net weight was measured using a beam balance.

In order to determine the changes in the chemical composition of the experimental soil, it is analyzed biochemically before sowing the seed and after harvesting the plants. Soil analysis was done at Soil Testing Laboratory, Kanchipuram. Physical and chemical properties of vermicompost are analyzed from Tamil Nadu Agricultural University, Department of Soil and Environment, Agricultural College and Research Institute, Madurai.

RESULTS AND DISCUSSION

Table 1: Physical and Chemical properties of vermicompost of *E. eugeniae* and *L. mauritii*

	pH	EC	N %	P %	K %	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
Vermicompost of *Eudriluseugeniae*	7.75	0.70	1.27	0.65	1.05	3.57	3.64	3.34	3.20
Vermicompost of *Lampitomauritii*	7.68	0.50	1.06	0.50	0.86	5.93	2.15	5.90	2.50

EC-Electrical Conductivity

The pH and EC value of vermicompost of *E. eugeniae* was higher (7.75 and 0.70) than that of vermicompost of *L. mauritii* (7.68 and 0.50). The macronutrients such as N, P, K (1.27%, 0.65%, 1.05%) was also higher in *E. eugeniae* while compared to *L. mauritii* (1.06%, 0.50%, 0.86%) respectively. The amount of micronutrients like Iron and Manganese was higher in *L. mauritii* except Zinc and Copper (Table 1).

Table 2: Physical and Chemical properties of soil (C), and the vermicompost of *E. eugeniae* (T1) and *L. mauritii* (T2) before sowing the seeds

	pH	EC	N %	P %	K %	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
C	8.30	0.40	0.64	0.29	0.82	6.71	0.07	3.43	2.18
T1	8.03	0.55	0.96	0.47	0.94	5.14	1.86	3.39	2.69
T2	7.99	0.45	0.85	0.4	0.84	6.32	1.11	4.67	2.34

EC-Electrical Conductivity

The pH of worm casts *E. eugeniae* (8.03) and *L. mauritii* (7.99) was found to be lower than that of non-ingested control soil (8.30). The EC value was higher in the casts of *E. eugeniae* and *L. mauritii* (0.55 and 0.45) than the control (0.40). The NPK content of both the casts was higher than that of the control soil. The micronutrients (Zn, Mn and Cu) were also found to be higher in the casts than the control soil but Fe content (6.71 ppm) is more in control soil (Table 2).

Solanum nigrum

Table 3: Physical and Chemical properties of soil (C) and the vermicompost of *E. eugeniae* (T1) and *L. mauritii* (T2) after harvesting the *S. nigrum*

	Tex	LS	pH	EC	N %	P %	K %	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
Control (C)	SCL	P	8.5	0.6	0.90	0.29	2.94	30.24	9.60	23.63	3.55
Trial-1 (T1)	SCL	P	8.5	0.6	0.97	0.29	2.72	33.04	1.00	23.39	2.90
Trial-2 (T2)	SCL	P	8.4	0.6	0.81	0.29	1.21	24.31	2.29	24.90	1.56

Tex- Texture, LS- Lime status, EC-Electrical Conductivity, SCL-Sand, Clay, Loamy, P-Profuse

The result in Table 3 clearly demonstrates that generally the texture of experimental soil consists of sand, clay and loamy and the lime status is profuse. The pH value of both C and T1 was same. EC values were more or less same in all the treatments. The N (0.97 %), P (0.51 %) and Fe (33.04 ppm) content were higher in T1 than that of T2 and C. Similarly the K (2.94 %), Zn (9.60 ppm) and Cu (3.35 ppm) content were greater in control soil. The Mn (24.90 ppm) content was higher in T2 when compared to T1 and C.

Shoot length

The results presented in Table 4 and Fig. 1 has demonstrated that the shoot length of *S. nigrum* was significantly influenced by the application of vermicompost (T2) at the end of every week. After 56th day of harvesting the highest average plant height 29.88 cm (29.88±0.13) was recorded by applying vermicompost of *L. mauritii* (T2). The average shoot length of 10.82 cm (10.82±0.22) and 8.87 cm (8.87±0.20) were observed in plants treated with vermicompost of *E. eugeniae* (T1) and control plants (C) respectively (Fig. 2).

Table 4: Effects of vermicompost on shoot length of *Solanum nigrum*

Days	Control (C)	Trial -1 (T1)	Trial -2 (T2)
14	0.49±0.03	0.50±0.01	1.49±0.03
21	1.50±0.02	2.10±0.01	5.80±0.25
28	3.50±0.03	3.50±0.01	10.03±0.10
35	6.23±0.21	5.32±0.19	21.32±0.19
42	7.98±0.13	5.93±0.18	23.87±0.12
49	7.95±0.08	8.30±0.21	29.88±0.13
56	8.87±0.20	10.82±0.22	29.88±0.13

Values are mean of six observations, ± standard deviation
C - Control (Soil only)
T1 - Vermicompost of E. eugeniae + Soil (1:1)
T2 - Vermicompost of L. mauritii + Soil (1:1)

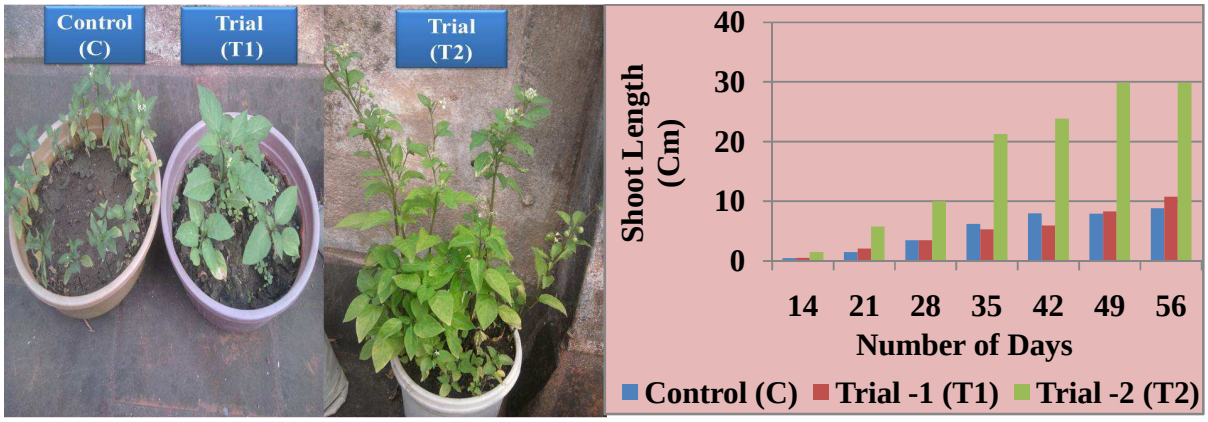

Fig. 1 and 2: Effects of vermicompost on shoot length of *Solanum nigrum*

Growth parameters

The leaf area, shoot length, root length and wet weight of *S. nigrum* were significantly influenced by the application of vermicompost at the end of every week. After 56th day of harvesting the highest average leaf area 15.06 cm^2 (15.06±0.06) was recorded by applying vermicompost of *L. mauritii* (T2). The average leaf area of 10.12 cm^2 (10.12±0.09) and 4.47 cm^2 (4.47±0.04) were observed in plants treated with vermicompost of *E. eugeniae* (T1) and control plants respectively (Table 5 and Fig.3).

The highest average root length 10 cm (10±0.14) was recorded by applying vermicompost of *L. mauritii* (T2). The average root length of 8 cm (8±0.14) and 6 cm (6±0.14) were observed in control plants (C) and plants treated with vermicompost of *E. eugeniae* (T1) respectively.

The highest average wet weight 20 g (20±0.14) was recorded by applying vermicompost of *L. mauritii* (T2). The average wet weight of 10 g (10±0.14) and 4.8 g (4.8±0.14) were observed in plants treated with vermicompost of *E. eugeniae* (T1) and control plants (C) respectively.

Table 5: Effects of vermicompost on growth parameters of *S. nigrum* after 56 days of harvesting

Growth Parameters	Control (C)	Trial -1 (T1)	Trial - 2 (T2)
Leaf area index (cm^2)	4.47±0.04	10.12±0.09	15.06±0.06
Shoot length (cm)	8.87±0.02	10.82±0.22	29.88±0.13
Root length (cm)	8.0±0.14	6.0±0.14	10.0±0.14
Wet weight of plant (g)	4.80±0.14	10.0±0.14	20.0±0.14

Values are mean of six observations, ± standard deviation
C - Control (Soil only)
T1 - Vermicompost of E. eugeniae+ Soil (1:1)
T2 - Vermicompost of L. mauritii + Soil (1:1)

Table 6: ANOVA for different growth parameters of *Solanumnigrum* after 56 days of harvesting

		Sum of Squares	Degree of freedom	Mean Square	F
Shoot Length	Between Groups	1618.081	2	809.041	22897.374
	Within Groups	0.530	15	0.035	
	Total	1618.611	17		
Root Length	Between Groups	48.000	2	24	1200
	Within Groups	0.300	15	0.020	
	Total	48.300	17		
Leaf Area	Between Groups	337.269	2	168.634	34571.946
	Within Groups	0.073	15	0.005	
	Total	337.342	17		
Wet Weight	Between Groups	716.160	2	358.080	17904
	Within Groups	0.300	15	0.020	
	Total	716.460	17		

The tablulated value of "F" for given d.f. at 1% level is 6.51.

The tabulated value of F for the given degree of freedom (i.e. 2 and 15), at 1% level is 6.51 is much less than the calculated value of all variables of *S. nigrum*. Thus the hypothesis was rejected and concluded that there is a difference in the average value of shoot length, root length, leaf area and wet weight of *S. nigrum* when treated with various vermicompost of T1, T2 and control (Table 6).

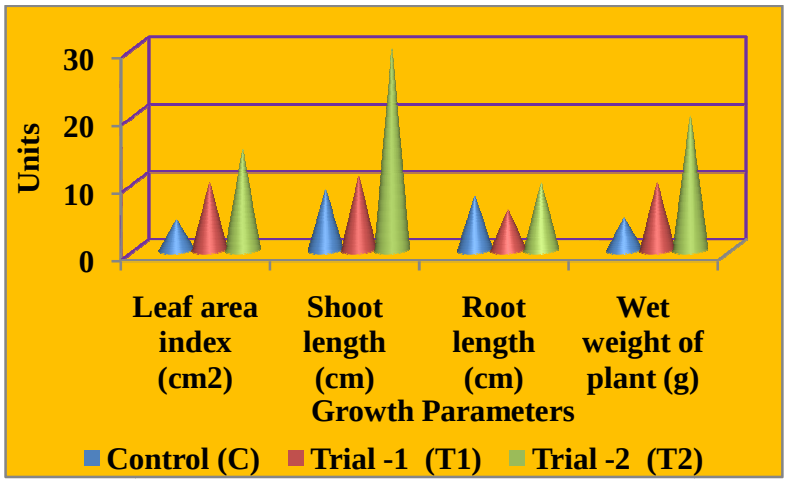

Fig. 3: Effects of vermicompost on growth parameters of *Solanumnigrum*

Hibiscus cannabinus

Table 7: Physical and Chemical properties of soil (C) and the vermicompost of E. eugeniae(T1) and L. mauritii (T2) after harvesting the *H. cannabinus*

	Tex	LS	pH	EC	N %	P %	K %	Fe ppm	Zn ppm	Mn ppm	Cu ppm
Control (C)	SCL	P	8.6	0.8	0.98	0.29	1.25	10.62	0.83	15.61	4.85
Trial-1 (T1)	SCL	M	8.7	1.0	0.94	0.29	1.42	21.36	0.73	23.36	2.31
Trial-2 (T2)	SCL	P	8.6	0.7	0.98	0.29	1.50	17.41	0.54	21.41	2.13

The results in the Table 7 have indicated that adequate amount of macro nutrients (N, P, K) and micro nutrients (Fe, Zn, Mn) and EC (0.70 – 1) were higher in the soils treated with vermicompost than the control. Cu content (4.85 ppm) is more in control. The pH of the soils were found to be basic or alkaline (8.6 - 8.7) in all the treatments.

Shoot length

Compared to control and plant treated with vermicompost of *L. mauritii* (T2) the average shoot length of T1 was significantly increased at the end of every week. At the time of 77th day of harvesting the average shoot length of plants applied with vermicompost of *E. eugeniae* (T1) was 24.33 cm (24.33±0.33) followed by 20.48 cm (20.48±0.23) and 20.27 cm (20.27±0.27) in T2 and C respectively (Table 8 and Fig. 4 and 5).

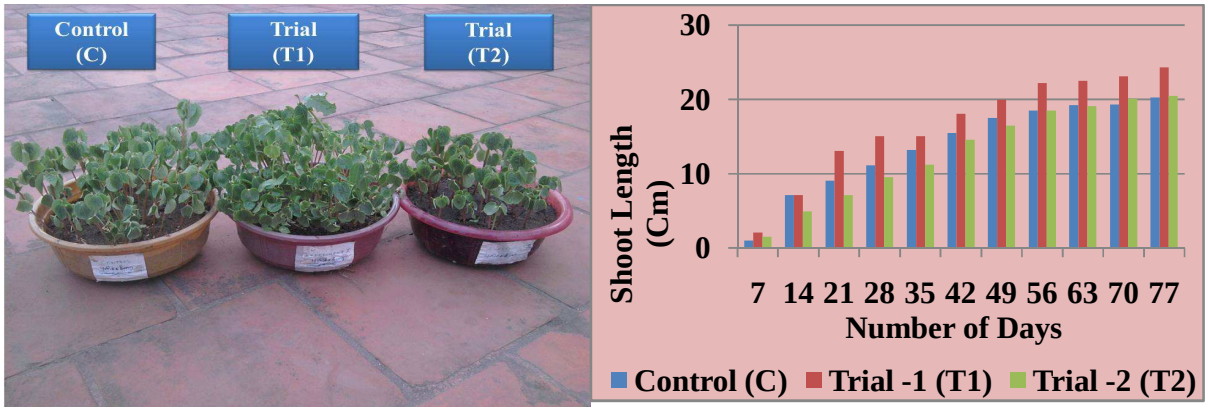

Fig. 4 and 5: Effects of vermicompost on shootlength of *Trigonella foenumgraecum*

Table 8: Effects of vermicompost on shoot length of *Hibiscus cannabinus*

Days	Control (C)	Trial -1 (T1)	Trial -2 (T2)
7	1.02±0.30	2.10±0.20	1.49±0.02
14	7.12±0.31	7.12±0.31	4.92±0.31
21	9.07±0.29	13.08±0.35	7.12±0.26
28	11.13±0.23	15.07±0.37	9.51±0.03
35	13.23±0.32	15.05±0.34	11.20 ±0.21
42	15.5±0.14	18.10±0.24	14.55±0.22
49	17.51±0.03	19.98±0.27	16.51±0.03
56	18.52±0.03	22.18±0.21	18.51±0.03
63	19.22±0.24	22.51±0.03	19.07±0.29
70	19.3±0.25	23.1±0.42	20.08±0.37
77	20.27±0.27	24.33±0.33	20.48±0.23

Values are mean of six observations, ± standard deviation
C- Control (Soil only)
T1- Vermicompost of E. eugeniae + Soil (1:1)
T2- Vermicompost of L. mauritii + Soil (1:1)

Growth parameters

The leaf area, shoot length, root length and wet weight of *H. cannabinus*were significantly influenced by the application of vermicompost at the end of every week. At the time of 77th day the average leaf area of T1 and T2 was 12.3 cm^2 (12.3±0.25) followed by 5 cm^2 (5.2±0.20) in control plants (C) respectively (Table 9 and Fig. 6).

At the end of harvesting the average root length of control plants (C) was 5 cm (5±0.14) followed by 4 cm (4±0.14) and 3.5 cm (3.5±0.14) in T1 and T2 respectively.

During harvesting the average wet weight of plants applied with vermicompost of T2 and C was 9 g (9±0.14) followed by 7.3 g (7.3±0.14) in T1 respectively.

Table 9: Effects of vermicompost on growth parameters of *Hibiscus cannabinus* after 77 days of harvesting

Growth Parameters	Control (C)	Trial -1 (T1)	Trial - 2 (T2)
Leaf area index (cm^2)	5.20±0.20	12.30±0.25	12.30±0.25
Shoot length (cm)	20.27±0.27	24.33±0.33	20.48±0.23
Root length (cm)	5.0±0.14	4.0±0.14	3.50±0.14
Wet weight of plant (g)	9.0±0.14	7.30±0.14	9.0±0.14

Values are mean of six observations, ± standard deviation
C- Control (Soil only)
T1- Vermicompost of E. eugeniae + Soil (1:1)
T2- Vermicompost of L. mauritii + Soil (1:1)

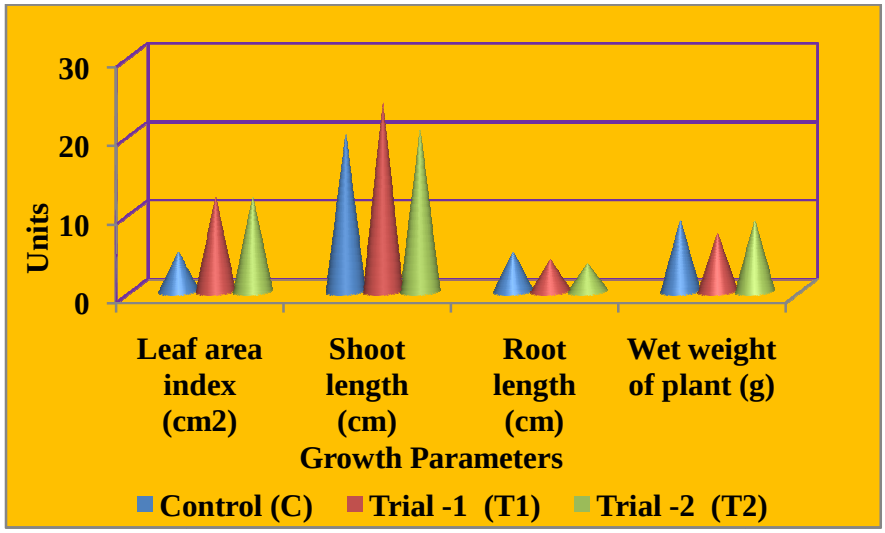

Fig. 6: Effects of vermicompost on growth parameters of *Hibiscus cannabinus*

Table 10: ANOVA for different growth parameters of *Hibiscus cannabinus* after 77days of harvesting

		Sum of Squares	Degree of freedom	Mean Square	F
Shoot Length	Between Groups	62.814	2	31.407	407.888
	Within Groups	1.155	15	0.077	
	Total	63.969	17		
Root Length	Between Groups	7.000	2	3.500	175.005
	Within Groups	0.300	15	0.020	
	Total	7.300	17		
Leaf Area	Between Groups	201.640	2	100.820	1759.513
	Within Groups	0.859	15	0.057	
	Total	202.500	17		
Wet Weight	Between Groups	11.560	2	5.780	289.005
	Within Groups	0.299	15	0.020	
	Total	11.860	17		

The tablulated value of “F” for given d.f. at 1% level is 6.51.

The tabulated value of F for the given degree of freedom (i.e. 2 and 15), at 1% level is 6.51 is much less than the calculated value of all variables of *H. cannabinus*. Thus the hypothesis was rejected and concluded that there is a difference in the average value of shoot length, root length, leaf area and wet weight of *H. cannabinus* when treated with various vermicompost of T1, T2 and control (Table 10).

Trigonella foenumgraecum

Table 11: Physical and Chemical properties of soil (C) and the Vermicompost of *E. eugeniae* (T1) and *L. mauritii* (T2) after harvesting the *Trigonella foenumgraecum*

	Tex	LS	pH	EC	N %	P %	K %	Fe ppm	Zn ppm	Mn ppm	Cu ppm
Control (C)	SCL	P	8.5	0.5	0.77	0.29	0.86	17.16	0.13	25.67	3.54
Trial-1 (T1)	SCL	M	8.2	0.7	0.91	0.26	1.42	10.16	0.16	18.53	4.19
Trial-2 (T2)	SCL	P	8.2	0.5	0.83	0.54	2.18	25.86	0.11	23.20	2.66

Tex- Texture, LS- Lime status, EC-Electrical Conductivity, SCL-Sand, Clay, Loamy, P-Profuse, M-Medium

The results reported that N (1.64 %), P (0.63 %), Zn (2.17 ppm), Cu (4.19 ppm) and EC (0.70) content were greater in T1. The K (2.18 ppm) and Fe (25.86 ppm) was more in T2 while pH (8.50) and Mn (25.67 ppm) content was larger in control (C) (Table 11).

Shoot length

Table 12: Effects of vermicompost on shoot length of *Trigonella foenumgraecum*

Days	Control (C) (cm)	Trial -1 (T1) (cm)	Trial -2 (T2) (cm)
7	2.10±0.30	2.80±0.20	3.50±0.02
14	4.51±0.03	5.50±0.04	6.10±0.33
21	7.50±0.03	8.51±0.04	8.03±0.24
28	11.49±0.03	13.03±0.24	12.13±0.42

Values are mean of six observations, ±standard deviation
C- Control (Soil only)
T1- Vermicompost of E. eugeniae + Soil (1:1)
T2- Vermicompost of L. mauritii + Soil (1:1)

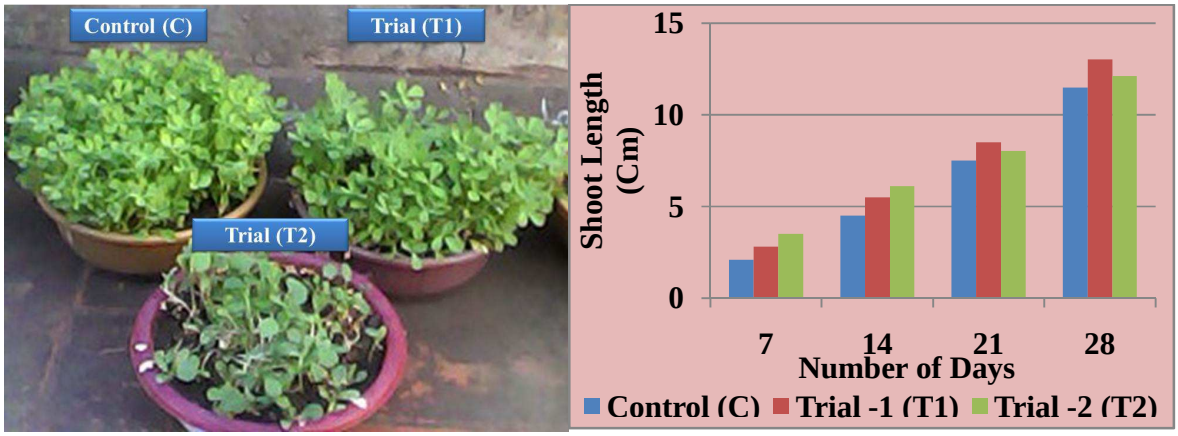

Fig. 7 and 8: Effects of vermicompost on shoot length of *Trigonella foenumgraecum*

The results (Table 12 and Fig. 7) showed that the average shoot length of *T. F. graecum*was moderately influenced by the application of various vermicompost (T1 and T2) at the end of every week with respect to control (C). After 4th week of harvesting the average plant height of 13.03 cm (13.03±0.24) was observed in the plants treated with vermicompost of *E. eugeniae* (T1). The average shoot length of 12.13 cm (12.13±0.42) and 11.49 cm (11.49±0.03) were noted in plants applied with vermicompost of *L. mauritii* (T2) and control plant (C) respectively (Fig. 8).

Growth parameters

Table 13: Effects of vermicompost on growth parameters of *Trigonella foenumgraecum* after 28 days of harvesting

Growth Parameters	Control (C)	Trial -1 (T1)	Trial - 2 (T2)
Leaf area index (cm^2)	6.20±0.20	12.30±0.25	8.74±0.03
Shoot length (cm)	11.49±0.03	13.03±0.24	12.13±0.42
Root length (cm)	12.0±0.14	10.0±0.14	9.0±0.14
Wet weight of plant (g)	9.20±0.14	8.40±0.14	4.0±0.14

Values are mean of six observations, ±standard deviation
C- Control (Soil only)
T1- Vermicompost of E. eugeniae + Soil (1:1)
T2- Vermicompost of L. mauritii + Soil (1:1)

The leaf area, shoot length, root length and wet weight of *T. F. graecum* were significantly influenced by the application of vermicompost at the end of every week. After 4th week of harvesting the average leaf area 12.3 cm^2 (12.3±0.25) was observed in the plants treated with vermicompost of *E. eugeniae* (T1). The average leaf area of 8.74 cm^2 (8.74±0.03) and 6.2 cm^2 (6.2±0.20) were noted in plants applied with vermicompost of *L. mauritii* (T2) and control plants (C) respectively.

After harvesting the average root length 12 cm (12±0.14) was observed in the control plants (C). The average root length of 10 cm (10±0.14) and 9 cm (9±0.14) were noted in the plants applied with vermicompost of *E. eugeniae* (T1) and vermicompost of *L. mauritii* (T2) respectively.

After 28th day of harvesting the average wet weight of plants 9.2 g (9.2±0.14) was observed in the control plants. The average wet weight of 8.4 g (8.4±0.14) and 4 g (4±0.14) were noted in the plants applied with vermicompost of *E. eugeniae* (T1) and *L. mauritii* (T2) respectively (Table 13 and Fig. 9).

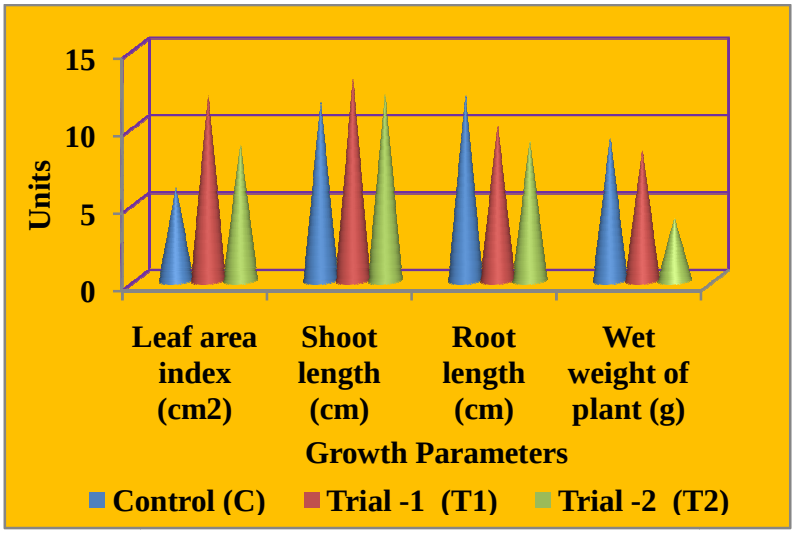

Fig. 9: Effects of vermicompost on growth parameters of *Trigonella foenumgraecum*

Table 14: ANOVA for different growth parameters of *Trigonella foenumgraecum* after 28 days of harvesting

		Sum of Squares	Degree of freedom	Mean Square	F
Shoot Length	Between Groups	7.240	2	3.620	46.4154
	Within Groups	1.169	15	0.078	
	Total	8.410	17		
Root Length	Between Groups	28.000	2	14.000	700.005
	Within Groups	0.299	15	0.020	
	Total	28.300	17		
Leaf Area	Between Groups	112.636	2	56.318	1547.208
	Within Groups	0.546	15	0.036	
	Total	113.183	17		
Wet Weight	Between Groups	94.080	2	47.040	2352
	Within Groups	0.300	15	0.020	
	Total	94.380	17		

The tablulated value of "F" for given d.f. at 1% level is 6.51.

The tabulated value of F for the given degree of freedom (i.e. 2 and 15), at 1% level is 6.51 is much less than the calculated value of all variables of *T. F. graecum*. Thus the hypothesis was rejected and concluded that there is a difference in the average value of shoot length, root length, leaf area and wet weight of *T. F. graecum* when treated with various vermicompost of T1, T2 and control (Table 14).

CONCLUSION

Vermicompost can be described as a complex mixture of earthworm faeces, humified organic matter and microorganisms, which when added to the soil or plant growing media increases germination, growth, flowering, fruit production and accelerates the development of a wide range of plant species. Stimulation of plant growth may depend mainly on the biological characteristics of vermicomposts, the plant species used, and the cultivation conditions. However, detailed aspects related to identify the suitable ratios of vermicompost and soil for different species of plant must be unraveled, in order to maximize yields.

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