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Research article

INFLUENCE OF VERMICOMPOSTS ON SOIL FERTILITY AND GROWTH OF AMARANTHUS PLANTS

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ABSTRACT: The present study cultured 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 two different amaranthus plants- *Amaranthus gangeticus* and *Amaranthus blitum* with respect to control soil. Comparative studies on growth (shoot length, wet weight, leaf area and root length) of the plants with relation to two different 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. Findings of the study confirm that *Amaranthus gangeticus* shows significant growth in *Eudrilus eugeniae* compost compared to *Lampito mauritii* with respect to control soil, whereas it is vice versa in the case of *Amaranthus blitum*.
Key words: *Eudrilus eugeniae, Lampito mauritii,* Vermicompost, *Amaranthus blitum, Amaranthus gangeticus*

INTRODUCTION

Earthworms (Annelida: Oligochaeta) contribute to soil fertility improvement, plant growth and play a key role in converting organic matter and composting garbage. There are about 3,627 species of terrestrial earthworms in the world [1]. Earthworms play many different roles in soil. They play an active role in soil organic matter dynamics and nutrient turnover. A significant proportion of the ingested material assimilated by earthworms is secreted as intestinal cutaneous mucus with a greater C/N ratio than original resources [2]. Results from laboratory experiments conducted over more than hundred years have indicated positive effects of earthworms on plant yield. Earthworms are becoming increasingly important as a common assay organism for soil fertility tests especially since they represent a major group in the terrestrial environments [3]. They are known to contribute to soil processes through faecal excretion in form of casts, burrows, feeding and digestion [4]. In the tropics, they are known to help in plant residue decomposition [5] and also convert plant residue into soil organic matter [6]. Vermicompost an organic source of plant nutrients contains a higher percentage of nutrients necessary for plant growth in readily available forms [7, 8] reported that diluted vermiwash and vermicomposting leachate when used as nutrient solution for *Plectranthus ambionicus*, chlorophyll and carotenoids content were higher if compared to control. 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. Vermicompost is a rich source of vitamins and growth hormones like gibberellins which regulate plant growth. At present information on the role of local earth worm fauna in soil fertility improvement is scanty and inconclusive. 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

Vermicomposting was prepared by means of monoculture method i.e. culturing two different species of earthworms separately.

Collection of earthworms

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).

Method of vermicomposting

A typical vermicomposting unit was be set up by first placing a basal layer of vermibed comprising broken bricks or pebbles followed by a layer of coarse sand to ensure proper drainage. This is followed by a layer of loamy soil and then a layer of saw dust was added. Small lumps of cattle dung (fresh or dry) may then be scattered over the soil to initiate the decomposing process, as the earthworms prefer partially decomposed organic matter in their diet. Then a layer of dry leaves and vegetable wastes were spread over.

The tank was kept moist by the addition of water by spraying or sprinkling over the surface taking care to avoid water logging. Water may be sprayed till the entire set up is moist but not wet. Less water kills the worms and too much chases them away. Coconut husks are placed over it to maintain the moisture content. The tanks were watered daily for the escape of gases formed and cooling.

Then the selected species of earthworms were introduced in to the tanks and covered with old jute bags. The moisture was maintained at about 60 percent by watering the tanks daily. Covering with gunny bags cuts off light, keeps moisture level high at the surface which induces the worms to come to the surface for feeding [9].

Watering the tank is continued and the unit is monitored for 30 days. The appearance of juvenile earthworms by this time may be taken as a healthy sign. Organic refuse may be added from bed after removing gunny bags and 45 days later the compost would be ready for harvest. As the organic refuse changes into dark brown compost, addition of water is stopped. This would move the worms into vermibed. The compost (Fig. 1) was then collected from the tanks without disturbing the vermibed.

Experimental design

Chemical and physical properties of the experimental garden soil and vermicompost were taken for the nutrient and trace element analysis. Each experimental tray was 7.5 cm long and 20 cm wide with 2kg capacity. The control trays (C) were filled up with 1500g of garden soil and the experimental trays (T1 and T2) were filled up with 750g of garden soil and 750g of vermicompost (1:1). The seeds were directly sown by hand into the trays at a rate of 1 tablespoon to a depth of 2 cm. There was no incidence of pest or disease on the plants during the experimental period. Weeding was done manually and the trays were watered daily. All necessary cultural practices and plant protection measures were followed uniformly for all the trays during the entire period of experimentation.

Selected plants

Seeds of two different short duration amaranthus plants are chosen, namely

- *Amaranthus gangeticus* also known as elephant-head amaranth is an annual flowering plant with deep purple flowers and it belongs to the family Amaranthaceae.
- *Amaranthus blitum* also known as purple amaranth is an annual plant species and it belongs to the family Amaranthaceae.

Experimental analysis

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) [10, 11]. 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 at Tamil Nadu Agricultural University, Department of Soil and Environment, Agricultural College and Research Institute, Madurai.

Statistical analysis

The results obtained in the study were statistically analyzed and the data were expressed in mean ± Standard Deviation from replicate (six) determination. The experimental data obtained were analyzed by using one-way Analysis of Variance (One-way ANOVA) technique.

RESULTS AND DISCUSSION

The pH and EC value of vermicompost of *E. eugeniae* was higher (7.75 and 0.70) than that 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 vermicompost of *L. mauritii* (1.06%, 0.50%, 0.86%) respectively. The amount of micronutrients like Iron and Manganese was higher in *L. mauritii* castings except Zinc and Copper (Table 1). 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).

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 *Eudrilus eugeniae*	7.75	0.70	1.27	0.65	1.05	3.57	3.64	3.34	3.20
Vermicompost of *Lampito mauritii*	7.68	0.50	1.06	0.50	0.86	5.93	2.15	5.90	2.50

EC-Electrical Conductivity

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

	Tex	LS	pH	EC	N%	P%	K%	Fe ppm	Zn ppm	Mn ppm	Cu ppm
Control (C)	SCL	P	8.30	0.40	0.64	0.29	0.82	6.71	0.07	3.43	2.18
Trial-(T1)	SCL	P	8.03	0.55	0.96	0.47	0.94	5.14	1.86	3.39	2.69
Trial-2(T2)	SCL	P	7.99	0.45	0.85	0.4	0.84	6.32	1.11	4.67	2.34

EC-Electrical Conductivity

The results indicated that the N (1.05 %), P (0.50 %), Fe (26.12 ppm) and Mn (25.50 ppm) content was significantly increased in T1 followed by T2 and C. Likewise K (2.14 %), Zn (3.55 ppm) and Cu (4.43 ppm) content was greater in control. The pH (8.50) and EC (0.60) value is more or less equal in all (Table 3). The results revealed that the application of various kind of vermicompost (T1 and T2) had significant effect on the shoot length of *A. gangeticus* at the end of every week. After the 6th week of harvesting the maximum average shoot lengths 30.08 cm (30.08 ± 0.34) and 26.52 cm (26.52 ± 0.17) were observed in plants applied with vermicompost of *E. eugeniae* and *L. mauritii* respectively whereas, the average height of control plant was 16.05 cm (16.05 ± 0.40) (Fig. 2 and Fig. 3). The leaf area, shoot length, root length and wet weight of *A. gangeticus* were significantly influenced by the application of vermicompost (T1) at the end of every week. After the 6th week of harvesting the maximum average leaf area 10.5 cm^2 (10.5 ± 0.14) and 8.74 cm^2 (8.74 ± 0.03) were observed in plants applied with vermicompost of *E. eugeniae* and *L. mauritii* respectively whereas, the average leaf area of control plants was 5 cm^2 (5.05 ± 0.21). After the 42nd day of harvesting the maximum average root length 10 cm (10 ± 0.14) and 7 cm (7 ± 0.14) were observed in plants applied with vermicompost of *E. eugeniae* and control plants respectively whereas, the average root length of plants treated with vermicompost of *L. mauritii* was 6 cm (6 ± 0.14). At the end of harvesting the maximum average wet weight 12.5g (12.5 ± 0.14) and 10g (10 ± 0.14) were observed in plants applied with vermicompost of *L. mauritii* and *E. eugeniae* respectively whereas the average weight of control plants was 7.5g (7.5 ± 0.14) (Fig. 4). Table 5 clearly stated that N (1.02 %), P (0.53 %), Fe (25.66 ppm), Zn (1.96 ppm) and Cu (4.06 ppm) content in vermicompost T1 is very high when compared to C and T2. But EC (0.80), K (1.61 %) and Mn (24.06 ppm) were higher in vermicompost T2 than C and T1. The pH (8.70) was same in soil and T2 when compared to T1 (8.60). The results reported that with respect to control plant (C) the average height of plants T1 as well as T2 were significantly increased at the end of every week. At the time of harvesting (49th day) the highest average shoot length of 40.23 cm (40.23 ± 0.21) was noted in the plants treated with vermicompost of *L. mauritii* followed by the average shoot length of 33.45 cm (33.45 ± 0.33) in T1 and 24.2cm (24.2 ± 0.23) in C were recorded (Fig. 5 and Fig. 6).

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

	Tex	LS	pH	EC	N%	P%	K%	Fe ppm	Zn ppm	Mn ppm	Cu ppm
Control (C)	SCL	P	8.5	0.6	0.85	0.29	2.14	14.45	3.55	23.30	4.43
Trial-1(T1)	SCL	P	8.5	0.6	1.05	0.29	1.77	26.12	2.72	25.16	2.55
Trial-2(T2)	SCL	P	8.6	0.4	0.92	0.29	1.88	24.76	0.43	0.14	2.56

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

Table-4: ANOVA for different growth parameters of *Amaranthus gangeticus* after 42 days of harvesting.

		Sum of Squares	Degree of freedom	Mean Square	F
Shoot Length	Between Groups	638.413	2	319.206	3126.413
	Within Groups	1.531	15	0.102	
	Total	639.945	17		
Root Length	Between Groups	52.000	2	26.001	1300.005
	Within Groups	0.299	15	0.020	
	Total	52.300	17		
Leaf Area	Between Groups	92.897	2	46.448	2037.214
	Within Groups	0.341	15	0.022	
	Total	93.238	17		
Wet Weight	Between Groups	75	2	37.500	1875
	Within Groups	0.299	15	0.020	
	Total	75.3	17		

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

Table-5: Physical and chemical properties of soil (C) and the vermicompost of *E. eugeniae* (T1) and *L. mauritii* (T2) after harvesting the *A. blitum*.

	Tex	LS	pH	EC	N%	P%	K%	Fe ppm	Zn ppm	Mn ppm	Cu ppm
Control (C)	SCL	P	8.7	0.7	0.80	0.29	1.04	20.15	0.78	23.07	3.61
Trial-1 (T1)	SCL	P	8.6	0.7	0.81	0.05	1.12	25.66	1.96	23.10	4.06
Trial-2 (T2)	SCL	P	8.7	0.8	0.81	0.29	1.61	13.53	0.87	24.06	3.21

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

Table-6: ANOVA for different growth parameters of *Amaranthus blitum* after 49 days of harvesting.

		Sum of Squares	Degree of freedom	Mean Square	F
Shoot Length	Between Groups	777.287	2	388.643	5783.391
	Within Groups	1.008	15	0.067	
	Total	778.296	17		
Root Length	Between Groups	61.000	2	30.500	
	Within Groups	0.299	15	0.020	1525.005
	Total	61.300	17		
Leaf Area	Between Groups	1728.253	2	864.126	14950.290
	Within Groups	0.860	15	0.057	
	Total	1729.120	17		
Wet Weight	Between Groups	196.000	2	98.000	4900.005
	Within Groups	0.299	15	0.020	
	Total	196.300	17		

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

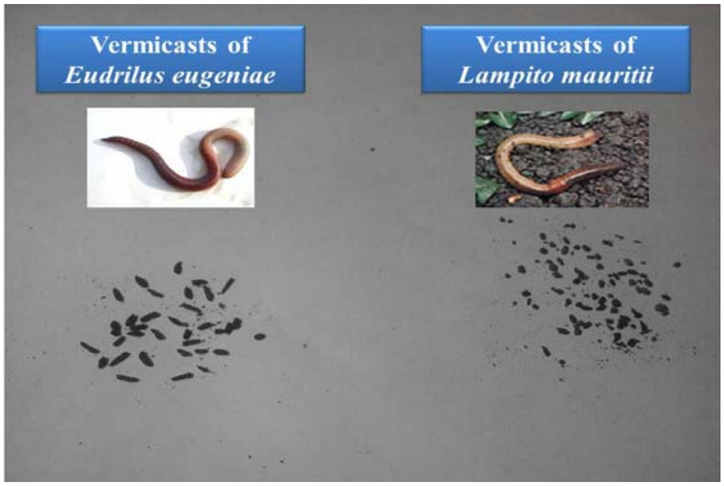
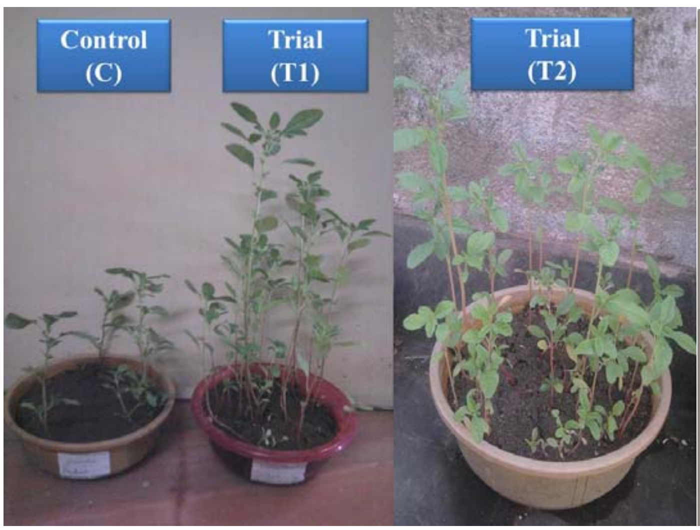


Fig. 1. Vermicomposts of *E. eugeniae* and *L. mauritii*



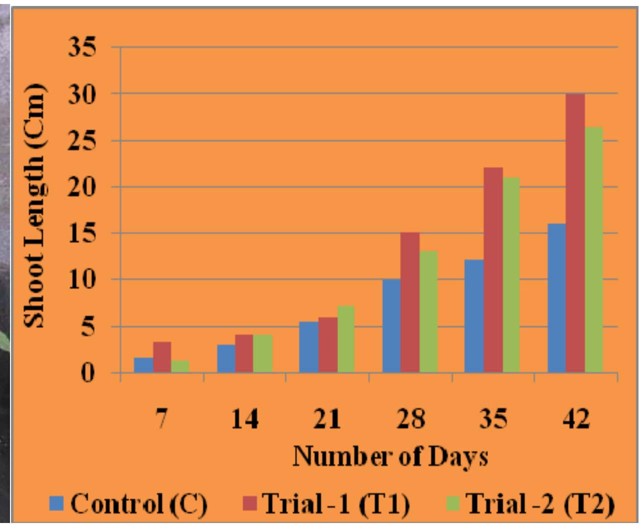


Fig. 2 and 3. Effects of vermicompost on shoot length of *Amaranthus gangeticus*.

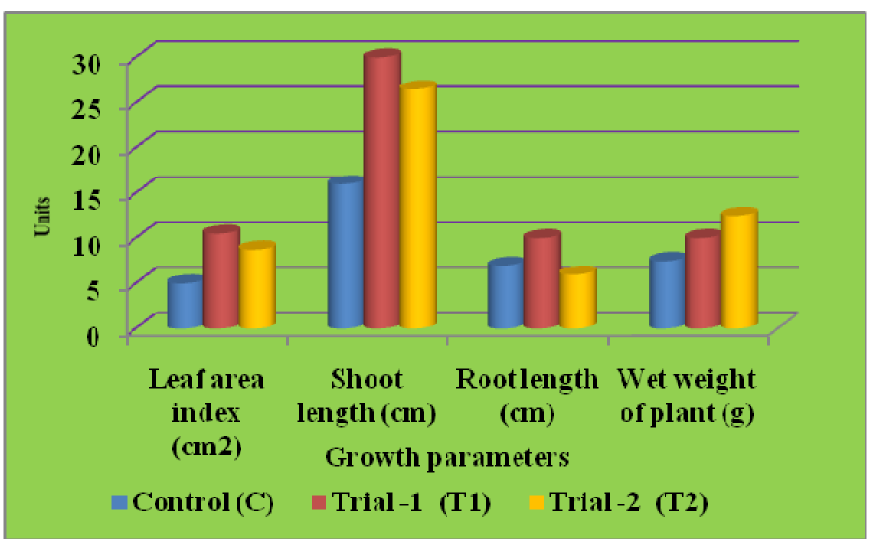
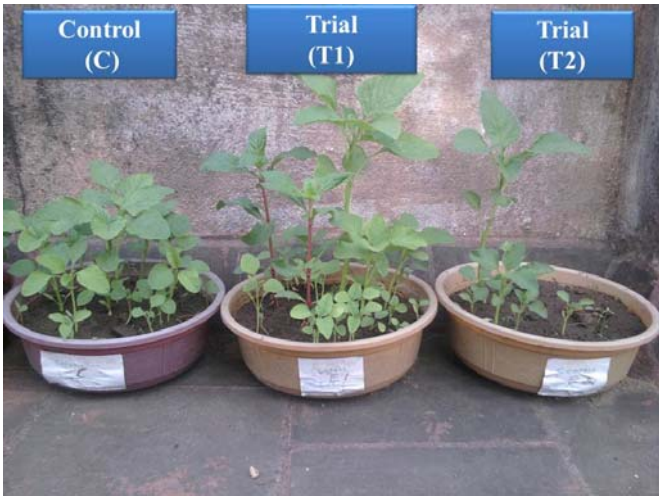


Fig. 4. Effects of vermicompost on growth parameters of *Amaranthus gangeticus.*



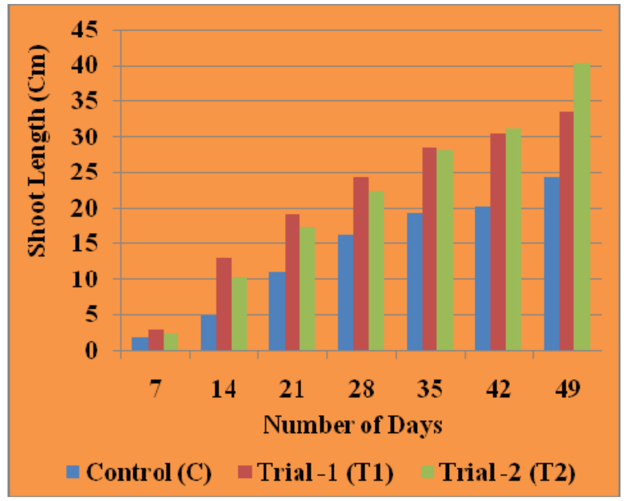


Fig 5 and 6.Effects of vermicompost on shoot length of *Amaranthus blitum*.

The leaf area, shoot length, root length and wet weight of *A. blitum* were significantly influenced by the application of vermicompost (T2) at the end of every week. At the end of harvesting the highest average leaf area of 40 cm^2 (40.16 ± 0.29) was noted in the plants treated with vermicompost of *L. mauritii* followed by the average leaf area of 31.4 cm^2 (31.4 ± 0.23) in T1 and 16.43 cm^2 (16.43 ± 0.17) in C were recorded. After 49th day the highest average root length of 14.5 cm (14.5 ± 0.14) was noted in the plants treated with vermicompost of *L. mauritii* followed by the average root length of 12 cm (12 ± 0.14) in T1 and 10 cm (10 ± 0.14) in C were recorded. At the time of harvesting the highest average wet weight of 15g (15 ± 0.14) was noted both in the plants treated with vermicompost of *L. mauritii* and control plants (C) followed by the average wet weight of 8g (8 ± 0.14) in T1 were recorded (Fig. 7). The tabulated value of F for the given degree of freedom (2 and 15), at 1% level is 6.51 which is less than the calculated value of all variables of *A. blitum* and *A. gangeticus*. Thus, there is a significant difference in the average value of shoot length, root length, leaf area and wet weight of *A. blitum* when treated with various vermicompost of T1, T2 and control (Table 4 and 6).

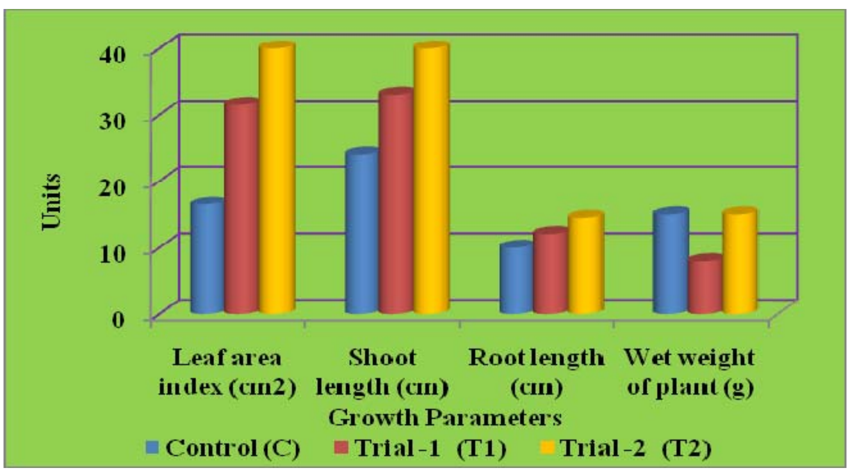


Fig. 7. Effects of vermicompost on growth parameters of *Amaranthus blitum.*

CONCLUSION

In conclusion, the study reveals that the 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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