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Effect of vermicompost produced out of different organic wastes by the epigeic earthworm, *Eisenia fetida* on germination and seedling growth of *Vigna radiata* (green gram)

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Abstract:

Vermicompost is one of the best organic fertilizers reported to contain a number of mineral nutrients, soil enzymes and microbes and also going to improve seed germination, seedling vigor and plant productivity rather than inorganic mineral nutrients. The present study was undertaken to know the influence of different vermicompost produced by the epigeic earthworm, *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, LGW and CM) amended with soil along with pure soil (PS) as control on germination and seedling growth such as root length, shoot length, number of leaves and leaflets of Green gram (Vigna radiata) at 10, 20, 30 days' time intervals maintained at uncontrolled environmental conditions.

The findings of the present research tells that the duration for seed germination in all the experimental pots was 5-6 days at 10, 20 and 30 days' time intervals. The root length of Green gram was higher in soils treated with vermicompost of CRW, CRW, CRW followed by CM, LGW, LGW; PS, PW, PS ; PW, PS, PW ;LGW, CM, CM and least in FAW, FAW, FAW at 10, 20, and 30 days' time intervals respectively. The shoot length was higher in vermicompost of LGW and least in Pure soil at 10, 20 and 30 days' time intervals among VC of different organic wastes and PS. Likewise, number of leaves and leaflets were also observed more in VC of LGW, CRW, CM followed by FAW, PW and least in PS among all the VC treated soils and PS. There is significant variation was observed among and between different VC treated soils and soil alone PS except between few parameters at 10, 20 and 30 days' time intervals.

On the basis of the above results, it can be concluded that the vermicompost produced by the epigeic earthworm, *E. fetida* out of different organic wastes have all the macro and micronutrients for better seedling growth and it can be used as an alternative organic biofertilizers so that it can reduce the dependance of chemical fertilizers

Key words: vermicompost, pure soil, *E. fetida*, Green gram and seedling growth

I. INTRODUCTION:

Earthworms have drawn the attention of philosophers and naturalists since ancient time as because of their great importance in soil formation and their improvement. The famous Greek philosopher Aristotle described the earthworms as "The Intestine of Earth", as early as 384-322 BC (Tripathi, 2003). Earthworms and their casts are very much useful in land improvement, reclamation and also in organic waste management (Edwards and Baker, 1992; Lavelle and Martin, 1992; Johnson, 1997; Villenave *et.al*., 1999). Earthworms eat soil organic matter and litter that in turn increase availability of plant nutrients in their casts (Brown *et. al.,* 2004). vermicomposting is an important aspect of vermitechnology involving the use of earthworms for processing various types of organic wastes into valuable resources. Now a days vermicompost is successfully used to clean up environment, (Lal *et.al*, 2003) by improving the soil texture, porosity and aeration (Kannan, *et.al.* 2011).

In the past few years, factory units of fertilizers are releasing various kinds of hazardous by-products that can pollute air, water and soil, if proper preventive measures are not taken. (Edward, 1998). More and more chemical fertilizer are currently used, the repeated use of chemicals in tropical lands is showing an increasingly adverse effect on soil properties, productivity and fertility. (Edwards, 1998)

Agricultural production of India increased remarkably during 60s onwards as a result of "Green Revolution" (Gupta, 1996). India could achieve self- sufficiency in agriculture by an increased use of chemical fertilizers. These chemicals deteriorate soil health and also the environment. Human beings and cattle were adversely affected due to the residues of these agro-chemicals in food products (Kumar and Bohra, 2006).

In developing countries like India, to meet the needs of short duration crops, which have evolved in the present day agriculture systems about reduction in the levels of pollution, which may be caused by different sources has been emphasized, where the trend is to switch over to more ecofriendly organic farming, Jambekar (1994) demonstrated an encouraging results about the improvements in the fertility status of the soil in wine yards due to the presence of earthworms and their effects on yield of grapes.

Epigeic earthworms are used in bioprocessing of different organic wastes such as coffee pulp (Arellano *et. al.,* 1994), sugar factory waste (Kale *et. al.,* 1994) and pig solids (Dominquez and Edwards, 1997) could all be converted into good quality soil additives in the form of vermicompost along with the worm biomass as vermiprotein.

Vermicompost is one of the best organic fertilizers reported to contain a number of mineral nutrients, soil enzymes and microbes (Dominguez, 2004) and also going to improve seed germination, seedling vigor and plant productivity rather than inorganic mineral nutrient (Gopalkrishnan *et. al.,* 2012).

The exudates of gut microorganisms as well as earthworms has a stimulatory effect on plant growth (Ross and Cairns, 1982). Springett and Syers (1979) have reported an increase in net crop production on application of worm casts. Similar information is also available on improvement in the growth and yield of crops as influenced by the worm exudates. Tomati *et. al.* (1990) have reported about the presence of growth regulatory substances in worm-worked soils. Increase in the rates and uptake of nutrients with the increase in a symbiotic microbial association in cereal and ornamental plants was observed by using vermicompost as a source of organic manure (Kale *et. al.* 1987, 1992). Vermicompost contain bioactive substances like plant growth regulators (Arancon *et. al.,* 2005).

Pulses are cheapest source of quality protein for human being. Green gram is one of the important and widely cultivated crop in India. Excessive use of nutrients by farmers is one of the most vital limiting factors for crop productivity especially in pulses (Sanchita Bhattacharya 2019). Thus, it is necessary to see the effects of vermicompost on the growth parameters of green gram (*V. radiata).*

Therefore, the present study aims to see the influence of different vermicompost produced out of various organic wastes by the epigeic earthworm, *Eisenia fetida* on germination and seedling growth of green gram crop (*Vigna radiata*)

II. MATERIALS AND METHODS:

a. Collection of vermicompost:

The vermicompost produced by using a epigeic earthworm, *Eisenia fetida* out of different organic wastes such as False Ashoka (*Polyalthia longifolia*), Parthenium waste (*Parthenium hysterophorus*), Cotton residue waste (*Gossypium*), Lawn grass waste (*Agrostis*) and Cattle manure were collected from previous experiment & used for the present experiment.

b. Experimental setup:

Healthy certified seeds of *V. radiata* were selected and used for study purpose. Five water washed seeds of green gram were introduced in each earthen pots of size 11 cm diameter X 10 cm height in triplicates with following experimental sets.

1) 15:1 soil & vermicompost of False Ashoka waste (*P. longifolia*).
2) 15:1 soil & vermicompost of Parthenium waste (*P. hysterophorus*).
3) 15:1 soil & vermicompost of Cotton residue waste (*Gossypium*).
4) 15:1 soil & vermicompost of Lawn grass waste (*Agrostis*).
5) 15:1 soil & vermicompost of Cattle manure.
6) Soil alone as control.

Sown seeds in all the pots were placed in proper sunlight with regular watering. The observations were made with respect to germination of seeds and other parameters like root length, shoot length, number of leaves and leaf lets at 10, 20 and 30 days of time intervals, respectively.

c. Statistical analysis:

All the experimental data were expressed in Mean ± SE. The analysis of variance (ANOVA) was carried out by using SPSS program to determine significant difference between different experimental setups along with soil alone as control experiments ($P \leq 0.05$).

III. RESULTS AND DISCUSSION:

The present work was carried out to know the influence of vermicompost produced out of different organic wastes on germination and growth of green gram (*Vigna radiate* L.) through different experimental setups and were represented in Table-1 to 6; Graph-1 to 5 and figures-1 to 3.

1. Germination:

The germination of seeds of green gram were observed from day one onwards in the sowing pots. The germination took about 5 to 6 days in all the experimental pots (Table -1 and Graph- 1). As such there is no significant difference was observed in germination of seeds among and between different experimental pots (Table-1) except between some pots at different time intervals 10, 20 and 30 days (Table-2).

2. Root length:

The root length of the green gram grown in different experimental pots was observed on 10, 20 and 30 days of time intervals. The maximum root length was observed in cotton residue waste (12.00±.57) followed by lawn grass waste (11.50±.28), Pure soil (10.00±.28), Parthenium waste (8.96±.20), Cattle manure (8.58±.22) and minimum in False Ashoka waste (8.00±.28) at 30 days of time intervals (Table-1 and Graph-2). There is a significant difference was observed in root length of green gram among and between different vermicomposts and soil alone as control (Table-1 and Table-3) except between some experimental pots like between 20 days of False Ashoka and 10 days of Parthenium waste; between 30 days of False Ashoka and 20 days of Parthenium waste; between 30 days of False Ashoka and 10, 20, 30 days of cattle manure and 10, 20 of days Pure soil; between 10 days of Parthenium waste and 10 days of Cattle manure; between 20 days of Parthenium waste and 20, 30 days of Cattle

manure and 10, 20 days of Pure soil; between 30 days of Parthenium waste and 20 days of Lawn waste, 20 and 30 days of Cattle manure and 20 days of Pure soil. Between 10 days of Cotton residue waste and 20 days of Lawn waste (Table-3).

3. Shoot length:

The shoot length of the green gram grown in different experimental pots were observed on 10, 20 and 30 days of time intervals (Table – 1 and Graph – 3). Maximum shoot length was observed in lawn waste (11.23±.43) followed by cotton waste (10.46±.29), Parthenium waste (10.23±.14), False Ashoka waste (10.06±.12), Cattle manure (10.06±.23) and minimum in Pure soil (9.70±.11) at 30 day of time interval. There is no significant difference was noticed in shoot length of green gram among and between soils treated with different vermicomposts and soil alone as control (Table-1 and Table-4) except between few combinations of different vermicompost and soil alone.

The significant difference was observed between 10, 20 days of False Ashoka waste and 30 days of Parthenium waste, 20 days and 30 days of Cotton residue waste; 10, 20, 30 days of Lawn grass waste; 10 days of False Ashoka waste and 30 days of Cattle manure; between 30 days of False Ashoka and 20, 30 days of Lawn grass waste, 10 days of cattle manure, 10 and 20 days of Pure soil; 10 days of Parthenium waste and 20, 30 days of Cotton residue wastes, 10, 20, 30 days of Lawn grass waste, 30 days of Cattle manure; between 20 days of Parthenium wastes and 20, 30 days of Cotton residue wastes, 10, 20, 30 days of Lawn grass waste; between 30 days of Parthenium waste and 20, 30 days of Lawn grass waste, 10, 20 days of Cattle manure, 10, 20 days of Pure soil; between 10 days of Cotton residue waste and 10, 20 ,30 days of Lawn grass wastes; between 20, 30 days of Cotton residue waste and 30 days Lawn grass waste, 10, 20 days Cattle manure, 10, 20, 30 days of Pure soil; between 10, 20, 30 days of Lawn wastes and 10, 20 days of Cattle manure, 10, 20, 30 days Pure of soil; between 30 days of Cattle manure and 10, 20 days of Pure soil (Table-4).

4. Number of leaves and leaflets:

Similarly, the number of leaves and leaflets of green gram were also counted on 10, 20 and 30 days of time intervals (Table-1 and Graph-4 & 5). Maximum leaves and leaflets were noticed in cattle manure (CM), CRW, G/LGW (11.00±.00 & 3.00±.00) followed by False Ashoka waste (10.00±1.00) and Parthenium waste (10.00±1.00) and least number of both were noticed in Pure soil (control) (8.00±.00 & 2.00±.00) at 30 days of time intervals. Here, also there is a significant variation (≤0.05) was observed in number of leaves and leaflets among and between different vermicomposts and soil alone except between few combinations (Table-1 & Table-5&6).

There is no significant difference was noticed in the number of leaves between10, 20 & 30 days of False Ashoka and 10, 20 & 30 days of Parthenium wastes, Cotton residue wastes and Cattle manure respectively (Table-5). Similarly, no significant difference was also observed in the number of leaflets between 10, 20 and 30 days of False Ashoka waste and 10, 20 and 30 days of Parthenium wastes, Cotton residue wastes, Lawn grass wastes and Cattle manure respectively; between 10, 20, 30 days of Parthenium wastes and 10, 20, 30 days of Cotton residue wastes and Cattle manure (Table-6).

Maximum percentage of seed germination was observed for vermicompost treated soil in *V. mungo* (Javed and Panwar, 2013). Mc Coll *et.al.* (1982) have also observed similar results of seed germination for wheat seeds. Nijawan and Kanwar (1952) have observed similar results of increased root length in the application of earthworm compost than the control in wheat and other crops. Application of vermicasts have also showed significant increase in the length and weight of the shoot and root systems in the sorghum plant (Reddy *et. al.* 1994).

Percentage of seed germination and seedling length and growth parameters such as shoot length root length, number of leaves per plant and leaf area or size of tomato increased (*Lycopersicum esculentum*) when grown in vermicompost amended soil as compared to other treated soil (Eswaran and Mariselvi, 2016) which correlated with our present findings. These increased parameters may be due to the increased soil moisture content, soil porosity by the application of vermicompost (Mahmud *et. al*., 2016). Application of vermicompost improve average root and shoot length of the tested crop over control set.

In case of *Pisum sp.* and *Cicer sp*. plant grown in vermicompost pre-treated soil showed maximum increase in morphological parameters such as root length, shoot length, number of root branches, number of leaves, number of root nodules in four months sampling in comparison to control set (Sinha *et. al.*, 2010), these results also supported the present findings of our studies.

Hopkins (1995) have also reported that vermicompost increase the plant growth and development as well as crop quality significantly. Jadhav (1996) have reported a reduction of 50% nitrogen of the recommended dose of nitrogen was supplemented by the use of vermicompost.

Table-1. The data of germination and seedling growth parameters of *Vigna radiate* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, LGW and CM) and in pure soil as control with F and P values. Data are in Mean ± SE.

Sl No.	Organic wastes	Days	Germination (in days)	Root length (cms)	Shoot length (cms)	No. of Leaves	No. of Leaflets
1	False Ashoka waste	10	5.33±.33	5.00±.28	9.40±.20	2.00±.00	00±.00
		20	5.33±.33	7.00±.28	9.54±.14	5.00±.00	1.33±.33
		30	5.33±.33	8.00±.28	10.06±.12	10.00±1.00	2.66±.33
2	Parthenium waste	10	5.33±.33	6.26±.14	9.33±.12	2.00±.00	.00±.00
		20	5.00±.00	8.58±.22	9.75±.14	5.00±.00	.00±.00
		30	5.00±.00	8.96±.20	10.23±.14	10.00±1.00	2.66±.33
3	Cotton residue waste	10	5.33±.33	9.93±.23	9.73±.14	2.00±.00	.00±.00
		20	5.33±.33	11.76±.39	10.43±.29	5.00±.00	1.00±.00
		30	6.33±.33	12.00±.57	10.46±.29	11.00±.00	3.00±.00
4	Lawn grass waste	10	5.33±.33	6.50±.28	10.56±.23	2.00±.00	.00±.00
		20	5.33±.33	9.25±.14	11.00±.28	7.00±1.00	1.66±.33
		30	6.00±.57	11.50±.28	11.23±.43	11.00±.00	3.00±.00
5	Cattle manure	10	5.33±.33	8.00±.28	9.20±.15	2.00±.00	.00±.00
		20	5.33±.33	8.25±.14	9.53±.17	5.00±.00	1.00±.00
		30	5.33±.33	8.58±.22	10.06±.23	11.00±.00	3.00±.00
6	Pure Soil (Control)	10	5.00±.00	8.00±.11	9.26±.14	2.00±.00	.00±.00
		20	5.00±.00	8.56±.06	9.46±.08	5.00±.00	1.00±.00
		30	5.66±.33	10.00±.28	9.70±.11	8.00±.00	2.00±.00
7	F-VALUE		1.17	47.85	8.11	75.00	56.05
8	P-VALUE		0.33	0.00	0.00	0.00	0.00

Table-2. Significant variation (≤0.05) in germination of *V. radiata* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, LGW, and CM) and pure soil as control.

Sl. No.	Organic wastes	No. of Days	False Ashoka waste			Parthenium waste			Cotton residue waste			Lawn grass waste			Cattle manure			Pure soil (Control)		
			10	**20**	**30**	**10**	**20**	**30**	**10**	**20**	**30**	**10**	**20**	**30**	**10**	**20**	**30**	**10**	**20**	**30**
1	**False Ashoka waste**	**10**	------	1.00	1.00	1.00	.45	.45	1.00	1.00	**.03**	1.00	1.00	.14	1.00	1.00	1.00	.45	.45	.45
		20	1.00	------	1.00	1.00	.45	.45	1.00	1.00	**.03**	1.00	1.00	.14	1.00	1.00	1.00	.45	.45	.45
		30	1.00	1.00	------	1.00	.45	.45	1.00	1.00	**.03**	1.00	1.00	.14	1.00	1.00	1.00	.45	.45	.45
2	**Parthenium waste**	**10**	1.00	1.00	1.00	------	.45	.45	1.00	1.00	**.03**	1.00	1.00	.14	1.00	1.00	1.00	.45	.45	.45
		20	.45	.45	.45	.45	------	1.00	.45	.45	**.00**	.45	.45	**.03**	.45	.45	.45	1.00	1.00	.14
		30	.45	.45	.45	.45	1.00	------	.45	.45	**.00**	.45	.45	**.03**	.45	.45	.45	1.00	1.00	.14
3	**Cotton residue waste**	**10**	1.00	1.00	1.00	1.00	.45	.45	------	1.00	**.03**	1.00	1.00	.14	1.00	1.00	1.00	.45	.45	.45
		20	1.00	1.00	1.00	1.00	.45	.45	1.00	------	**.03**	1.00	1.00	.14	1.00	1.00	1.00	.45	.45	.45
		30	**.03**	**.03**	**.03**	**.03**	**.00**	**.00**	**.03**	**.03**	----	**.03**	**.03**	.45	**.03**	**.03**	**.03**	**.00**	**.00**	.14
4	**Lawn grass waste**	**10**	1.00	1.00	1.00	1.00	.45	.45	1.00	1.00	**.03**	------	1.00	.14	1.00	1.00	1.00	.45	.45	.45
		20	1.00	1.00	1.00	1.00	.45	.45	1.00	1.00	**.03**	1.00	------	.14	1.00	1.00	1.00	.45	.45	.45
		30	.14	.14	.14	.14	**.03**	**.03**	.14	.14	.45	.14	.14	------	.14	.14	.14	**.03**	**.03**	.45
5	**Cattle manure**	**10**	1.00	1.00	1.00	1.00	.45	.45	1.00	1.00	**.03**	1.00	1.00	.14	------	1.00	1.00	.45	.45	.45
		20	1.00	1.00	1.00	1.00	.45	.45	1.00	1.00	**.03**	1.00	1.00	.14	1.00	------	1.00	.45	.45	.45
		30	1.00	1.00	1.00	1.00	.45	.45	1.00	1.00	**.03**	1.00	1.00	.14	1.00	1.00	------	.45	.45	.45
6	**Pure soil (Control)**	**10**	.45	.45	.45	.45	1.00	1.00	.45	.45	**.00**	.45	.45	**.03**	.45	.45	.45	------	1.00	.14
		20	.45	.45	.45	.45	1.00	1.00	.45	.45	**.00**	.45	.45	**.03**	.45	.45	.45	1.00	-----	.14
		30	.45	.45	.45	.45	.14	.14	.45	.45	.14	.45	.45	.45	.45	.45	.45	.14	.14	------

Table-3. Significant variation (≤0.05) in root length of *V. radiata* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, LGW, and CM) and pure soil as control.

Sl. No.	Organic wastes	No. of Days	False Ashoka waste			Parthenium waste			Cotton residue waste			Lawn grass waste			Cattle manure			Pure soil (Control)		
			10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30
1	False Ashoka waste (FAW)	10	-----	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		20	.00	-----	.01	**.06**	.00	.00	.00	.00	.00	**.20**	.00	.00	.01	.00	.00	.01	.00	.00
		30	.00	.01	-----	.00	**.14**	.01	.00	.00	.00	.00	.00	.00	**1.00**	**.52**	**.14**	**1.00**	**.15**	.00
2	Parthenium waste (PW)	10	.00	**.06**	.00	-----	.00	.00	.00	.00	.00	**.55**	.00	.00	.00	.00	.00	.00	.00	.00
		20	.00	.00	**.14**	.00	-----	**.32**	.00	.00	.00	.00	**.09**	.00	**.14**	**.39**	**1.00**	**.14**	**.96**	.00
		30	.00	.00	.01	.00	**.32**	-----	.01	.00	.00	.00	**.46**	.00	.01	**.07**	**.32**	.01	**.30**	.01
3	Cotton residue waste (CRW)	10	.00	.00	.00	.00	.00	.01	-----	.00	.00	.00	**.08**	.00	.00	.00	.00	.00	.00	**.86**
		20	.00	.00	.00	.00	.00	.00	.00	-----	**.55**	.00	.00	**.49**	.00	.00	.00	.00	.00	.00
		30	.00	.00	.00	.00	.00	.00	.00	**.55**	-----	.00	.00	**.20**	.00	.00	.00	.00	.00	.00
4	Lawn grass waste (G/LGW)	10	.00	**.20**	.00	**.55**	.00	.00	.00	.00	.00	-----	.00	.00	.00	.00	.00	.00	.00	.00
		20	.00	.00	.00	.00	**.09**	**.46**	**.08**	.00	.00	.00	-----	.00	.00	.01	**.09**	.00	**.08**	**.06**
		30	.00	.00	.00	.00	.00	.00	.00	**.49**	**.20**	.00	.00	-----	.00	.00	.00	.00	.00	.00
5	Cattle manure (CM)	10	.00	.01	**1.00**	.00	**.14**	.01	.00	.00	.00	.00	.00	.00	-----	**.52**	**.14**	**1.00**	**.15**	.00
		20	.00	.00	**.52**	.00	**.39**	**.07**	.00	.00	.00	.00	.01	.00	**.52**	-----	**.39**	**.52**	**.41**	.00
		30	.00	.00	**.14**	.00	**1.00**	**.32**	.00	.00	.00	.00	**.09**	.00	**.14**	**.39**	-----	**.14**	**.96**	.00
6	Pure soil (Control)	10	.00	.01	**1.00**	.00	**.14**	.01	.00	.00	.00	.00	.00	.00	**1.00**	**.52**	**.14**	-----	**.15**	.00
		20	.00	.00	**.15**	.00	**.96**	**.30**	.00	.00	.00	.00	**.08**	.00	**.15**	**.41**	**.96**	**.15**	-----	.00
		30	.00	.00	.00	.00	.00	.01	**.86**	.00	.00	.00	**.06**	.00	.00	.00	.00	.00	.00	-----

Table-4. Significant variation (≤0.05) in shoot length of *V. radiata* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, G/LGW, and CM) and pure soil as control.

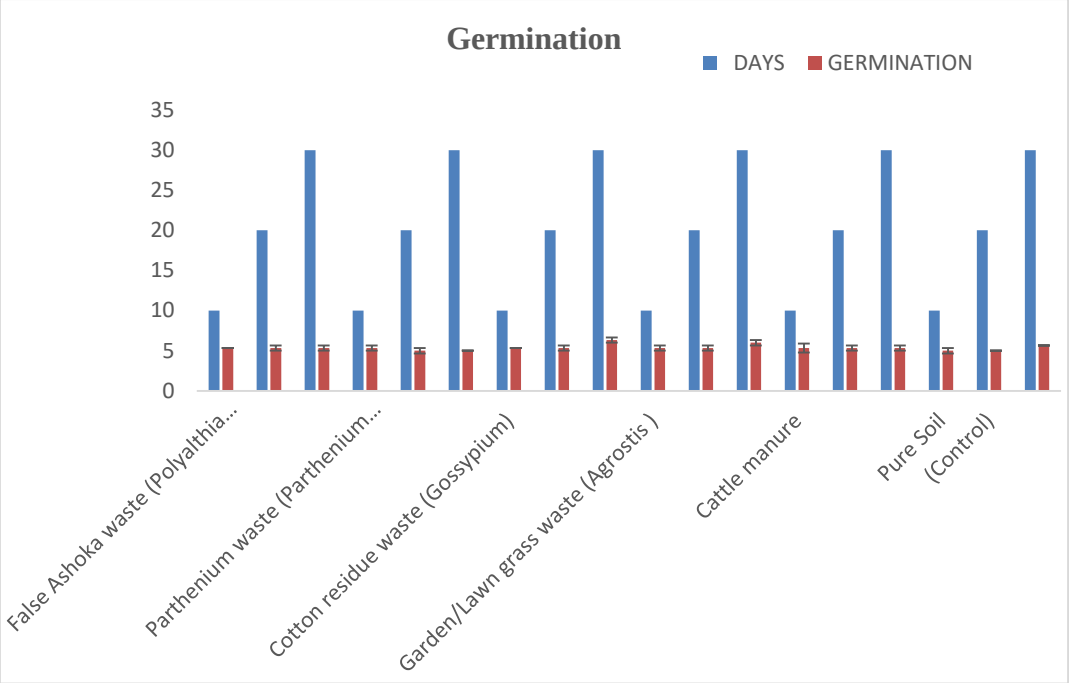
Sl. No.	Organic wastes	No. of Days	False Ashoka waste			Parthenium waste			Cotton residue waste			Lawn grass waste			Cattle manure			Pure soil (Control)		
			10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30
1	False Ashoka waste	10	-----	.63	**.03**	.82	.25	**.00**	.27	**.00**	**.00**	**.00**	**.00**	**.00**	.50	.65	**.03**	.65	.82	.32
		20	.63	-----	.08	.48	.49	**.02**	.52	**.00**	**.00**	**.00**	**.00**	**.00**	.25	.97	.08	.36	.79	.60
		30	**.03**	.08	-----	**.01**	.29	.58	.27	.22	.18	.10	**.00**	**.00**	**.00**	.08	1.00	**.01**	**.05**	.22
2	Parthenium waste	10	.82	.48	**.01**	-----	.17	**.00**	.18	**.00**	**.00**	**.00**	**.00**	**.00**	.65	.50	**.01**	.82	65	22
		20	.25	.49	.29	.17	-----	.11	.95	**.02**	**.02**	**.01**	**.00**	**.00**	.07	.47	.29	.11	.35	.86
		30	**.00**	**.02**	.58	**.00**	.11	-----	.10	.50	.44	.27	**.01**	**.00**	**.00**	**.02**	.58	**.00**	**.01**	.08
3	Cotton residue waste	10	.27	.52	.27	.18	.95	.10	-----	**.02**	**.01**	**.00**	**.00**	**.00**	.08	.50	.27	.12	.37	.91
		20	**.00**	**.00**	.22	**.00**	**.02**	.50	**.02**	-----	.91	.65	.06	**.01**	**.00**	**.00**	.22	**.00**	**.00**	**.01**
		30	**.00**	**.00**	.18	**.00**	**.02**	.44	**.01**	.91	-----	.74	.08	**.01**	**.00**	**.00**	.18	**.00**	**.00**	**.01**
4	Lawn grass waste	10	**.00**	**.00**	.10	**.00**	**.01**	.27	**.00**	.65	.74	-----	.15	**.03**	**.00**	**.00**	.10	**.00**	**.00**	**.00**
		20	**.00**	**.00**	**.00**	**.00**	**.00**	**.01**	**.00**	.06	.08	.15	-----	.44	**.00**	**.00**	**.00**	**.00**	**.00**	**.00**
		30	**.00**	**.00**	**.00**	**.00**	**.00**	**.00**	**.00**	**.01**	**.01**	**.03**	.44	-----	**.00**	**.00**	**.00**	**.00**	**.00**	**.00**
5	Cattle manure	10	.50	.25	**.00**	.65	.07	**.00**	.08	**.00**	**.00**	**.00**	**.00**	**.00**	-----	.27	**.00**	.82	.37	.10
		20	.65	.97	.08	.50	.47	**.02**	.50	**.00**	**.00**	**.00**	**.00**	**.00**	.27	-----	.08	.37	.82	.58
		30	**.03**	.08	1.00	**.01**	.29	.58	.27	.22	.18	.10	**.00**	**.00**	**.00**	.08	-----	**.01**	**.05**	.22
6	Pure soil (Control)	10	.65	.36	**.01**	.82	.11	**.00**	.12	**.00**	**.00**	**.00**	**.00**	**.00**	.82	.37	**.01**	-----	.50	.15
		20	.82	.79	**.05**	.65	.35	**.01**	.37	**.00**	**.00**	**.00**	**.00**	**.00**	.37	.82	**.05**	.50	-----	.44
		30	.32	.60	.22	.22	.86	.08	.91	**.01**	**.01**	**.00**	**.00**	**.00**	.10	.58	.22	.15	.44	-----

Table-5. Significant variation (≤0.05) in number of leaves of *V. radiata* (green gram) crop grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, LGW, and CM) and pure soil as control.

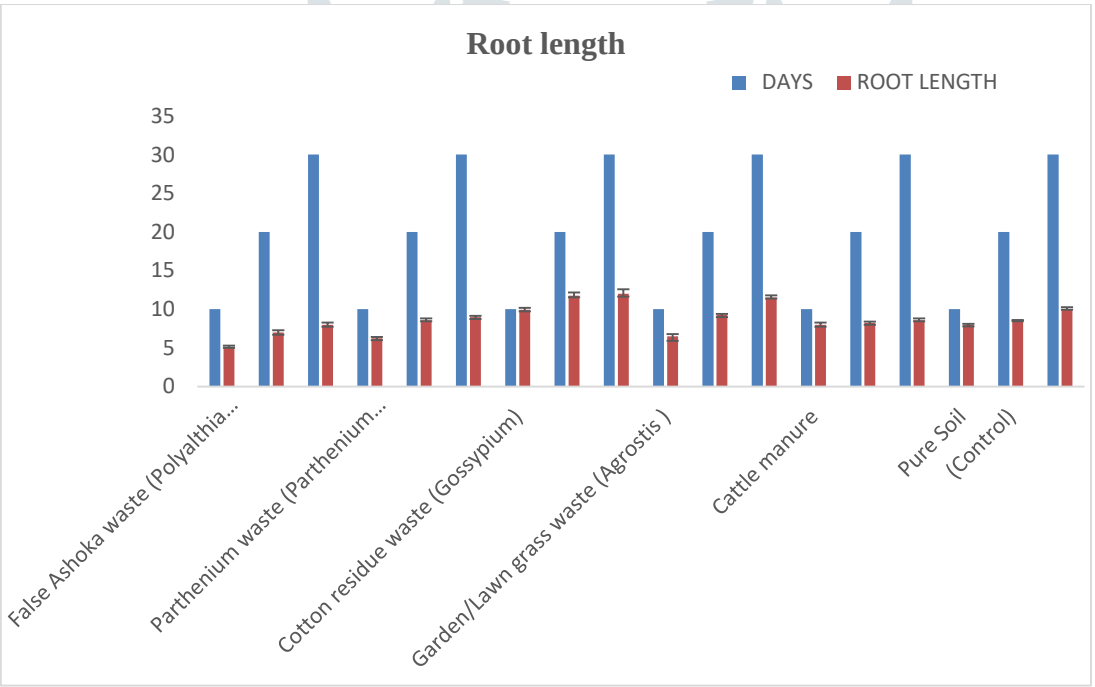
Sl. No.	Organic wastes	No. of Days	False Ashoka waste			Parthenium waste			Cotton residue waste			Lawn grass waste			Cattle manure			Pure soil (Control)		
			10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30
1	False Ashoka waste	10	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00
		20	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	.00	.00	.00	**1.00**	.00	.00	**1.00**	.00
		30	.00	.00	-----	.00	.00	**1.00**	.00	.00	**.09**	.00	.00	**.09**	.00	.00	**.09**	.00	.00	.00
2	Parthenium waste	10	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00
		20	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	.00	.00	.00	**1.00**	.00	.00	**1.00**	.00
		30	.00	.00	**1.00**	.00	.00	-----	.00	.00	**.09**	.00	.00	**.09**	.00	.00	**.09**	.00	.00	.00
3	Cotton residue waste	10	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00
		20	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	.00	.00	.00	**1.00**	.00	.00	**1.00**	.00
		30	.00	.00	**.09**	.00	.00	**.09**	.00	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	.00
4	Lawn grass waste	10	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00
		20	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-----	.00	.00	.00	.00	.00	.00	**.09**
		30	.00	.00	**.09**	.00	.00	**.09**	.00	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	.00
5	Cattle manure	10	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00
		20	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	.00	.00	.00	-----	.00	.00	**1.00**	.00
		30	.00	.00	**.09**	.00	.00	**.09**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	.00
6	Pure soil (Control)	10	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00
		20	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	.00	.00	.00	**1.00**	.00	.00	-----	.00
		30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	**.09**	.00	.00	.00	.00	.00	.00	-----

Table-6. Significant variation (≤0.05) in number of leaflets of *V. radiata* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, LGW, and CM) and pure soil as control.

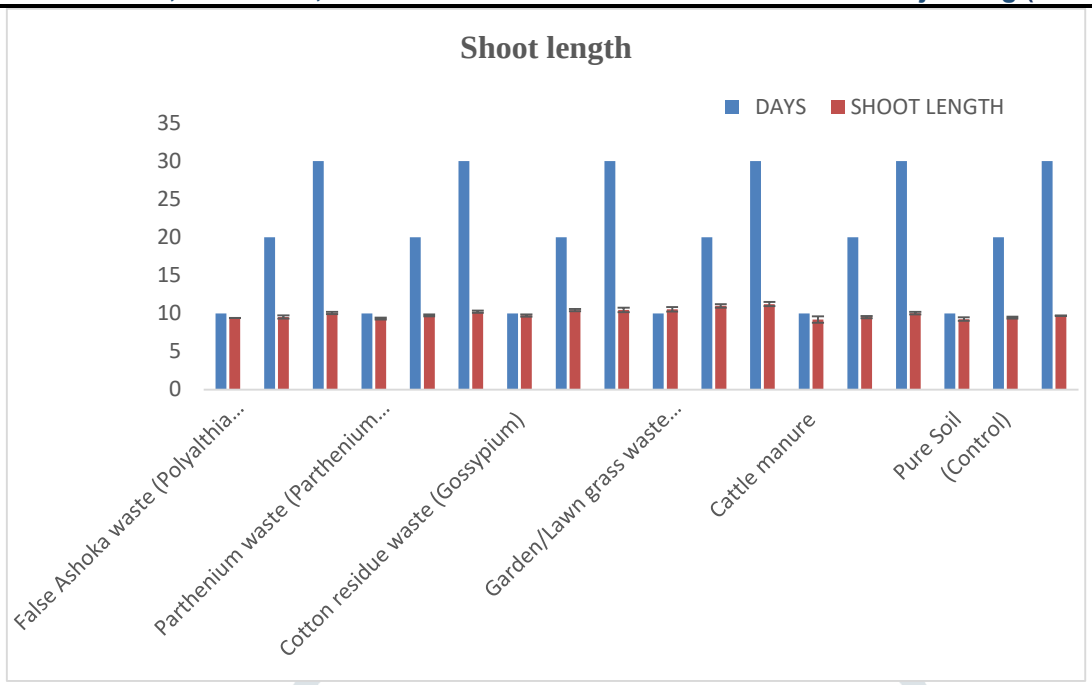
Sl. No.	Organic wastes	No. of Days	False Ashoka waste			Parthenium waste			Cotton residue waste			Lawn grass waste			Cattle manure			Pure soil (Control)		
			10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30
1	False Ashoka waste	10	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00
		20	.00	-----	.00	.00	**.14**	.00	.00	**.14**	.00	.00	**.14**	.00	.00	**.14**	.00	.00	**.14**	.00
		30	.00	.00	-----	.00	.00	**1.00**	.00	.00	**.14**	.00	.00	**.14**	.00	.00	**.14**	.00	.00	.00
2	Parthenium waste	10	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00
		20	.00	**.14**	.00	.00	-----	.00	.00	**1.00**	.00	.00	.00	.00	.00	**1.00**	.00	.00	**1.00**	.00
		30	.00	.00	**1.00**	.00	.00	------	.00	.00	**.14**	.00	.00	**.14**	.00	.00	**.14**	.00	.00	.00
3	Cotton residue waste	10	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00
		20	.00	**.14**	.00	.00	**1.00**	.00	.00	-----	.00	.00	.00	.00	.00	**1.00**	.00	.00	**1.00**	.00
		30	.00	.00	**.14**	.00	.00	**.14**	.00	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	.00
4	Lawn grass waste	10	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00
		20	.00	**.14**	.00	.00	.00	.00	.00	.00	.00	.00	-----	.00	.00	.00	.00	.00	.00	**.14**
		30	.00	.00	**.14**	.00	.00	**.14**	.00	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00	.00
5	Cattle manure	10	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	**1.00**	.00	.00
		20	.00	**.14**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	.00	.00	.00	-----	.00	.00	**1.00**	.00
		30	.00	.00	**.14**	.00	.00	**.14**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00	.00
6	Pure soil (Control)	10	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	-----	.00	.00
		20	.00	**.14**	.00	.00	**1.00**	.00	.00	**1.00**	.00	.00	.00	.00	.00	**1.00**	.00	.00	-----	.00
		30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	**.14**	.00	.00	.00	.00	.00	.00	-----



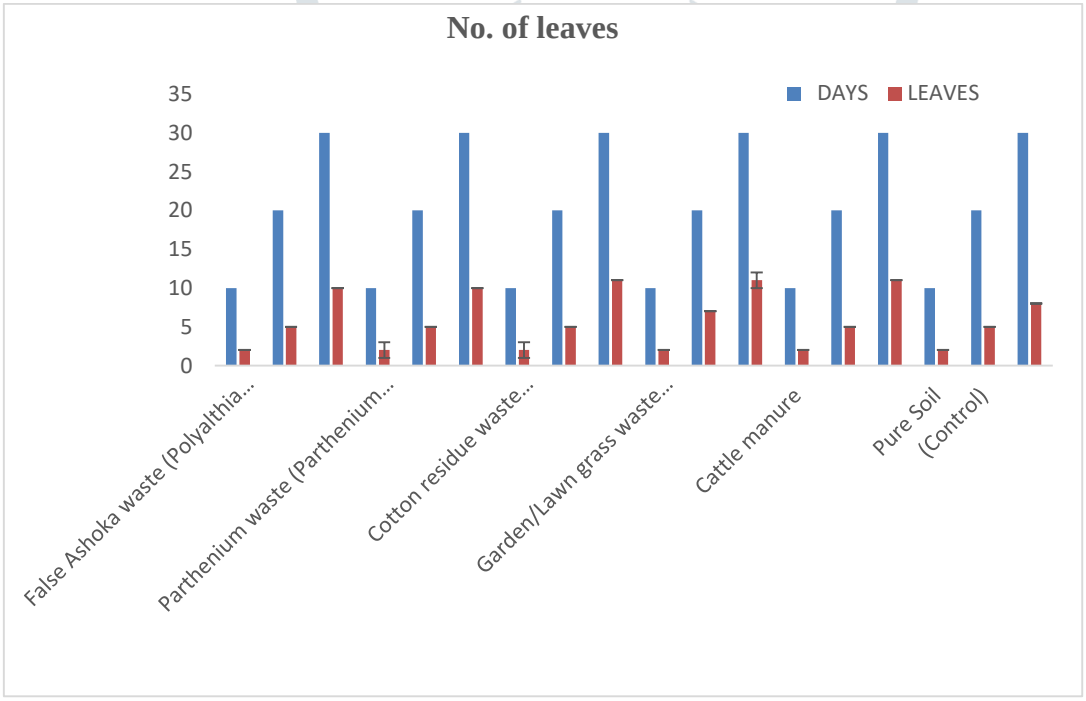
Graph-1. Comparison of seed germination of *Vigna radiate* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, G/LGW, and CM) and pure soil as control.



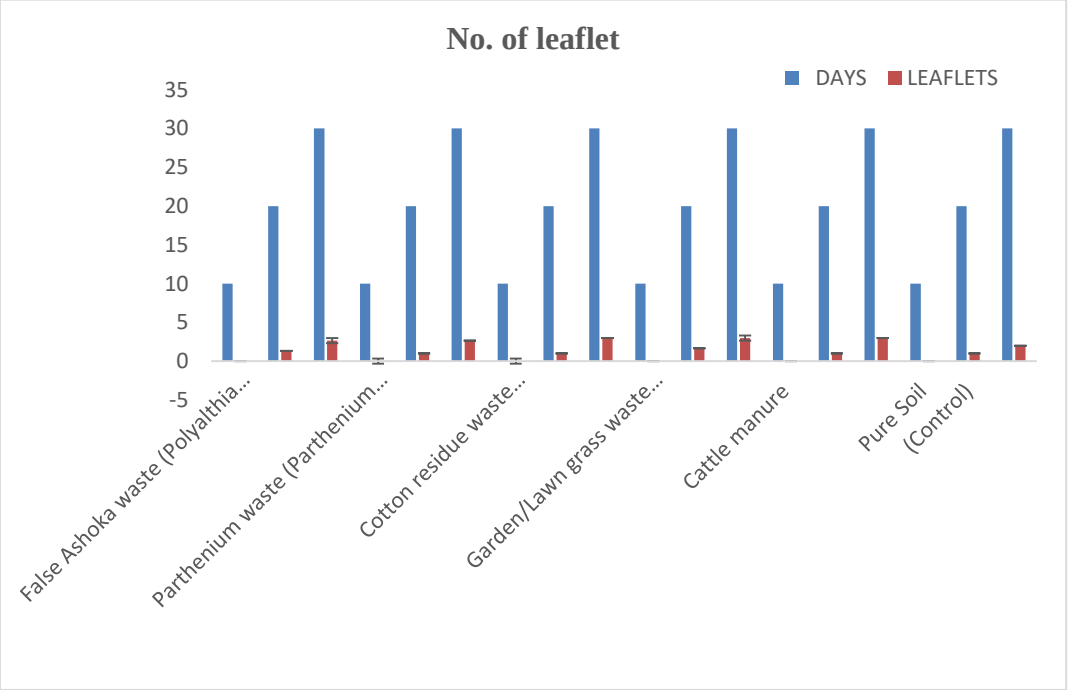
Graph-2. Comparison of root length of *Vigna radiate* (green gram) crop grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, G/LGW, and CM) and pure soil as control.



Graph-3. Comparison of shoot length of *Vigna radiate* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, G/LGW, and CM) and pure soil as control.



Graph-4. Comparison of number of leaves of *Vigna radiate* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, G/LGW, and CM) and pure soil as control.



Graph-5. Comparison of number of leaflets of *Vigna radiate* (green gram) grown in vermicompost produced by *Eisenia fetida* out of different organic wastes (FAW, PW, CRW, G/LGW, and CM) and pure soil as control.

IV. SUMMARY AND CONCLUSION:

The germination of the green gram seeds were observed from 4th day onwards in all the experimental sowing pots. There is no significant difference in seed germination among and between all experimental pots except between some experimental pots during different time intervals 10, 20 and 30 days were observed. The maximum root length was observed in cotton residue waste (12.00±0.57) followed by garden / lawn grass waste (11.50±0.28), Pure soil (10.00±0.28), Parthenium waste (8.96±0.20), Cattle manure (8.58±0.22) and minimum in False Ashoka waste (8.00±0.28) vermicompost amended soil at 30 days of time intervals. Maximum shoot length is observed in Garden/lawn waste (11.23±0.43) followed by cotton waste (10.46±0.29), Parthenium waste (10.23±0.14), False Ashoka waste (10.06±0.12), Cattle manure (10.06±0.23) vermicompost amended soil and minimum in Pure soil (9.70±0.11) at 30 day time intervals. Maximum leaves & leaflets were noticed in cattle manure (11.00±0.00 & 3.00±0.00) followed by False Ashoka waste (10.00±1.00) and Parthenium waste (10.00±1.00 & 3.00±0.00) vermicompost amended soil and they were noticed less in Pure soil (control) (8.00±0.00 & 2.00±0.00).

It is concluded based on the results obtained in this study and also through literature. The vermicompost produced by the epigeic earthworm, *E. fetida* out of different organic wastes have all the macro and micro nutrients for better seedling growth and it can be used as an alternative organic biofertilizer so that it can reduce the dependence of synthetic or chemical fertilizer as it provides sufficient amount of available plant nutrients and other growth promoter parameters for the growth and development of plants and crops. Over all, the vermicompost directly or indirectly improves the physico-chemical and biological properties of soil for long term sustainability and soil health.

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