Impact Study Of Bombex Ceiba Leaf Litter Vermicompost On Locally Popular Crop Sorgham Vulgare

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Abstract:
The excess use of chemical fertilizers and pesticides, insecticides have made soil sick, thereby losing important micronutrient and mineral that is associated with the growth of plants. It has also caused environmental hazards affecting human health. Farmers are encouraged to undertake organic farming and chemical free method of cultivation of crops. Animal wastes and plant residues like dried leaves are converted into nutrient rich vermicompost in organic farming. This study aims to investigate the influence of vermicompost on plant development in order to attain high output while maintaining sustainable soil fertility. Vermicomposting is an excellent choice for organic farming since it helps maintain the chemical, physical, and biological aspects of the soil.

Keywords: Leaf Litter, Vermicompost, Impact Study, Sorgham Vulgare**,** Earthworm

Introduction:
Fallen dry leaves from trees (also called as leaf litter), covers the major part of the garden waste Huge quantity of waste generated in gardens, not only creates the storage problem but is also responsible for eutrophication of surface water bodies through nutrient leaching. In many cases, the leaf litter waste is mostly collected and piled up in heaps and is set on fire which results in the loss of organic nutrients and many important nutrients from forest floor.

Besides this, accumulation of dead forest litter is also responsible for the incidence of surface forest fires (Ameen et. al, 2022; Gómez-Brandón M et al 2021; Varjani S et. al 2021; Jacques R G et al 2021). These uncontrolled surface forest fires cause danger to the forest and neighboring human inhabitations. Leaf litter waste in urban areas is often piled in open where it degrades naturally, thus occupying land resource. But these practices sometimes create problems such as blockage of urban water drainage and sewers The burning of leaf litter also leads to release of pollutants in air causing air pollution. The rural populations in India make use of leaf litter as fuel that causes indoor air pollution (Wu M. et. al. 2021).

But this leaf litter waste can be a good source of nutrients for the soil if proper waste management process is adopted. Leaf litter can maintain soil fertility as it is a good supplier of organic matter. For sustainable environmental management, recycling of waste is required. Converting the negative waste into beneficial product is an important aspect of resource recycling (Singh A, et. al. 2021; Alkobaisy J S et. al. 2021; Zulhipri et. al. 2021).Leaf litter has the ability to provide nutrients for agriculture, but this potential has not been utilized yet. (Govindarajan, M. et al., 2008).

The accumulation of leaf litter is a problem that frequently occurs in the environment of residential areas. In most cases, the leaves that fall from the trees are either piled up and burned or they are disposed of along with the municipal solid garbage. Not only does the ash that is produced return part of the nitrogen, phosphorus, and organic carbon that was present in the litter to the soil, but it also loses a significant amount of these elements.

Air pollution is also caused by the burning of trash and other waste. (S. Gajalaxmi, 2005; Abbasi 1999). According to Dash (1993), when leaf litter is left on the soil, it makes a substantial contribution to the protection and enrichment of the soil resources.Leaf litter can be decomposed and the resulting compost can be utilized as a fertilizer or soil amendment, but its commercial value is rather low.

As a result of this factor, a small number of individuals in urban and suburban areas are motivated to gather leaf litter and produce compost from it. However, vermicompost is far more expensive than compost, costing around three times as much. It is highly favored by farmers, particularly in developing nations, as a soil conditioner. In addition to supplying organic carbon and NPK to the soil, which compost also does, vermicompost is said to possess additional qualities of supplying enzymes and hormones that enhance plant growth. According to Gajalakshmi (2005), vermicompost is considered to have fewer pathogens compared to compost.

Material and Methods:
Bombax ceiba (Family-Bombacaceae) leaf litter is selected for the production of biofertilizer through vermicomposting. The leaf litter was collected from our college campus shade dried and used as organic waste. Urine free fresh cow manure (cow dung) was collected from Gaousala, Suratgarh.Feed mixture having 1:1 ratio of leaf litter and cow dung will be established in plastic containers of appropriate size. This mixture will be turned over manually every 24 hours for 15 days. Ten non-ciliated earthworm *Eudrilus eugeniae* will be introduced in each container separately. All containers will be kept in darkness at room temperature. The moisture content of the feed in each container will be maintained at 60-80% throughout the study period by periodic sprinkling of adequate quantities of water.

Impact study:

Plant selection and Seed sowing:
To study efficacy of vermicompost of leaf litter upon plant growth, ***Sorghum vulghar*** **(Jowar)** was chosen as the candidate plant based on the following characteristic of the plant: short term variety, easily procurable seed and higher germination capacity. The seeds were obtained from the officially recognized local seed provider.
Prior to conducting the experiment, the germination rate of these cultivars was assessed.

Experimental setup for impact study:
Plastic polythene bags of 9 cm (diameter) x 21cm (height) size were used as pots for impact study under laboratory conditions. The experimental design for the impact study consisted of seven treatments containing different concentrations of soil, vermicompost, recommended NPK and cowdung as shown in table 1.
The poly bags were filled with growth feed mixtures. To allow aeration small pores were made in these bags with help of a needle. Each container was seeded with ten seeds of a crop variety. There were three replicates for each treatment. Seeds were thinned after germination to promote optimal development.

Treatment	Soil(%)	Cowdung(%)	Vermicompost(%)	NPK
T1	100	0	0	0
T2	100	0	0	100% of recommended dose
T3	50	0	50	50% of recommended dose
T4	25	75	0	0
T5	75	25	0	0
T6	25	0	75	0
T7	75	0	25	0

Table 1 : Concentration of Soil, C.D., V.C. and recommended NPK in different treatments.

CD= Cowdung VC= Vermicompost of leaf litter + cowdung
Observations of germination % were carried out after 7 days from the initiation of the experimentation. After 15 days of experimentation 3 plants were randomly chosen from each replicate of the treatments. The plant characteristics *Viz.* length of root shoot, leaves and fresh weight of leaves, shoot, root of plant were recorded. After recording fresh weight of leaves, shoot, root the material was dried at 65^0 in a hot air oven for 24 hours. Then dry weight was taken and values averaged.

Statistical Analysis
The provided data are derived from three duplicate samples of each treatment and have been expressed as mean±S.E of three replicates. Two-way analysis of variance (ANOVA) was applied to determine any significant ($p<0.05$) difference among the parameters observed in vermicompost bed.

RESULTS AND DISCUSSION
Impact of V.C., C.D., and R.D. of NPK on the growth parameters of *Sorghum vulgare.*
Impact of different concentration of V.C. (Eudrilus Eugiene), C.D., R.D. of NPK and soil on germination of seeds of plant *Sorghum vulgare*

Germination: -
The results given in Table-2 and Fig-3 displays that there was noteworthy increase in the germination percentage of *Sorghum vulgare* seeds in the presence of vermicompost.
Maximum increase was observed in T6 (9) which was 83.3%. There was an increase of 34.93% with respect to control T1 (6.67).
Minimum increase was observed in T5 (6.33) which was 63.3%. There was an increase of 0.48% with respect to control T1 (7).

Fig. 1: Experimental Setup for Impact Study

Fig. 2: Plants chosen for experimentation after 15 days

		I day	II day	III day	IV day	V day	VI day	VII day	VIII day	IX day	X day	Total	Mean	% Germination
Soil	R1	0	0	0	0	1	1	2	1	0	1	6		
(T$_1$)	R2	0	0	0	0	1	1	1	1	1	2	7	6.333	63
	R3	0	0	0	0	0	2	1	2	0	1	6		
Soil + NPK	R1	0	0	0	0	0	1	1	1	1	2	6		
(T$_2$)	R2	0	0	0	0	1	1	2	2	0	2	8	6.667	66.66666667
	R3	0	0	0	0	0	2	0	2	1	1	6		
50% Soil+50%V.C.+R.D. of NPK	R1	0	0	0	0	1	1	2	1	2	1	8		
(T$_3$)	R2	0	0	0	0	2	1	2	0	2	1	8	8	80
	R3	0	0	0	0	1	1	1	2	1	2	8		
75%Soil+25%C.D.	R1	0	0	0	0	0	1	1	1	2	1	6		
(T$_4$)	R2	0	0	0	0	1	2	0	2	1	1	7	6.667	66.66
	R3	0	0	0	0	1	0	2	1	1	2	7		
25%Soil+75%C.D.	R1	0	0	0	0	0	2	0	2	2	1	7		
(T$_5$)	R2	0	0	0	0	1	1	1	1	0	2	6	6.333	63.33
	R3	0	0	0	0	0	2	0	3	1	0	6		
75%Soil+25%V.C.	R1	0	0	0	1	2	0	2	1	2	1	9		
(T$_6$)	R2	0	0	0	0	2	1	2	1	1	1	8	8.333	83.33333
	R3	0	0	0	1	1	2	0	1	2	1	8		
25%Soil+75%V.C.	R1	0	0	0	1	1	2	1	1	1	0	7		
(T$_7$)	R2	0	0	0	1	0	2	1	2	1	1	8	8	80
	R3	0	0	0	0	1	1	3	1	2	1	9		

Table 2: Germination Percentage of Sorgham Vulgare in the Presence of Vermicompost

V.C. = Vermicompost

C.D. = Cowdung R.D. of NPK = Recommended doge of NPK

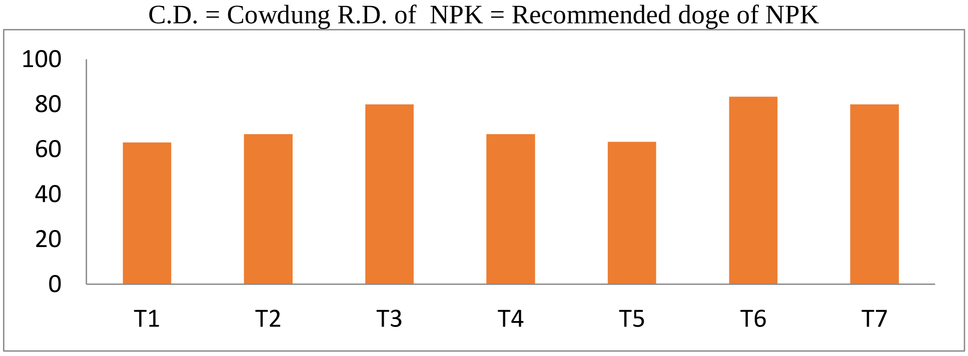

Fig 3: Germination Percentage of Sorgham Vulgare in the Presence of Vermicompost

Leaf Length :-

The results given in Table-3 and Fig-4 displays that there was noteworthy increase in the Leaf Length percentage of *Sorghum vulgare* seeds in the presence of vermicompost.

Maximum increase was observed in T3 (28.07). There was an increase of 86.26 % with respect to control T1 (15.07). Minimum increase was observed in T5 (19.87). There was an increase of 24.16 % with respect to control T1 (31.85).

Treatment	Leaf length			Mean
	R1	R2	R3	R
Soil (T_1)	14.9	15.3	15.02	15.07
Soil + NPK (T_2)	19.8	20.2	20.1	20.03
50% Soil+50%V.C.+R.D. of NPK (T_3)	28.3	27.4	28.5	28.07
75%Soil+25%C.D. (T_4)	25.4	26.3	25.6	25.77
25%Soil+75%C.D. (T_5)	20.7	16.4	22.5	19.87
75%Soil+25%V.C. (T_6)	25.4	26.3	27.3	26.33
25%Soil+75%V.C. (T_7)	24.5	26.3	26.4	25.73

Table 3: Root Length Percentage of Sorgham Vulgare in the Presence of Vermicompost

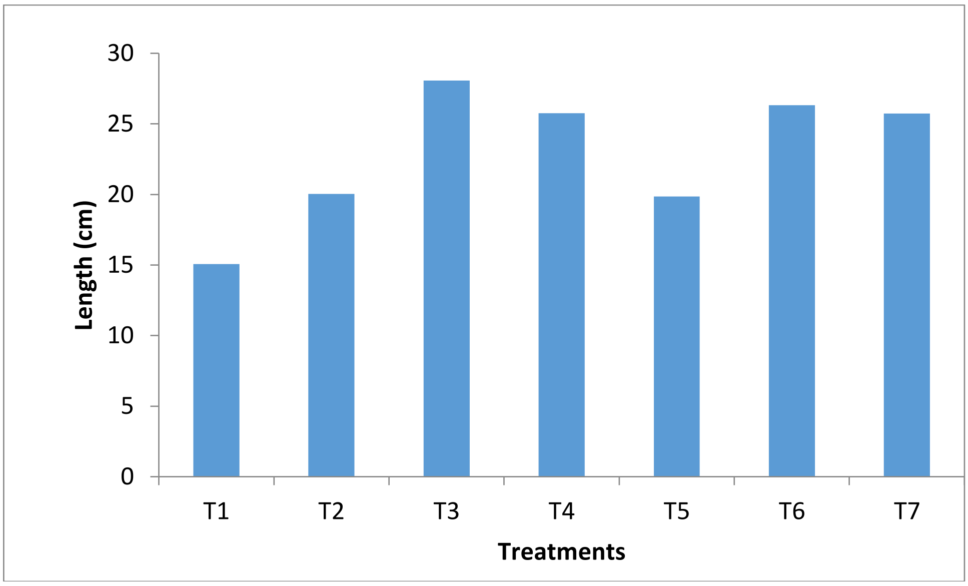

Fig 4: Root Length Percentage of Sorgham Vulgare in the Presence of Vermicompost

Shoot Length :-

The results given in Table-4 and Fig-5 displays that there was noteworthy increase in the Shoot Length percentage of *Sorghum vulgare* seeds in the presence of vermicompost.
Maximum increase was observed in T3 (5.7). There was an increase of 67.64 % with respect to control T1 (3.4).

Minimum increase was observed in T5 (3.41). There was an increase of 0.29% with respect to control T1 (3.4).

Treatment	Leaf length			Mean
	R1	R2	R3	R
Soil (T_1)	3.4	3.6	3.2	3.4
Soil+NPK (T_2)	5	5.3	5.2	5.17
50% Soil+50%V.C.+R.D. of NPK (T_3)	5.8	5.3	6	5.7
75%Soil+25%C.D. (T_4)	3.3	3.43	3.52	3.41
25%Soil+75%C.D. (T_5)	4.2	3.9	4.26	4.12
75%Soil+25%V.C. (T_6)	4	4.1	4.36	4.15
25%Soil+75%V.C. (T_7)	4	4.02	4.76	4.26

Table 4 : Shoot Length Percentage of Sorgham Vulgare in the Presence of Vermicompost

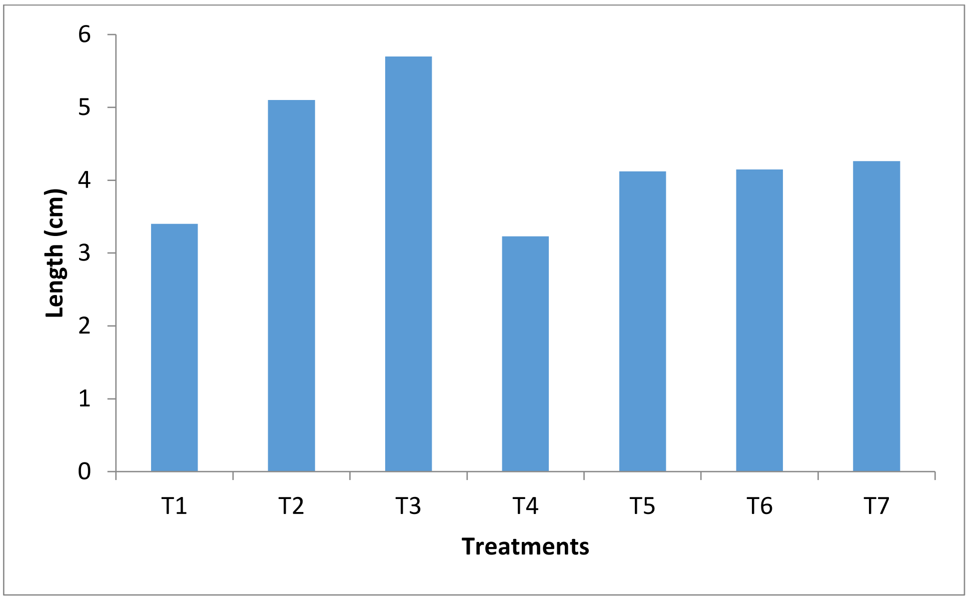

Fig 5: Shoot Length Percentage of Sorgham Vulgare in the Presence of Vermicompost

Root Length :-

The results given in Table-5 and Fig-6 displays that there was noteworthy increase in the Root Length percentage of *Sorghum vulgare* seeds in the presence of vermicompost.

Maximum increase was observed in T3 (16.49). There was an increase of 63.59 % with respect to control T1 (10.08).

Minimum increase was observed in T2 (10.24). There was an increase of 1.59 % with respect to control T1 (10.08).

Treatment	Root length			Mean
	R1	R2	R3	R
Soil (T_1)	10.4	9.8	10.03	10.08
Soil+NPK (T_2)	10.26	10.2	10.25	10.24
50% Soil+50%V.C.+R.D. of NPK (T_3)	16.67	16.8	16	16.49
75%Soil+25%C.D. (T_4)	14.5	14.63	14.16	14.43
25%Soil+75%C.D. (T_5)	13.8	14.8	14	14.2
75%Soil+25%V.C. (T_6)	15.6	15.4	15.3	15.43
25%Soil+75%V.C. (T_7)	15.9	15.5	14.7	15.37

Table 5: Root Length Percentage of Sorgham Vulgare in the Presence of Vermicompost

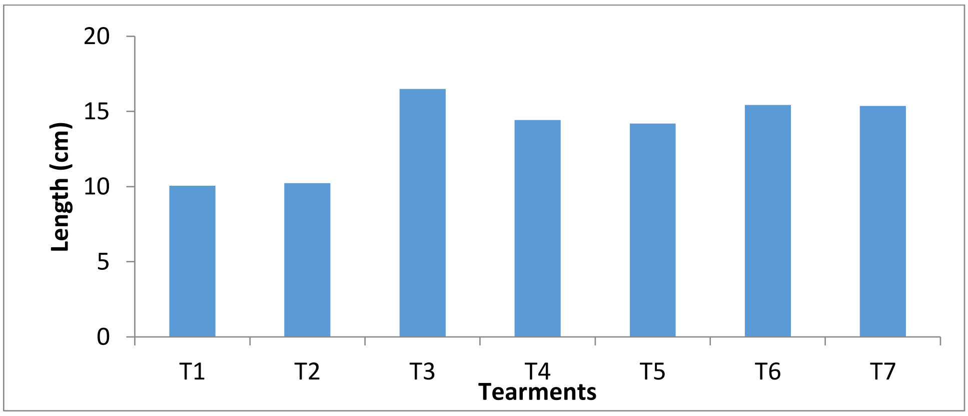

Fig 6: Root Length Percentage of Sorgham Vulgare in the Presence of Vermicompost

Leaf Fresh Weight: -

The results given in Table-6 and Fig-7 displays that there was noteworthy increase in the Leaf Fresh Weight percentage of *Sorghum vulgare* seeds in the presence of vermicompost.

Maximum increase was observed in T6 (0.166). There was an increase of 66.23 %. With respect to control T1 (0.143).

Minimum increase was observed in T7 (0.180). There was an increase of 45.61 % with respect to control T1 (0.114).

Treatment	Leaf Weight (gm.)			Mean
	R1	R2	R3	R
Soil (T_1)	0.115	0.115	0.113	0.114
Soil + NPK (T_2)	0.115	0.116	0.118	0.116
50% Soil+50%V.C.+R.D. of NPK (T_3)	0.126	0.122	0.126	0.125
75%Soil+25%C.D. (T_4)	0.124	0.125	0.123	0.124
25%Soil+75%C.D. (T_5)	0.125	0.125	0.119	0.123
75%Soil+25%V.C. (T_6)	0.167	0.167	0.164	0.166
25%Soil+75%V.C. (T_7)	0.159	0.154	0.158	0.157

Fig 6: Leaf Fresh Weight of Sorgham Vulgare in the Presence of Vermicompost

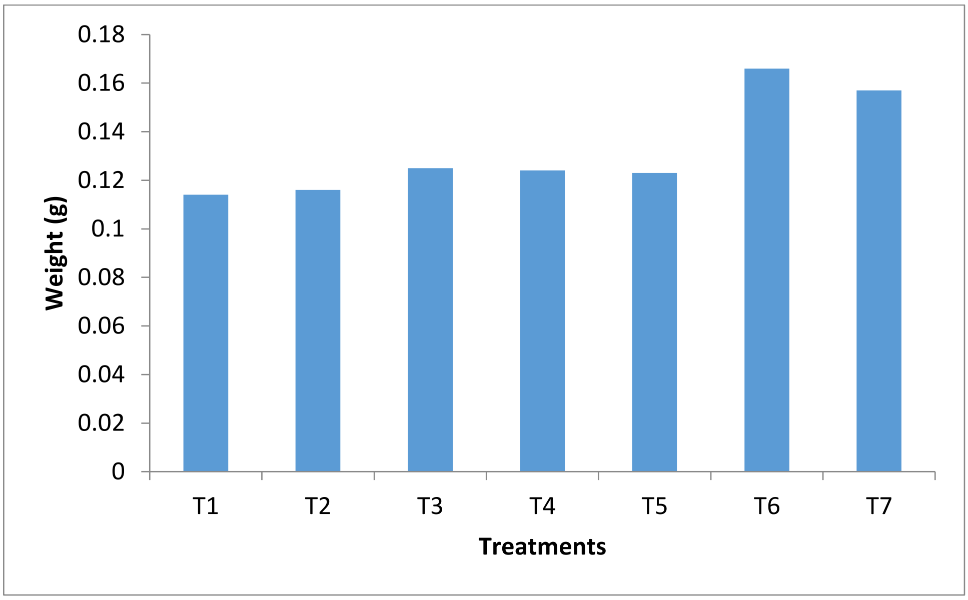

Fig 7: Leaf Fresh Weight of Sorgham Vulgare in the Presence of Vermicompost

Shoot Fresh Weight: -

The results given in Table-7 and Fig-8 displays that there was noteworthy increase in the Shoot Fresh Weight percentage of Sorghum *vulgare* seeds in the presence of vermicompost.

Maximum increase was observed in T3 (0.033). There was an increase of 200 % with respect to control T1 (0.011). Minimum increase was observed in T5 (0.015). There was an increase of 36.36 % with respect to control T1 (0.011).

Treatment	Shoot Weight			Mean
	R1	R2	R3	R
Soil (T_1)	0.010	0.012	0.011	0.011
Soil + NPK (T_2)	0.024	0.025	0.024	0.024
50% Soil+50%V.C.+R.D. of NPK (T_3)	0.032	0.031	0.035	0.033
75%Soil+25%C.D. (T_4)	0.021	0.019	0.022	0.021
25%Soil+75%C.D. (T_5)	0.015	0.017	0.014	0.015
75%Soil+25%V.C. (T_6)	0.022	0.020	0.024	0.022
25%Soil+75%V.C. (T_7)	0.023	0.024	0.023	0.023

Table 7: Shoot Fresh Weight of Sorgham Vulgare in the Presence of Vermicompost

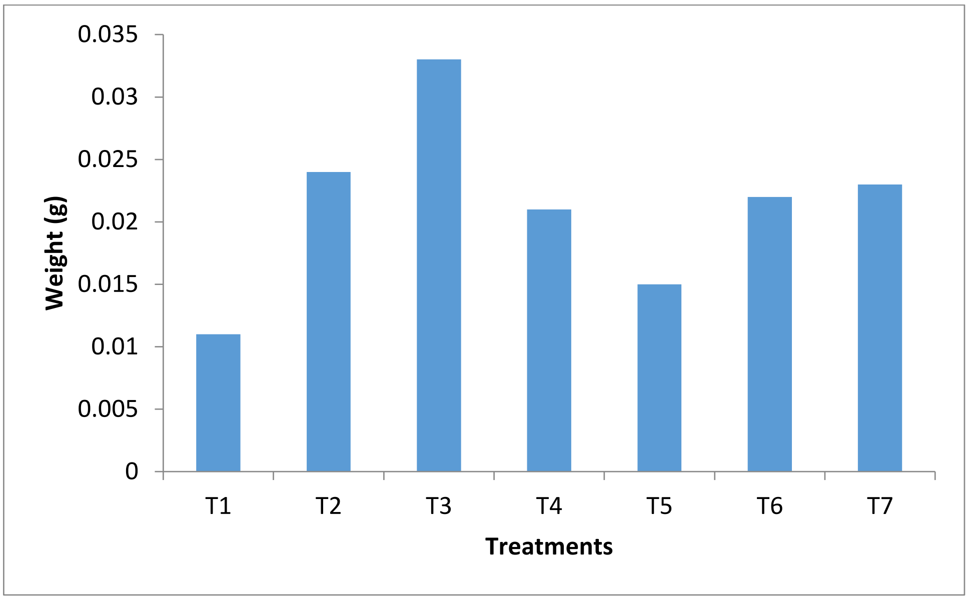

Fig 8: Shoot Fresh Weight of Sorgham Vulgare in the Presence of Vermicompost

Root Fresh Weight: -

The results given in Table-8 and Fig-9 displays that there was noteworthy increase in the Root Fresh Weight percentage of *Sorghum vulgare* seeds in the presence of vermicompost.

Maximum increase was observed in T3 (0.020). There was an increase of 150 % with respect to control T1 (0.008).

Minimum increase was observed in T2 (0.011). There was an increase of 37.5 % with respect to control T1 (0.008).

Treatment	Root Fresh Weight (gm)			Mean
	R1	R2	R3	R
Soil (T_1)	0.009	0.008	0.007	0.008
Soil+NPK (T_2)	0.011	0.012	0.011	0.011
50% Soil+50%V.C.+R.D. of NPK (T_3)	0.019	0.021	0.021	0.020
75%Soil+25%C.D. (T_4)	0.013	0.012	0.015	0.013
25%Soil+75%C.D. (T_5)	0.012	0.012	0.013	0.012
75%Soil+25%V.C. (T_6)	0.015	0.013	0.012	0.013
25%Soil+75%V.C. (T_7)	0.016	0.016	0.017	0.016

Table 8: Root Fresh Weight of Sorgham Vulgare in the Presence of Vermicompost

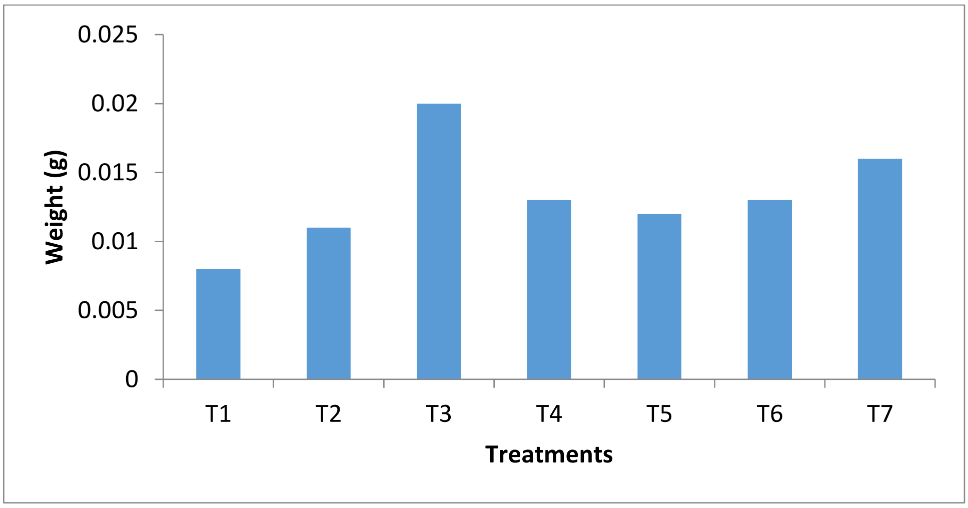

Fig 9: Root Fresh Weight of Sorgham Vulgare in the Presence of Vermicompost

Leaf Dry Weight:-

The results given in Table-9 and Fig-10 displays that there was noteworthy increase in the Leaf Dry Weight percentage of *Sorghum vulgare* seeds in the presence of vermicompost.

Maximum increase was observed in T5 (0.022). There was an increase of 340 % with respect to control T1 (0.005). Minimum increase was observed in T2 (0.010). There was an increase of 100 % with respect to control T1 (0.005).

Treatment	Leaf Dry Weight (gm)			Mean
	R1	R2	R3	R
Soil (T_1)	0.005	0.006	0.005	0.005
Soil+NPK (T_2)	0.009	0.012	0.009	0.010
50% Soil+50%V.C.+R.D. of NPK (T_3)	0.018	0.018	0.017	0.018
75%Soil+25%C.D. (T_4)	0.016	0.015	0.012	0.014
25%Soil+75%C.D. (T_5)	0.022	0.023	0.022	0.022
75%Soil+25%V.C. (T_6)	0.020	0.018	0.021	0.020
25%Soil+75%V.C. (T_7)	0.021	0.022	0.020	0.021

Table 9: Leaf Dry Weight of Sorgham Vulgare in the Presence of Vermicompost

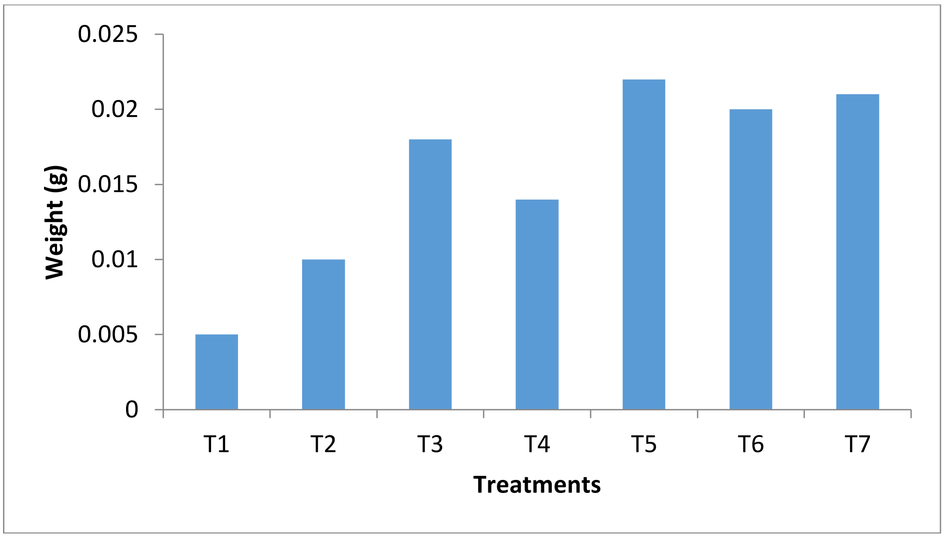

Figure 10: Leaf Dry Weight of Sorgham Vulgare in the Presence of Vermicompost

Shoot Dry Weight:-

The results given in Table-10 and Fig-11 displays that there was noteworthy increase in the Shoot Dry Weight percentage of *Sorghum vulgare* seeds in the presence of vermicompost.
Maximum increase was observed in T4 (0.008). There was an increase of 400 % with respect to control T1 (0.002).
Minimum increase was observed in T7 (0.003). There was an increase of 50 % with respect to control T1 (0.002)

Treatment	Shoot Dry Weight (gm)			Mean
	R1	R2	R3	R
Soil (T_1)	0.002	0.002	0.003	0.002
Soil+NPK (T_2)	0.003	0.004	0.004	0.004
50% Soil+50%V.C.+R.D. of NPK (T_3)	0.006	0.008	0.007	0.007
75%Soil+25%C.D. (T_4)	0.007	0.008	0.01	0.008
25%Soil+75%C.D. (T_5)	0.004	0.005	0.004	0.004
75%Soil+25%V.C. (T_6)	0.004	0.005	0.006	0.005
25%Soil+75%V.C. (T_7)	0.003	0.004	0.003	0.003

Table 10: Shoot Dry Weight of Sorgham Vulgare in the Presence of Vermicompost

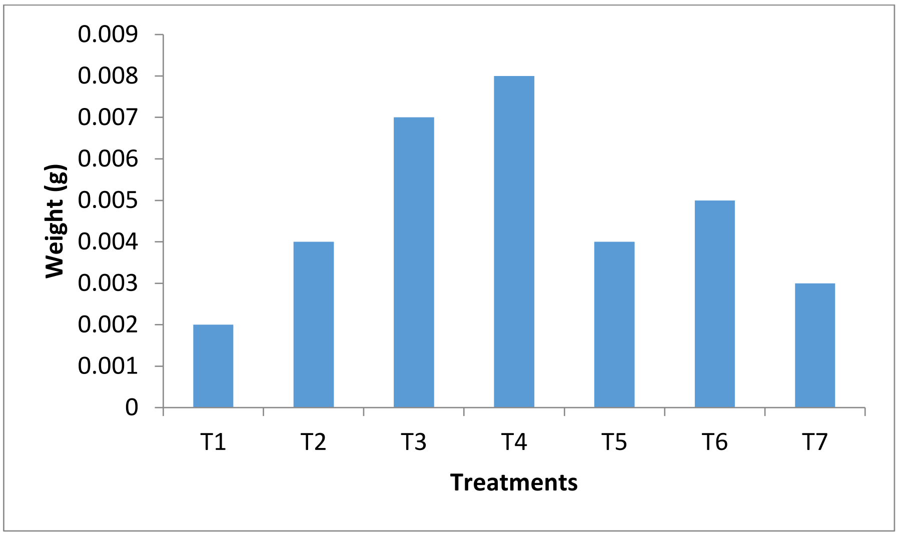

Figure 11: Shoot Dry Weight of Sorgham Vulgare in the Presence of Vermicompost

Root Dry Weight: -

The results given in Table-11 and Fig-12 displays that there was noteworthy increase in the Root Dry Weight percentage of *Sorghum vulgare* seeds in the presence of vermicompost.

Maximum increase was observed in T5 (0.010). There was an increase of 150 %.with respect to control T1 (0.004).

Minimum increase was observed in T2 and T7 (0.005). There was an increase of 25 %. with respect to control T1 (0.004)

Treatment	Root Dry Weight			Mean
	R1	R2	R3	R
Soil (T_1)	0.004	0.005	0.004	0.004
Soil+NPK (T_2)	0.003	0.006	0.005	0.005
50% Soil+50%V.C.+R.D. of NPK (T_3)	0.007	0.008	0.006	0.007
75%Soil+25%C.D. (T_4)	0.007	0.008	0.01	0.008
25%Soil+75%C.D. (T_5)	0.009	0.011	0.009	0.010
75%Soil+25%V.C. (T_6)	0.005	0.006	0.007	0.006
25%Soil+75%V.C. (T_7)	0.004	0.005	0.005	0.005

Table 11: Root Dry Weight of Sorgham Vulgare in the Presence of Vermicompost

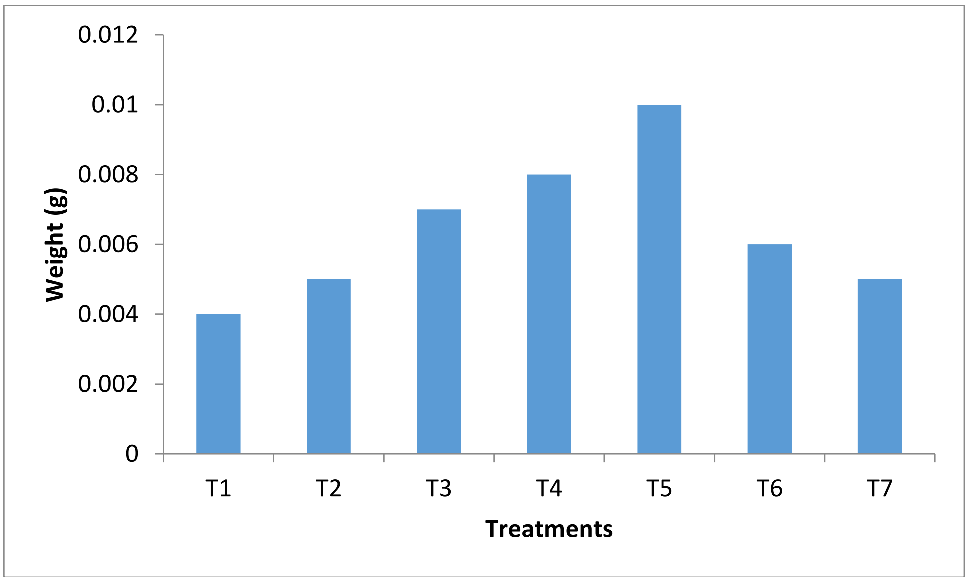

Figure 12: Root Dry Weight of Sorgham Vulgare in the Presence of Vermicompost

Total Height: -

Treatment	Total Height (cm.)			Mean
	R1	**R2**	**R3**	R
Soil (T_1)	20	30	35.89	28.63
Soil + NPK (T_2)	20	35	52.28	35.76
50% Soil+50%V.C.+R.D. of NPK (T_3)	40.5	51.6	62.7	51.6
75%Soil+25%C.D. (T_4)	45	40	49.31	44.77
25%Soil+75%C.D. (T_5)	30	35	43.39	36.13
75%Soil+25%V.C. (T_6)	40	45	54.29	46.43
25%Soil+75%V.C. (T_7)	40	45	52.49	45.83

Table 12: Total Height of Sorgham Vulgare in the Presence of Vermicompost

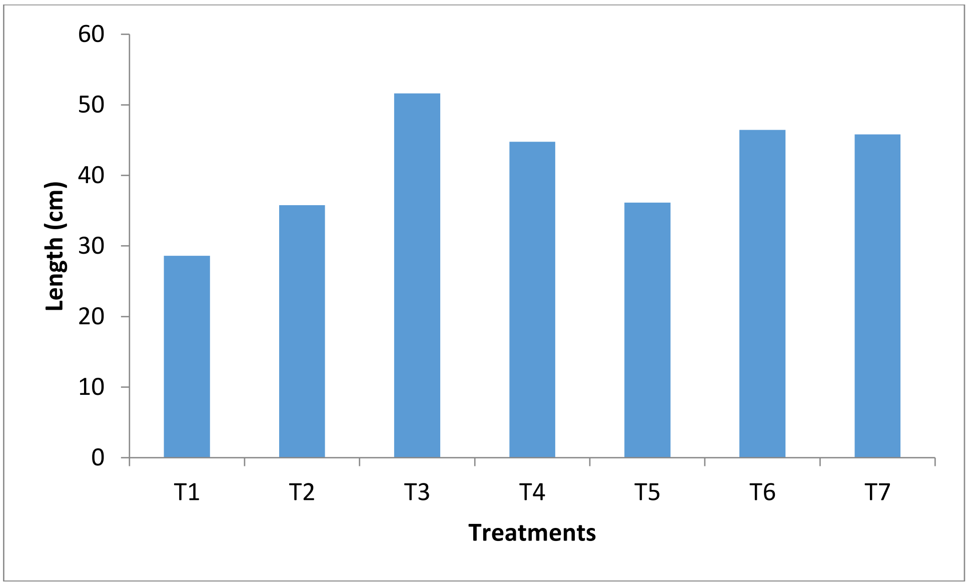

Figure 13: Total Height of Sorgham Vulgare in the Presence of Vermicompost

Applications of vermicompost had consistent growth promoting effects on Sorghum Vulgare, such as increasing leaf weight, shoot weight, root weight, plant dry weight and shoot and root length. These effects occurred in all growth periods and also affected plant structure. The effects of vermicompost on Sorghum Vulgare growth was found to be quite variable between the different media tested.

The addition of vermicompost significantly increased shoot biomass and root biomass. These values are higher than the increases in plant biomass following the addition of earthworms (respectively 23% and 20% for shoot and root biomass values) found in another meta-analysis (van Groenigen et al. 2014). This difference was likely due to the fact that studied the impact of adding organic matter that had been processed by earthworms, i.e., vermicompost, while van Groenigen et al. (2014) studied the impact of adding earthworms without adding organic matter. In this latter case, organic matter was supplied as litter to feed epigeic or anecic earthworms or mixed to the soil for endogeic earthworms in both the earthworm and earthworm-free treatments. In our study, we assessed the concomitant impact of the addition of vermicompost and it is recognized that adding vermicompost to a growth medium improves soil functioning, with complex but generally positive effects on plant growth (Murphy 2014). This stresses that the compost literature is still focused on demonstrating a beneficial effect of vermicompost but does not seek to analyze the underlying mechanisms precisely or to specifically assess the effect of the processing of organic residues by epigeic earthworms.

Together with the observed increases in plant root, shoot, and total biomass values, the increase in commercial yield suggests that vermicompost is an efficient mean to increase crop yield in agriculture, confirming the results of former non-quantitative reviews (Chaudhary et al. 2004; Lazcano and Domínguez 2011). The use of vermicompost is thought to be particularly useful in organic farming because vermicompost provides nutrients that would otherwise need to be brought by synthetic mineral fertilizers that are prohibited in organic agriculture.

Generally, there were positive effects of vermicompost application in impact study experiment, which agree with the findings of previous research, that vermicompost application results in improvements in the growth and development of plants (Joshi et al., 2015). Nevertheless, many previous studies only focused on the influence of the source and concentration of the vermicompost on plant growth, while little work has been done on the effects of the other influencing factors. For example, an application of 5% vermicompost derived from pig manure and a mixture of pig and cattle manure (50:50) in a commercial plant growth medium (Metro-Mix 360) significantly promoted the growth of tomato plants (Atiyeth et al., 1998; Atiyeth et al., 2000). It was proposed that this effect was not only attributed to the nutritional and physical properties of the vermicompost used but was also linked with other biological changes, such as an increase in plant growth regulator content of the growth medium.

Generally, plants amended with both vermicompost and chemical fertiliser had the greatest improvement in plant growth (dry weight, leaf number and leaf area) followed by pure vermicompost, chemical fertilisers and control. A significant lower number of leaves, leaf area and dry weight was observed for plants treated with chemical fertiliser alone compared to vermicompost treatments.

Vermicompost application resulted in significant increases in plant growth. All treatments with vermicompost addition had a significantly higher leaf number, leaf area and plant dry weight than the pure chemical fertiliser treatments. In addition, mixing chemical fertiliser and vermicompost together led to a further improvement in plant growth in comparison with the use of vermicompost alone. This result indicates that plants may uptake nutrients more easily from vermicompost, and it could be a good strategy to use vermicompost and chemical fertiliser in horticultural production.

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