RESEARCH ARTICLE

ASSESSING THE EFFICACY OF VERMICOMPOST RELATIVE TO CHEMICAL FERTILIZERS IN ENHANCING GROWTH DYNAMICS OF MICROGREENS

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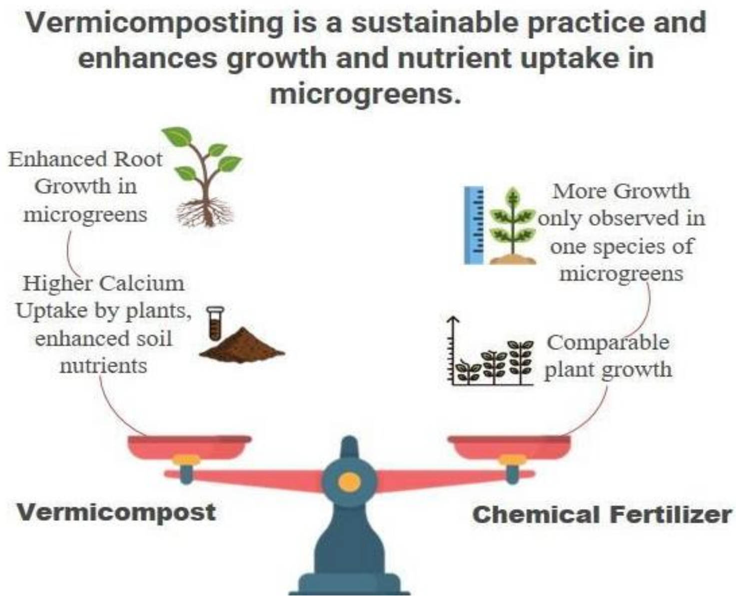
Abstract:

The application of vermicompost as a suitable and sustainable alternative has led to a renewed interest in its usage in agriculture. This study evaluates the comparative effects of vermicompost and chemical fertilizer on the growth and mineral uptake among microgreens like mung (*Vigna radiata*), methi (*Trigonella foenum-graecum*), and mustard (*Brassica juncea*). Growth parameters observed include root length, plant height, stem length, and leaf area, along with calcium (Ca) and magnesium (Mg) content in harvested products. Soil treated with vermicompost showed improved structure and nutrient balance. Among the treatments, vermicompost significantly enhanced root length, stem length and plant height in mung microgreens, with an increase up to 27.68% compared to chemical fertilizers along with a statistical difference ($p<0.0001$) in both treatments. Methi microgreens, however, showed compatible growth under chemical fertilizer. Analysis also revealed that microgreens grown in vermicompost had higher content of Calcium and Magnesium, with calcium levels in mustard increasing by 65% with statistical difference of ($p<0.0001$) between the treatments. The results suggest that vermicompost had a significant effect on growth of microgreen compared to chemical fertilizer and hence can be used as an alternative in agriculture which is both sustainable and economic.

Keywords: Vermicompost, Chemical Fertilizer, Microgreen, Growth Parameters.

Graphical Abstract



Introduction:

A rapid increase in global population and the subsequent consumerism leads to rise in pollution. Consequently waste management has become a challenge in the 21st century. Studies by Shekdar A (1999) states that nearly 38 billion metric tonnes of organic waste are being generated overall in the world. India being the second most densely populated country in the world generates nearly 100000 metric tonnes of organic waste (Shekdar A 1999, Costi P *et al.,* 2004). The rate of this generated waste is rapidly increasing by 1% (Shekdar A 1999) and it is assumed that the continuation of waste generated would rise up to 260 million tonnes by 2047 (Costi P *et al.,* 2004). Interestingly around 40% to 60% of this waste is organic in nature which with appropriate measures may become easier for management subsequently leading to less emission and pollution. There exists a promising solution to convert the organic waste, a technique that is sustainable and eco-friendly, one that can strengthen the economic and environment conditions.

Vermicomposting is a technique in which organic waste is converted into nutrient rich compost using earthworms. Vermicompost proves to be a sustainable technique with zero byproducts in toxins and serves as an excellent fertilizer for augmenting crop quality and product quantity. Vermicompost has been emerging as an important source in supplementing and substituting chemical fertilizers in agriculture. While chemical fertilizer has turned out to be an excellent variable for crop production by efficiently increasing crop yield, its consecutive negative impact on the environment and loss in fertility of soil with time cannot be ignored. Moreover chemical fertilizer can be overpriced and unavailable in some regions as per farmer's convenience and crop need, hence the chemical fertilizer is being replaced with organic manure which not only increases the quality of crop but also is eco-friendly (Zariri *et al.,* 2014; Kashem *et al.,* 2015).

Various types of organic waste—such as animal manure, crop residues, sewage sludge, and industrial byproducts—can be processed by earthworms into nutrient-rich vermicompost. Earthworms not only decompose this waste but also enhance microbial activity, speed up nutrient mineralization, and produce a refined, humus-like compost with a rich microbial profile (Zucco *et al.,* 2015). Research by Suthar (2009) demonstrated improved growth and yields in garlic crops treated with vermicompost, likely due to the compost's nutrient content, active soil microbes, enzymes, and plant growth hormones derived from worm digestion.

Microgreens are staged with a delicate stem and a pair of either fully or partially expanded cotyledon leaves or another pair of young leaves (Bala and Selvi, 2022). Microgreens are the emerging class of fresh produce and they are tiny greens which are used as the decoration component in fine dining for its attractive flavours. Microgreens are young seedlings of vegetables and herbs and are good sources of nutrients and antioxidants, minerals, carotenoids, and phenolic compounds. In recent times, interest towards fresh and functional foods is developing rapidly as the health benefits of microgreens attracted the consumers to develop growing interest.

This study aims to evaluate the effect of vermicompost and chemical fertilizers on growth and morphological features as well as Magnesium and Calcium content of selected microgreen species. This research seeks to contribute to the development of sustainable agriculture practices by assessing whether vermicompost can serve as a viable alternative to chemical fertilizer in the cultivation of nutrient dense, high quality microgreens.

Methodology

1. Experimental Site

The experiment was carried out at the laboratory of the Departments of Life Sciences, Sophia College for Women, Mumbai, Maharashtra, India at Lat 18.973416° Long 72.807137°.

2. Preparation of Vermicompost

The maintenance and preparation of vermicompost bin as per the techniques mentioned by Ganti (Ganti, 2018). *Eisenia foetida* was acquired from UPL company Moon Garden, Ankleshwar- Gujarat. Beddings were prepared using coarse materials to facilitate the oxygen diffusion and moisture control. Necessary care while preparing the beddings: As Ganti S (2018) mentioned the bedding materials were shredded to minimize the oxygen blockage and once the bedding is prepared the red worms are released on top of the bedding being that they are surface eaters. The bin was kept under dark shade and little water was sprinkled every day since worms prefer moist environments.

Chemical Fertilizer

The chemical fertilizers were modified in composition by dissolving in 1 liter of tap water the following constituents.The chemicals used were synthetic urea (1g), diammonium phosphate (DAP) (1g), and single superphosphate (SSP) (1g) and NPK (1g). The formulation was stored away from sunlight.

1. Cultivation of Microgreens

Three types of microgreens—fenugreek aka Methi (*Trigonella foenum-graecum*), Mung bean (*Vigna radiata*), and Mustard (*Brassica juncea*)—were selected for the study. The seeds were not pre-treated with any chemical and were only soaked in tap water for 24hrs and placed at room temperature. Each set contains 40 seeds per glass pot for both treatments. The microgreens were cultivated under controlled environmental conditions to maintain uniform light exposure, temperature, and watering across all treatments. Plants were grown until they reached the microgreen stage, defined by the full or partial expansion of cotyledon leaves, at which point they were harvested for further morphological analysis.

2. Treatment

The selected microgreens were cultivated under the treatments as mentioned above along with the controls.

3. Parameters Recorded

Morphological parameters included:

Germination Rate – As mentioned by (Bala and Selvi, 2022) the rate of germinated seeds was calculated by determining the germinated seeds and the total number of seeds sown.

$$\text{Germination rate} = \frac{\text{Germinated seeds}}{\text{Total number of seeds sown}} \times 100$$

Plant Height – plant height is calculated by placing the base of the scale on the soil surface to the tip of the leaves (Sim & Kim, 2020).

Stem Length Root Length – Stem length and root length is measured by placing the plant on scale and calculating an average mean of the data.

Leaf Area - leaf area was measured using scale and the formula is by multiplying leaf length,breadth and correction factor based on leaf shapes. The length was measured along the central vein of the leaf, while the width was measured at the widest part of the central portion of the leaf lamina (Bala and Selvi, 2022).

Chemical Parameter:

Magnesium And Calcium – The Mg and Ca content of microgreens were analyzed using a titrimetric method by dry ashing the leaves and titrating the solution against 0.01M EDTA solution (Trivedy, Goel and Trisal, 1987).

Organic Matter and Calcium Carbonate: Soil samples of both control and treatment were analyzed by Walkley and Black method by titrating against ferrous ammonium sulphate and calcium carbonate determined by titrating against sodium hydroxide (Trivedy *et al.,* 1987).

Statistical Analysis

To evaluate the statistical significance of the treatment effect, two-way ANOVA was performed. The statistical analysis was performed using Graphpad PRISM model 8.0.2. The F tests in ANOVA were performed to analyze whether there was significant difference in the treatment and their effect of growth factors. Further to analyze the effect of Fertilizer on growth factors Student t test was performed on PRISM Graphpad for accurate significance level for each treatment.

Results and Discussion:

This experiment analyzed the effect of vermicompost versus chemical fertilizer on the growth parameters of microgreens. Red earthworm (*Eisenia foetida*) is a preferred species of earthworms because of its high multiplication rate and thereby converts the organic matter into vermicompost within 45-50 days. Since it is a surface feeder it converts organic materials into vermicompost from top. In the preparation of vermicompost, bedding plays a crucial role in maintaining proper oxygen levels and moisture within the bin. To support these conditions, non-toxic, lightweight materials were selected for bedding, including dry leaves, dry grass clippings, and sandy loam. Additionally, bedding additives were used to neutralize the pH of the worm bin. Dried eggshells were chosen as the additive, as they are effective in reducing the acidic nature of the worm pit (Ganti S., 2018). Worms were acclimatized to the prepared bedding materials over a period of 15 days to ensure optimal conditions, and the vermicomposting process took approximately 40 days to mature into a humus-like material. Microgreens—mustard, methi, and mung—were then grown under controlled conditions, with observations made over approximately 16 weeks. Throughout the experiment, consistent monitoring was conducted to track growth parameters, including root and stem length, under both vermicompost and chemical fertilizer treatments.

Soil Chemical Properties:

The analysis of the chemical properties of soil (Table 1.1) under vermicompost treatment shows significant improvements compared to chemical fertilizer and control treatments. The observed increase in organic carbon, organic matter, and calcium carbonate in vermicompost-treated soil can be attributed to the minerals present in the organic material and the enhanced microbial activity induced by earthworms during the digestion and egestion of organic matter (Jayakumar & Sakthivel, 2012).

Growth Parameters:

The growth parameters consisted of germination rate, plant height, root length, stem length and leaf area of each microgreen species analyzed separately for both treatments as follows:

The analysis revealed a significant relationship between the usage of fertilizers *($F= 2191$, $p< 0.0001$)* and of plant parameters *($F= 70.89$, $p < 0.0001$)*. Additionally, a significant interaction between fertilizer type and plant parameter also was observed *($F= 50.98$, $p < 0.0001$)*, indicating that the effect of fertilizer varies depending on the plant trait measured. It was observed that the mean outcome of vermicompost was significantly higher in comparison with chemical fertilizer (Table 1.2). The plant height in Methi microgreen showed a significant variation in both treatments as shown in graph Fig. 3(B). The vermicompost and chemical fertilizer showed effective significance of ($F= 6.30$, $p < 0.0001$) and on plant parameters ($F= 134.5$, $p < 0.0001$). The mean outcome of vermicompost (M= 5.67) is less compared to chemical fertilizer (M = 5.58) with a mean difference of 0.08± 0.03 SE. In mustard, the difference between the treatments varied represented in (figure 3(C)) by significance of ($F = 806.9$, $p<0.0001$) with vermicompost having mean outcome of around (M= 4.94) and chemical fertilizers (M=4.27) with a difference of 0.67± 0.02 SE representing vermicompost to be of high influence as fertilizer on growth factor in Mustard microgreen. The significance of interaction ($F = 24.3$, $p<0.0001$) between treatments implies that the effect of treatments varies on plant growth factors.

Stem Length

In Mung microgreens, the stem length in vermicompost (M= 10.76, n=131.9) was comparatively higher than that in chemical fertilizer (M=6.98, n=80.42) with statistical significance ($t=5.98$, $df=22$, $p < 0.0001$) with a mean difference of 3.793 ± 0.6336. In methi microgreens the stem length in vermicompost (M= 4.883, n= 49.6) was comparable to that in chemical fertilizer (M=4.808, n= 58.4) with statistical significance ($t= 0.19$, $df= 22$). The stem length in mustard plant in vermicompost

(M= 4.06, n= 48.6) was more significant (t= 5.48, df= 22, *p <0.0001*) than that in chemical fertilizer (M=3.45, n= 38.3) with mean difference of 0.61±0.11 SE.

Root Length

In Mung microgreen the root length in vermicompost were lengthier (M= 7.76, n= 94.39) showed statistical significance (t=2.48, df=22, *p* =0.0357) compared to chemical fertilizer (M = 6.9, n= 71.62) with mean difference 0.8592± 0.3839 SE. In Methi, the difference in the root length in vermicompost (M=6.25, n= 73.7) is lower compared to chemical fertilizer (M = 7.0, n= 84.8) with mean difference 0.8 ± 0.5 SE. The effect of vermicompost (M=6.7, n= 79.2) on root length i smore (t= 4.75, df= 22, *p* <0.0001) compared to chemical fertilizer (M = 5.4, n= 64.6) with mean difference 1.31± 0.27 SE in Mustard micro green.

The plant growth factors like stem length, plant height, root length and leaf area showed significant elevation in vermicompost treatment in comparison to chemical fertilizer. The plant height in microgreens like Mung and Mustard revealed effectiveness of vermicompost in relative to chemical fertilizer treatment as *Segura-Castruita et al.,* (2024) claims that certain plant growth regulators like auxins and cytokinins stimulate process like cell elongation and division leading to increased plant height. Furthermore, these hormones are produced by microbial activity whilst the composting process. In Methi microgreens, the plant height was comparable in both treatment of chemical fertilizer and vermicompost. While Mung, Methi and Mustard microgreens treated with chemical fertilizer showed inhibition in growth parameters as combination of chemical fertilizer like urea, DAP, NPK and SSP can lead to significant increases in malondialdehyde (MDA) levels, a marker of oxidative stress, suggesting that these treatments induced stress responses in the plants (Kaur and Singh, 2016). Vermicompost consists of rich nutrients like nitrogen, phosphorus, potassium and trace elements that function in promoting the overall growth parameters of plants. Roots in plants support absorption of nutrients from soil and water and supply it throughout the plant's organs. Hence the root length of microgreens is high in vermicompost treatment as vermicompost consist of high nutrients as well as the organic matter in it improves soil aeration and water retention capacity thus creating a favourable environment for root expansion (Edward and Arancon, 2004). The vermicompost also contains coelomic fluid that is secreted by earthworms, which enhances the microbial growth and activity and nutrient content in soil which result in stimulating the growth factors of plants (Chattopadhyay 2015).

Germination Rate in microgreens: The rate of germination in all microgreens (Fig. 4) species seeds showed significance variation (F= 4.99, *p* <0.005) along with strong variation in time factor of (F=16.28, *p* <0.005) in both treatments,vermicompost and chemical fertilizer. The mean outcome of vermicompost was more significant (M=55.00) than that of chemical fertilizer (M=45) with mean difference of 9.5 ± 2.37 SE.

Leaf area in microgreens: A statistically significant difference (F= 16.23, *p* = 0.0004) was noted among the leaf area of microgreens (Fig. 5) and also variation among the microgreen types (F= 30.13, *p* < 0.0001) were notable. The mean outcome of vermicompost was significant (M=0.65) than that of chemical fertilizer (M=0.44) with mean difference of 1.86 ± 0.04 SE.

Calcium and Magnesium content in Microgreens: The calcium content in microgreens (Fig. 6) also varied among treatment (F= 182.21, p <0.0001) and it also had a bearing on the effect of fertilizer used (F= 9.75, p < 0.0001).The mean outcome of vermicompost is slightly higher (M=0.64) than that of chemical fertilizer (M=0.32) with mean difference of 0.31 ± 0.02 SE. The calcium content in mung bean microgreen is significant (t= 12.93, df= 4, p =*0.0002*) in vermicompost (M=0.61) compared to chemical fertilizer (M= 0.31) with mean difference of 0.30±0.02. Methi microgreens had significant calcium content (t= 10.57, df=4, p= 0.0005) in vermicompost (M=0.78) compared to chemical fertilizer (M=0.28) with a mean difference of 0.49±0.04. The mustard microgreen also showed significance (t= 4.8, df= 4. p=0.0086) in calcium content in vermicompost (M=0.53) treatment in relation to chemical fertilizer (M= 0.36) with mean difference of 0.16 ± 0.034. Vermicompost is made from nutrient rich organic kitchen waste, biodegradable materials like decaying leaves and agricultural residues which are retained and concentrated during vermicomposting process and hence yield high amount of nutrients like magnesium and calcium (Srimathi *et al.,* 2019).

The comparative analysis (Fig. 7) for magnesium content in microgreens revealed a significant (F= 452, p <0.0001) effect of treatment as well as in the interaction (F= 8.307, p <0.0001) between the treatment and microgreen species. The Mung bean microgreen had significant magnesium content (t= 4.38, df=4, p= 0.0119) in vermicompost treatment (M= 0.45) in comparison to chemical fertilizer (M= 0.18) with mean difference of 0.23±0.052 SE. The magnesium content in Methi microgreens is significantly higher (t= 5.46, df= 4, p=0.0055) in vermicompost (M= 0.44) treatment relative to chemical fertilizer (M=0.16) with difference of 0.28±0.05 SE. The mustard microgreens showed a highly significant difference (t = 9.19, df = 4, p = 0.0006) in the vermicompost treatment (M = 0.66) compared to the chemical fertilizer treatment (M = 0.21), with a mean difference of 0.44 ± 0.045 SE. The magnesium and calcium content in Mung, Methi and Mustard microgreens thus revealed elevated magnesium content in vermicompost treatment as the near neutral pH in vermicompost makes it optimal condition for nutrition solubility, thus more easily absorbed by roots (Aira *et al.,* 2007). The microgreens treated with chemical fertilizers show low levels of magnesium and calcium in plant due to increased chemical concentration on soil leading into soil acidification which in turn reduces the solubility of magnesium and calcium in soil (Demidchik, Shabala, and Isayenkov, 2018). Methi microgreens exhibited the lowest concentration of magnesium and calcium content followed by Mustard and Mung bean microgreen in chemical fertilizer treatment. It may be reasoned that high concentration of ammonia in fertilizer can compete with calcium and magnesium for uptake by plant roots (Van Iperen, 2020).Earthworm in vermicomposting play crucial role in bio-concentrating nutrients, as organic matter passing through earthworms gut, minerals like magnesium and calcium are solubilized and becomes more bioavailable later taken up by the roots this increasing the content in the plant (Kale *et al.,* 1982). Our study indicates that the vermicompost has a positive influence on growth factors as well as mineral content of microgreens which may be due to the fact that organic content, calcium carbonate showed overall enhancement in vermicompost soil compared to that in chemical fertilizer and control.

Table 1.1: Chemical properties of soil in treatments (mean ± standard error)

Parameters	Vermicompost (g%)	Chemical Fertilizer (g%)	Control (g%)
C%	2.25 ± 0.04	2.05±0.05	1.93±0.07
OM%	3.88 ± 0.06	3.53 ±0.05	3.33±0.07
$CaCO_3$	2.50± 0.10	1.95±0.05	1.40±0.10
pH	7	8.5	8

Table 1.2: The table represents plant height in microgreen in both treatments in values mean±SD

Treatment	Height in Mung (cm)	Height in Methi (cm)	Height in Mustard (cm)
Vermicompost	9.70 ± 0.73	5.10 ± 0.70	4.03 ± 0.30
	12.74 ± 0.83	5.60 ± 0.50	4.03 ± 0.16
	13.73 ± 1.32	7.14 ± 0.30	4.00 ± 0.16
	7.85 ± 0.92	7.20 ± 0.20	4.00 ± 0.16
	12.19 ± 0.94	6.00 ± 0.30	4.10 ± 0.20
	11.77 ± 1.69	5.50 ± 0.30	3.99 ± 0.15
	12.61 ± 0.85	7.26 ± 0.20	4.00 ± 0.12
	11.18 ± 0.86	7.01 ± 0.20	4.01 ± 0.07
	8.35 ± 0.58	5.37 ± 0.20	4.05 ± 0.17
	7.46 ± 1.84	7.11 ± 0.20	3.90 ± 0.15
	12.65 ± 0.69	3.60 ± 0.50	3.40 ± 0.40
	14.04 ± 0.78	3.80 ± 0.30	3.70 ± 0.29
Chemical Fertilizer	7.70 ± 0.96	4.60 ± 0.36	3.61 ± 0.27
	7.90 ± 0.96	5.20 ± 0.19	3.33 ± 0.29
	8.00 ± 0.93	4.10 ± 0.17	2.93 ± 0.60
	7.20 ± 1.19	5.98 ± 0.29	3.10 ± 0.24
	7.61 ± 0.75	5.10 ± 0.18	3.20 ± 0.30
	7.80 ± 0.82	5.97 ± 0.23	3.57 ± 0.32
	9.20 ± 0.61	4.87 ± 0.15	3.48 ± 0.33
	11.35 ± 1.23	3.90 ± 0.21	3.42 ± 0.38
	7.20 ± 0.75	7.20 ± 0.64	3.87 ± 0.18
	8.30 ± 0.98	4.01 ± 0.11	3.40 ± 0.31
	7.30 ± 0.89	3.90 ± 0.35	3.29 ± 0.24
	7.50 ± 0.65	4.00 ± 0.54	3.10 ± 0.16

Table 1.3: The table represents stem length in microgreen in both treatments in values mean±SD.

Treatment	Stem length in Mung (cms)	Stem length in Methi (cms)	Stem length in Mustard (cms)
Vermicompost	9.60 ± 0.92	4.90 ± 0.70	4.17 ± 0.36
	10.80 ± 1.50	4.50 ± 0.40	4.15 ± 0.26
	12.70 ± 1.30	5.60 ± 1.40	4.07 ± 0.22
	8.00 ± 0.75	7.00 ± 0.20	4.20 ± 0.23
	12.47 ± 1.30	4.80 ± 0.90	4.34 ± 0.24
	11.60 ± 1.80	4.80 ± 0.70	4.12 ± 0.19
	12.16 ± 0.80	4.40 ± 0.50	4.12 ± 0.16
	10.20 ± 1.10	5.10 ± 1.40	4.14 ± 0.23
	7.90 ± 0.70	5.00 ± 0.50	4.35 ± 0.24
	7.90 ± 0.70	5.50 ± 1.40	4.02 ± 0.13
	12.50 ± 1.60	3.50 ± 0.60	3.32 ± 0.40
	13.10 ± 1.50	3.50 ± 0.50	3.88 ± 0.28
chemical Fertilizer	6.20 ± 0.60	5.20 ± 0.22	3.61 ± 0.93
	6.70 ± 0.60	5.50 ± 0.27	3.37 ± 0.47
	5.50 ± 1.00	4.20 ± 0.23	2.90 ± 0.81
	6.60 ± 0.80	6.30 ± 0.21	3.28 ± 0.44
	6.00 ± 1.30	4.40 ± 0.17	3.43 ± 0.32
	7.00 ± 0.60	5.00 ± 0.21	3.63 ± 0.30
	8.32 ± 0.70	5.50 ± 0.22	3.49 ± 0.40
	8.68 ± 1.80	3.90 ± 0.22	3.56 ± 0.32
	6.80 ± 0.80	6.10 ± 0.26	3.93 ± 0.22
	7.50 ± 0.80	3.90 ± 0.52	3.64 ± 0.19
	7.00 ± 0.80	3.80 ± 0.48	3.52 ± 0.32
	7.32 ± 0.60	3.90 ± 0.23	3.04 ± 0.33

Table 1.4: The table represents root length in microgreen in both treatments in values mean ± SD

Treatment	Root length in Mung (cms)	Root length in Methi (cms)	Root length in Mustard (cms)
	7.69 ± 1.16	7.00 ± 0.50	7.00 ± 0.95
	8.13 ± 0.68	6.70 ± 0.40	8.10 ± 0.39
	7.59 ± 0.81	6.70 ± 0.60	7.20 ± 0.91
	7.80 ± 0.98	6.00 ± 0.70	7.30 ± 0.85
Vermicompost	8.65 ± 1.45	5.50 ± 0.70	6.50 ± 0.74
	8.59 ± 1.45	7.60 ± 0.70	5.80 ± 0.69
	7.18 ± 0.87	6.80 ± 0.50	6.30 ± 0.67
	8.26 ± 0.54	7.90 ± 0.60	6.60 ± 0.65
	9.50 ± 1.76	5.10 ± 0.40	7.10 ± 0.47
	7.61 ± 0.55	6.70 ± 0.40	6.00 ± 0.44
	6.28 ± 0.67	4.50 ± 0.60	6.40 ± 0.62
	6.16 ± 0.93	4.50 ± 0.70	6.30 ± 0.63
Chemical			
Ftilizer	7.18 ± 0.32	6.20 ± 0.20	6.90 ± 0.29
	6.72 ± 0.39	7.50 ± 0.40	6.30 ± 0.39
	7.35 ± 0.44	6.60 ± 1.20	5.40 ± 0.46
	6.57 ± 0.31	7.10 ± 0.20	4.40 ± 0.38
	6.35 ± 0.30	9.10 ± 0.60	4.70 ± 0.38
	8.43 ± 0.60	7.70 ± 0.40	4.90 ± 0.30
	8.22 ± 0.57	7.70 ± 0.20	5.20 ± 0.42
	6.03 ± 0.40	8.20 ± 0.60	5.80 ± 0.37
	6.33 ± 0.38	7.70 ± 0.30	5.80 ± 0.41
	7.01 ± 0.43	8.20 ± 0.40	5.30 ± 0.31
	6.18 ± 0.50	4.40 ± 0.70	4.80 ± 0.78
	6.44 ± 0.35	4.20 ± 0.50	5.30 ± 0.75

Figure 1.1: Vermicompost prepared in 45-50 days

Figure 1.2: The image shows sets of Methi and Mung bean microgreen set

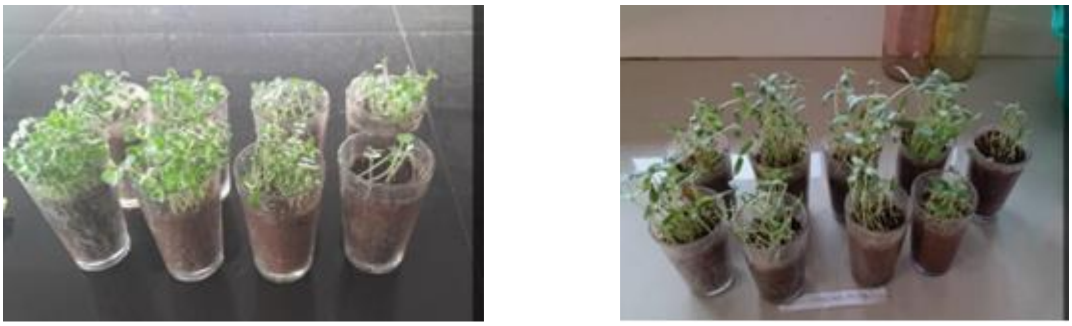


Figure 1.3: The image represents root and stem length of Methi microgreens in Vermicompost and Chemical fertilizer treatment

Figure 1.5: The images represent the stem length, root length (cms) and leaf area measurements of Mustard microgreen in both vermicompost and chemical fertilizer treatment

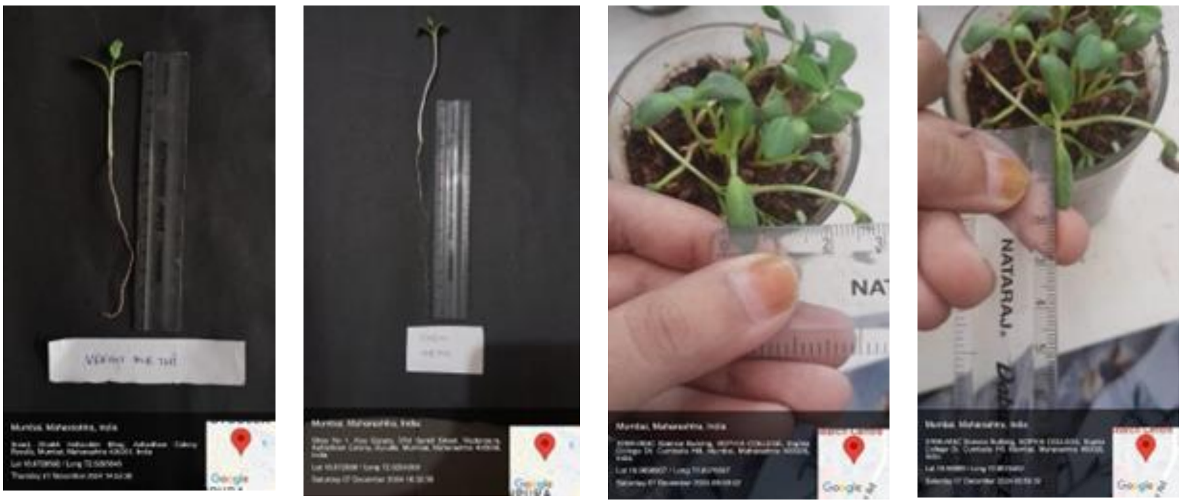


Figure 1.6: The images represent the stem length, root length (cms) and leaf area measurements of Methi microgreen in both vermicompost and chemical fertilizer treatment

Figure 1.7: The images represent the stem length, root length (cms) and leaf area measurements of Mung bean microgreen in both vermicompost and chemical fertilizer treatment

Figure 1.8: The image represents the method of dry ashing method of the plant leaves for analysis of calcium and magnesium content

Figure 1.9: The image represents analysis of Calcium content in Microgreen using titrimetric method

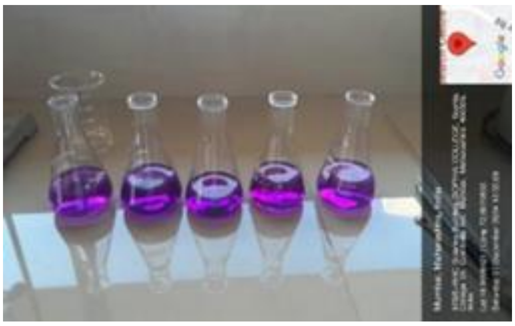


Figure 2: The image represents analysis of Magnesium content in Microgreen using titrimetric method

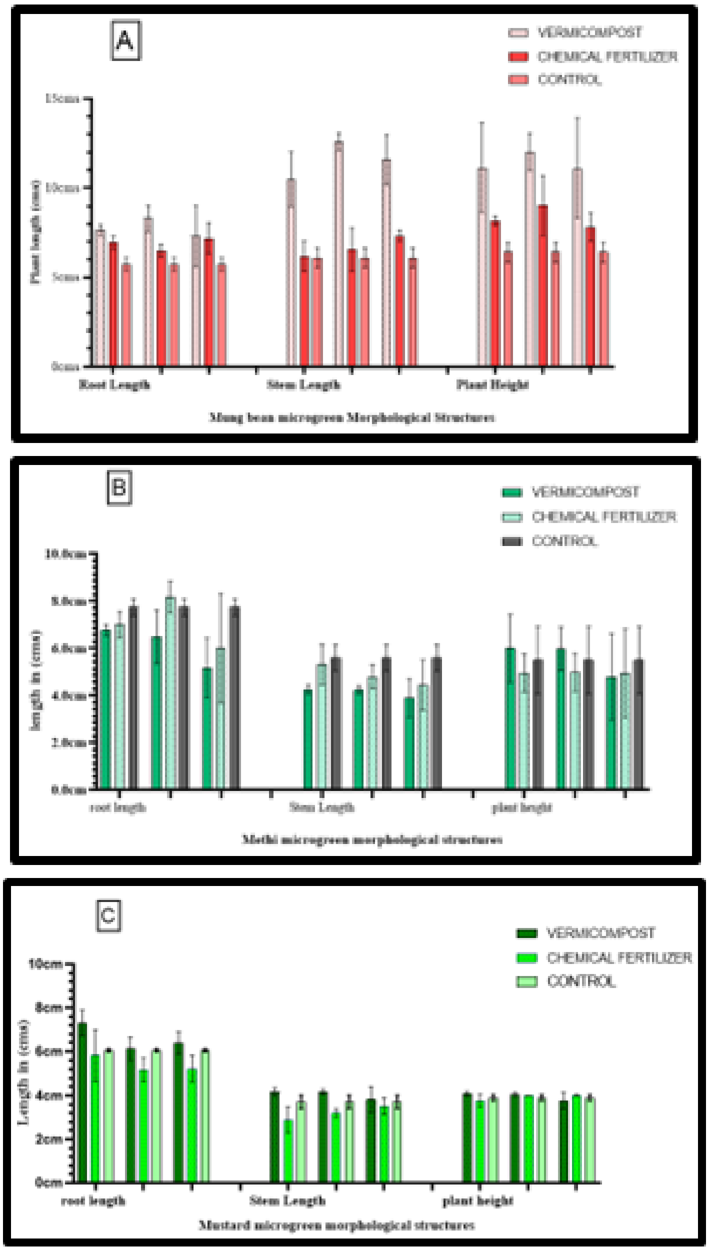


Figure 3: The graph represents the comparative effect of treatments on growth parameters in (A) Mung bean (B) Methi and (C) Mustard

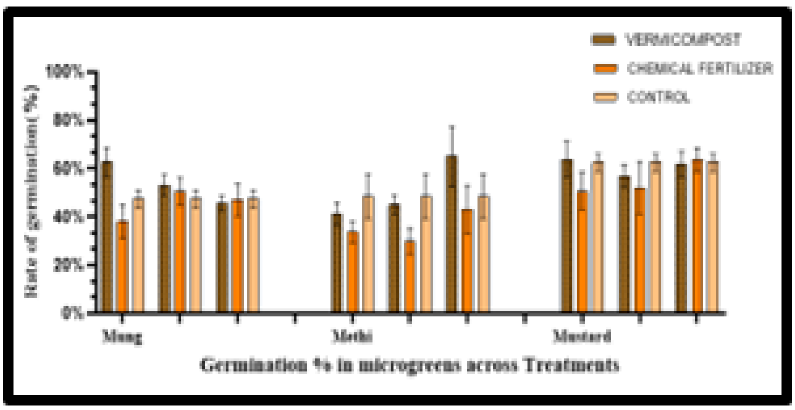


Figure 4: Germination rate in microgreens species in both treatments

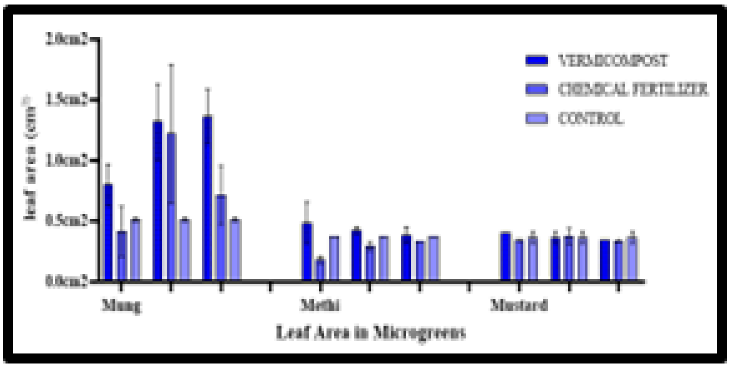


Figure 5: Leaf Area microgreens species in both the treatments across both the treatments

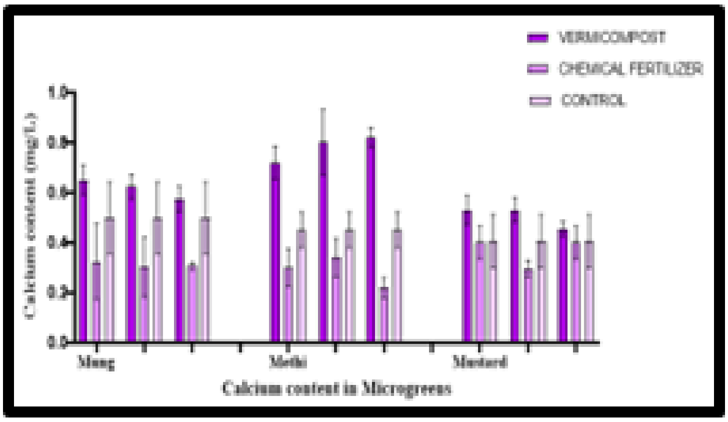


Figure 6: Calcium content in microgreen species in both treatments

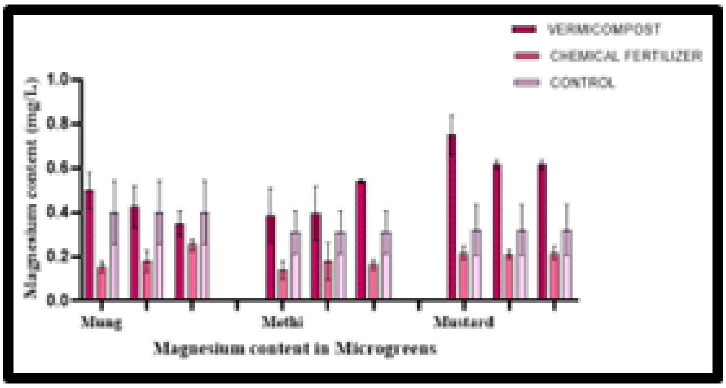


Figure 7: Magnesium content in microgreen in both treatments

Conclusion:

This study denotes that vermicompost functioned as an organic biofertilizer. Our experiments indicate that it could be a sustainable technique which enhances the soil structure, the fertility of the soil as well as an increase in the growth of the plants and its nutrient qualities. These findings highlight the potential of vermicomposting as a sustainable solution to increasing organic waste.The emerging issue of increased organic waste could be positively channelised to disposal techniques via employing vermiculture and converting it into an excellent fertilizer. Amid the rapid increase in urban population and consequent scarcity of the agricultural land, vermicompost can serve as the ultimate scalable solution for intensive crop production in urban agro ecosystems.

The data implies that vermicompost has positive influence on growth parameters as well as mineral content of microgreens as well as the inhibiting effect of chemical fertilizer on growth and mineral content of microgreens.

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Availability of Data and Material:

The data sets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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