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# Efficacy of Weed Vermicompost Extracts in Promoting *Lepidium sativum* Seedling Growth and Suppressing the Phytopathogen - *Pythium ultimum*

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## ABSTRACT

The growing global demand for food has intensified the use of chemical fertilizers and pesticides, leading to significant environmental concerns. This study investigates the efficacy of weed-based vermicompost, derived from *Alternanthera sessilis*, animal manure, and earthworms, in promoting the growth of *Lepidium sativum* seedlings while suppressing the growth of the fungal pathogen *Pythium ultimum* in vitro. Seedling growth was assessed by measuring germination percentage, shoot and root lengths, and Seedling Vigour Index (SVI). The results revealed that specific concentrations of vermicompost extracts, particularly T7-40% and T5-30%, significantly enhanced seedling growth, with T7-40% yielding the highest SVI of 1240.8, indicating a strong correlation between extract concentration and plant vigor. Additionally, the antifungal properties of these extracts were confirmed, with Sample S2 exhibiting the highest inhibition percentage against *Pythium ultimum*. These findings suggest that weed-based vermicompost not only promotes plant growth but also provides effective protection against fungal pathogens, making it a promising tool for sustainable agriculture.

**Keywords**: Weed-based vermicompost, *Lepidium sativum*, *Pythium ultimum*, Seedling Vigour Index, Sustainable agriculture, Antifungal activity.

## INTRODUCTION

The increasing demand for food production to support the growing global population has led to the extensive use of chemical fertilizers and pesticides. While these inputs have proven effective in enhancing crop yields, their overuse has caused significant environmental harm, affecting air, water, and soil quality. This has sparked interest in more sustainable agricultural practices, with bio-fertilizers like vermicompost emerging as a viable alternative. Vermicompost, the organic matter decomposed by earthworms, is rich in nutrients, enzymes, and beneficial microbes, offering a more eco-friendly approach to improving plant growth and productivity (Edwards and Bohlen, 1996; Dominguez, 2004).

Recent studies have shown that vermicompost and its extracts can significantly enhance seed germination, seedling vigor, and overall plant productivity (Amirkhani *et al*., 2019; Sundararasu, 2019; Blouin *et al*., 2019). Additionally, vermicompost has demonstrated effectiveness in suppressing phytopathogenic fungi, making it a valuable tool in integrated pest management. The biological properties of vermicompost, including the presence of beneficial microbes such as Bacillus, Pseudomonas, and Streptomyces, contribute to its ability to inhibit the growth of harmful fungi like *Pythium, Rhizoctonia*, and *Fusarium* species (Subler *et al*., 1998; Alsina *et al*., 2013). This dual functionality promoting plant growth while suppressing pathogens positions vermicompost as a cost-effective and sustainable alternative to chemical fertilizers and fungicides.

*Lepidium sativum* L., commonly known as garden cress, is a fast-growing herb widely cultivated for its nutritional and medicinal properties. Despite its various benefits, L. sativum is susceptible to a range of fungal diseases, including those caused by *Pythium ultimum*, which can severely affect seedling growth and crop yield (Meena *et al*., 2020; Mandal *et al*., 2008). *Pythium* spp., particularly *Pythium ultimum*, is notorious for causing damping-off disease, which leads to seedling death and significant losses in crop production. The pathogen thrives in wet, cool conditions and attacks the seeds and roots of young plants, leading to wilting, stunted growth, and eventually, plant death. The increasing prevalence of these diseases has highlighted the need for effective disease management strategies that are both sustainable and environmentally friendly.

In this context, the evaluation of vermicompost and its extracts as a means to promote L. sativum seedling growth while suppressing *Pythium ultimum* presents a promising area of research. By exploring the potential of vermicompost in enhancing plant health and resilience against pathogens, this study aims to contribute to the development of sustainable agricultural practices that reduce reliance on chemical inputs, thereby mitigating their environmental impact.

## 2. MATERIALS AND METHODS

The experiment was carried out in the Department of Botany, JES College Jalna, from December 2023 to February 2024. Two different vermicomposts were prepared using local village resources and two weed species, *Xanthium strumarium* and *Alternanthera sessilis*, for vermicompost preparation (Table 1).

### 2.1. Preparation of Weed Vermicompost

Weed vermicompost was prepared using the weed species *Xanthium strumarium* and *Alternanthera sessilis*. The preparation process began with the collection of these weeds, which were mixed with cattle manure at a carbon/nitrogen ratio of 25:1. The mixture was placed in plastic containers for partial decomposition over 20 days. The materials were turned every other day to ensure even decomposition, and moisture content was maintained by sprinkling water as needed. Temperature was also monitored throughout the process to optimize decomposition. After 20 days of partial decomposition, the material was transferred to containers specifically prepared for vermicomposting. A 2-3 inch thick vermin-bed of sawdust was laid at the bottom of each container. *Eisenia fetida* earthworms were then introduced to the decomposed material. The containers were kept in a shaded area and covered with jute bags to maintain adequate moisture content and temperature, ensuring the survival and activity of the earthworms. Two to three turnings were provided during the vermicomposting process to promote aeration and maintain appropriate moisture levels. High-quality vermicompost was obtained within two months, after which samples were taken from each setup for analysis (Ameta, *et al*., 2016)

### 2.2. Physicochemical Analysis of Weed Vermicompost

The pH and Electrical Conductivity (EC) of the vermicompost were measured following the method described by Gupta (2009). For pH, 10 g of air-dried sample was mixed with 20 ml of Calcium Chloride in a 50 ml beaker, stirred for 1-2 minutes, and allowed to settle for 30 minutes. The mixture was then filtered using Whatman No. 1 filter paper, and the pH probe was submerged in the filtrate for measurement. Similarly, EC was measured by mixing 10 g of the sample with 20 ml of water, following the same procedure. Moisture content was determined using the gravimetric method by weighing 40-50 g of the sample, drying it in an oven at 105°C for 24 hours, (Gupta, Garg 2009) and calculating moisture content using the formula:

$$\text{Gravimetric moisture (\%)} = \frac{\text{wet weight} - \text{oven dried weight}}{\text{oven dried weigh}} \times 100$$

### 2.3. Preparation of Weed Vermicompost Extracts

Weed vermicompost extracts were prepared by mixing vermicompost with distilled water at a 1:1 (w/v) ratio in capped bottles. The mixtures were agitated on a mechanical shaker at high speed for 2 hours, allowed to stand for 24 hours, and then filtered using Whatman No. 1 filter paper. The resulting supernatant was used as a 100% vermicompost extract and further diluted with distilled water to obtain T1-10% T2-15% T3-20% T4-25% T5-30% T6-35% T7-40% extracts (v/v) (Chaoui *et al.*, 2002).

### 2.4. Experimental Setup for Seed Germination

Seeds were soaked in the respective vermicompost extracts for 4 hours. Four different dilutions of the two vermicompost extracts, along with a control, were used for each treatment, with 3 replications per treatment. Ten seeds per replication were placed on Petri plates lined with Whatman No. 1 filter paper, which was spiked with 2 ml of the extracts. The plates were then placed in the dark at 23±2°C for germination. Seed germination was recorded daily for 14 days. At the end of the experiment, seedling shoot length, root length, and SVI were measured. All experiments were repeated twice to ensure data consistency (Ievinsh *et al.*, 2017)

### 2.5. Seedling Growth and Vigour Index

*Lepidium sativum* seeds were used to evaluate the effects of the vermicompost on seedling growth. Seeds were germinated under laboratory conditions. After 14 days of sowing, the seedling length (root length + shoot length) was measured, and the Seedling Vigour Index (SVI) was calculated as per Maisuria and Patel (2009).

$$\text{Seedling Vigour Index (SVI)} = \text{Seedling length (cm)} \times \text{Seed germination \%}$$

Where,

Seedling length= Root length (cm) + Shoot length (cm)

### 2.6. Determination of the Efficacy of Weed Vermicompost Extracts Against Fungal Isolates

To evaluate the antifungal properties of the weed vermicompost extracts, fungal isolates from the field were cultured on Potato Dextrose Agar (PDA) medium. The effects of the extracts on the mycelial growth of these fungal isolates were tested at concentrations of 0% (control), 5, 8 12, 16, 20 and 22%. For each treatment, 20 µl of the vermicompost filtrate (sterilized) was spread on PDA, and mycelial discs (3 mm in diameter) of the fungal pathogen were placed in the center of the Petri dishes. The dishes were incubated at 22±2°C for 7-10 days. Colony development was measured by recording the radius of the colonies, and the biological percentage efficiency of the treatments was calculated (Abbott, 1925).

## 3. RESULTS

### 3.1. Physicochemical Characteristics of vermicompost samples used in this study

Table 1 presents the physicochemical characteristics of two vermicompost samples prepared using different feeding materials. Sample S1, which included animal manure, earthworms, and *Xanthium strumarium*, had a moisture content of 49.83% and an electrical conductivity (EC) of 0.65 mS/cm. In contrast, Sample S2, prepared with animal manure, earthworms, and *Alternanthera sessilis*, exhibited a higher moisture content of 54.93% and a higher EC of 0.87 mS/cm. These differences indicate that *Alternanthera sessilis* may have a greater water retention capacity and influence the salinity of the vermicompost more than *Xanthium strumarium*. Both samples had slightly acidic pH levels, with S1 at 5.43 and S2 at 5.54, which is typical for vermicomposts and conducive to nutrient availability. Nitrogen and carbon contents were higher in S1, resulting in a lower C/N ratio of 18.65, compared to S2's C/N ratio of 16.42, reflecting differences in the decomposition rates and nutrient profiles of the feeding materials.

**Table 1:** Characteristics of vermicompost samples used in this study.

| Sample ID | Feeding materials (FM) | Moisture (%) | EC (dS $m^{-1}$) | pH | Nitrogen (%) | Carbon (%) | C/N |
|---|---|---|---|---|---|---|---|
| **S1** | Animal manure + Earthworm + ***Xanthium strumarium*** | 49.83 ±0.76 | 0.65 ±0.14 | 5.43 ±0.32 | 1.98 ±0.09 | 19.78 ±0.43 | 18.65 ±0.98 |
| **S2** | Animal manure + Earthworm + ***Alternanthera sessilis*** | 54.93 ±0.34 | 0.87 ±0.76 | 5.54 ±0.12 | 1.65 ±0.65 | 14.76 ±0.83 | 16.42 ±0.43 |

EC: Electrical conductivity, C/N: Carbon /Nitrogen

### 3.2. Efficacy of weed vermicompost (sample - S1) extracts on Germination (%), Seedling Vigour Index (SVI) and length of shoot and root of *Lepidium sativum*

The experiment involved soaking *Lepidium sativum* seeds in various dilutions of vermicompost extracts derived from *Xanthium strumarium*, animal manure, and earthworms. These seeds were incubated on Petri plates with spiked filter paper, followed by daily monitoring of germination over 14 days. The Seedling Vigour Index (SVI) and lengths of shoot and root were measured to evaluate the effectiveness of the treatments. The data in Table 2 demonstrate the differential efficacy of vermicompost treatments on the germination percentage, shoot and root lengths, and Seedling Vigour Index (SVI) of *Lepidium sativum*. The treatment T7-40% resulted in the highest germination rate (60%), with a relatively moderate shoot length (4.2 cm) and SVI of 390. Although the T5-30% treatment also showed a high germination percentage (59%), it exhibited a shorter shoot length (3.6 cm) and root length (2.4 cm), resulting in a slightly lower SVI of 354. Notably, the T2-15% treatment achieved a substantial increase in SVI (357), despite a lower germination rate of 35%, indicating that this concentration effectively promoted seedling vigor through enhanced shoot and root development. These findings suggest that specific concentrations of vermicompost extracts, particularly T7-40% and T5-30%, significantly enhance seedling growth metrics, demonstrating potential as effective bio-fertilizers.

### 3.2. Efficacy of weed vermicompost (sample - S1) extracts on Germination (%), Seedling Vigour Index (SVI) and length of shoot and root of *Lepidium sativum*

The experiment investigated the effects of vermicompost derived from *Alternanthera sessilis*, animal manure, and earthworms on *Lepidium sativum* seeds. The seeds were subjected to varying concentrations of vermicompost extracts, followed by a 14-day germination period. Parameters such as germination percentage, shoot and root lengths, and Seedling Vigour Index (SVI) were measured to assess the efficacy of the treatments. Table 3 illustrates the impact of different concentrations of vermicompost (Sample – S2) on the germination and seedling growth of *Lepidium sativum*. The T7-40% treatment emerged as the most effective, with the highest germination rate (88%) and the greatest shoot and root lengths (8.2 cm and 5.9 cm, respectively), resulting in a superior SVI of 1240.8. This indicates a significant enhancement in seedling vigor compared to other treatments. The T5-30% and T6-35% treatments also exhibited strong performances, with germination rates of 75% and 86%, and corresponding SVIs of 1012.5 and 989, respectively. Interestingly, the control group, which showed a high germination rate of 79%, also had a robust SVI of 1003.3, comparable to the T5-30% treatment. These results suggest that higher concentrations of vermicompost extracts, particularly T7-40%, are highly effective in promoting vigorous seedling growth, making them potent bio-fertilizer candidates for enhancing agricultural productivity.

**Table: 2.** Efficacy of weed vermicompost (sample - **S1**) extracts on Germination (%), Seedling Vigour Index (SVI) and length of shoot and root of *Lepidium sativum.*

| Treatment | Germination (%) | Length of shoot (cm) | Length of root (cm) | Seedling vigour index (SVI) |
|---|---|---|---|---|
| T1-10% | 26 | 6.2 | 4.5 | 278.2 |
| T2-15% | 35 | 6.1 | 4.1 | 357 |
| T3-20% | 40 | 5.9 | 4.2 | 404 |
| T4-25% | 55 | 3.1 | 2 | 280.5 |
| T5-30% | 59 | 3.6 | 2.4 | 354 |
| T6-35% | 58 | 3.9 | 2.5 | 371.2 |
| T7-40% | 60 | 4.2 | 2.3 | 390 |
| Control | 49 | 3.4 | 2.1 | 269.5 |

**Table: 3.** Efficacy of weed vermicompost (Sample – **S2**) extracts on Germination (%), Seedling Vigour Index (SVI), and length of shoot and root of *Lepidium sativum.*

| Treatment | Germination (%) | Length of shoot (cm) | Length of root (cm) | Seedling vigour index (SVI) |
|---|---|---|---|---|
| T1-10% | 57 | 5.2 | 2.3 | 427.5 |
| T2-15% | 52 | 5.9 | 2.3 | 426.4 |
| T3-20% | 60 | 5.3 | 3.2 | 510 |
| T4-25% | 50 | 4.6 | 2.4 | 350 |
| T5-30% | 75 | 8.2 | 5.3 | 1012.5 |
| T6-35% | 86 | 6.4 | 5.1 | 989 |
| T7-40% | 88 | 8.2 | 5.9 | 1240.8 |
| Control | 79 | 7 | 5.7 | 1003.3 |

**Table 4**: Antifungal Efficacy of Vermicompost Extracts (Sample S1 and S2) on *Pythium ultimum*

| Sr. No. | Concentration of VC Extract (%) | Mycelial Growth Radius (cm) - S1 | Inhibition (%) - S1 | Mycelial Growth Radius (cm) - S2 | Inhibition (%) - S2 |
|---|---|---|---|---|---|
| 1 | **5** | 4.2 | 15.6 | 3.9 | 20.3 |
| 2 | **8** | 3.8 | 25.9 | 3.5 | 29.2 |
| 3 | **12** | 3.4 | 36.8 | 3.1 | 39.6 |
| 4 | **16** | 3 | 47.5 | 2.7 | 50.4 |
| 5 | **20** | 2.6 | 57.6 | 2.3 | 60.9 |
| 6 | **22** | 2.4 | 63.8 | 2.1 | 66.4 |
| 7 | **Control (0%)** | 5 | 0 | 4.9 | 0 |

### 3.3. Antifungal Efficacy of Weed Vermicompost Extracts (Sample S1 and S2) Against *Pythium ultimum* at Various Concentrations

Following the methodology outlined, an antifungal assay was conducted to evaluate the efficacy of weed vermicompost extracts (Sample S1 and S2) against *Pythium ultimum* at varying concentrations. The experimental setup involved culturing fungal isolates on Potato Dextrose Agar (PDA) medium, with vermicompost extract concentrations ranging from 5% to 22%. The mycelial growth was monitored, and the biological efficiency of each treatment was calculated using Abbott's formula. The assay was carried out by spreading 20 µl of vermicompost extract filtrate onto PDA medium, followed by inoculating with 3 mm mycelial discs of *Pythium ultimum*. The plates were incubated at 22±2°C for 7-10 days, with colony growth measured and inhibition percentages calculated to assess antifungal efficacy. The data presented in the table demonstrates that both Sample S1 and S2 vermicompost extracts exhibit significant antifungal properties against *Pythium ultimum*, with efficacy increasing alongside the concentration of the extracts. Notably, the S2 sample displayed a higher inhibition percentage at each concentration compared to S1, with the highest inhibition observed at 22% concentration (66.4% for S2 and 63.8% for S1). These results suggest that the antifungal activity of the vermicompost extracts, particularly S2, could be attributed to the presence of bioactive compounds from the medicinal plants incorporated during the vermicomposting process.

## DISCUSSION

Vermicomposting is increasingly recognized as an effective and sustainable method for converting organic waste into nutrient-rich soil amendments (Thakur *et al.*, 021). The process enhances soil physical and chemical properties, including pH balance, electrical conductivity, water holding capacity, and nutrient content, which are crucial for promoting plant growth and health (Tharmaraj *et al.*, 2011; Khater, 2015). The efficacy of vermicompost is largely dependent on the initial carbon to nitrogen (C/N) ratio of the raw materials, with lower ratios generally producing superior compost quality (Biruntha *et al.*, 2019). Vermicompost is particularly rich in essential plant nutrients such as nitrogen, phosphorus, and potassium, surpassing conventional compost in nutrient concentration and availability. This makes vermicompost a valuable alternative or supplement to synthetic fertilizers, especially when produced from a mixture of organic materials like crop residues and animal manure (Kifle *et al*., 2017).

The present study confirms the positive effects of weed-based vermicompost extracts on the germination and growth of *Lepidium sativum*. Our findings align with previous research, which has demonstrated that vermicompost extracts significantly enhance seed germination rates, seedling vigor, and the development of shoot and root systems in various plant species, including garden cress (Kenyangi and Blok, 2013; Arancon and Edwards, 2005). The observed efficacy can be attributed to the presence of plant growth regulators produced during the composting process, which stimulate these growth parameters (Aremu, *et al*., 2015). However, the maturity of the compost plays a critical role; immature composts can inhibit germination and early seedling growth due to the presence of phytotoxic compounds (Pare *et al*., 1997). Furthermore, our study emphasizes the importance of optimizing vermicompost extract concentrations, as the most effective concentration may vary depending on the plant species and the specific components of the extract (Ievinsh *et al*., 2017). For *Lepidium sativum*, the application of vermicompost at a concentration of 20-25% yielded the most pronounced benefits, supporting its use as a natural, eco-friendly growth enhancer.

In addition to its role in promoting plant growth, vermicompost has shown significant potential in disease suppression, particularly against soil-borne pathogens such as *Pythium ultimum* (Sarma, *et al*., 2010) The antifungal properties observed in this study, especially with the Animal manure + Earthworm + *Alternanthera sessilis* (S2) vermicompost extract, are consistent with previous research that underscores the ability of vermicompost to reduce the incidence of diseases caused by *Pythium* species. Scheuerell *et al*., (2005) reported a substantial reduction in *Pythium* damping-off in cucumber seedlings when vermicompost was incorporated into the growth medium. Additionally, compost teas made from specific biowastes, such as banana leaves and lawn clippings, have demonstrated varying levels of inhibition against *Pythium ultimum* in vitro, with factors like compost type, aeration, and brewing duration playing crucial roles in efficacy (Martin *et al*., 2012).

Further supporting these findings, studies by Jarald *et al*. (2008), Randhawa and Sharma (2012), and Sundaram *et al*. (2012) have exhibited similar results in the context of disease suppression caused by phytopathogenic fungi. The effectiveness of vermiwash, a liquid derivative of vermicompost, in controlling microbial infections, including those caused by pathogenic bacteria and fungi, is well-documented (Kiyasudeen, *et al*., 2016). This efficacy can be attributed to the antimicrobial, antibacterial and fungicidal properties of various plants used in the preparation of vermiwash, recent studies confirm the antifungal potential of plant extracts and vermicompost derivatives. *Foeniculum vulgare* extracts inhibit *Pythium ultimum*, *Penicillium expansum*, and *Fusarium solani* by altering cell membrane permeability (Hashem *et al*., 2016). Vermicompost derivatives, including vermiwash and coelomic fluid, also suppress soil-borne fungi (Gudeta *et al*., 2022). The presence of bioactive compounds and plant-derived secondary metabolites in these materials likely contributes to the broad-spectrum antimicrobial activity observed in vermiwash treatments, as demonstrated by van Haperen *et al*. (2019) and Visschers *et al*. (2019). These properties make vermicompost and vermiwash valuable tools for integrated pest and disease management in sustainable agriculture, offering a natural alternative to chemical pesticides and fungicides.

The findings from this study suggest that weed-based vermicompost, particularly from *Alternanthera sessilis*, is effective not only in enhancing plant growth but also in providing protection against fungal pathogens. The dual benefits of growth promotion and disease suppression position vermicompost as a valuable input for sustainable agriculture, reducing the reliance on chemical fertilizers and fungicides while promoting environmental health. Future research could further explore the mechanisms underlying the antifungal activity of vermicompost extracts and optimize application protocols for various crops and pathogens.

## CONCLUSION

The study demonstrates that weed-based vermicompost extracts, particularly those derived from *Alternanthera sessilis*, are highly effective in promoting the growth of *Lepidium sativum* seedlings while simultaneously suppressing the fungal pathogen

*Pythium ultimum*. The significant enhancement in seedling vigor and the pronounced antifungal activity observed, especially at higher extract concentrations, underscore the potential of these vermicompost extracts as valuable tools in sustainable agriculture. By reducing reliance on chemical fertilizers and fungicides, the use of such organic inputs can contribute to more environmentally friendly farming practices, promoting plant health and disease resistance naturally. Future studies should further explore the underlying mechanisms of these effects and optimize application strategies for broader agricultural use.

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**Ethical Consideration**
This research adhered to ethical standards, employing sustainable practices in vermicomposting and ensuring environmental responsibility throughout the study.

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