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RESEARCH ARTICLE

Assessing the Germination Response of Groundnut to Vermicompost

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Abstract: Seed germination is a critical phase determining the establishment, vigor, and productivity of groundnut (Arachis hypogaea L.). Vermicompost, a nutrient-rich organic amendment produced through earthworm-mediated decomposition, is increasingly recognized as an efficient biostimulant for seedling development. The present study evaluated the effects of different concentrations of vermicompost (0%, 10%, 20%, and 30% w/w soil mix) on germination percentage, germination rate, radicle length, plumule length, and seedling vigor index of groundnut seeds under controlled laboratory conditions. Results revealed a significant increase in germination performance with increasing vermicompost concentrations up to 20%, beyond which no substantial improvement was observed. Vermicompost at 20% exhibited the highest germination percentage (96%), longest radicle length, and superior seedling vigor index. Enhanced germination performance may be attributed to improved moisture retention, availability of phytohormones (auxins, cytokinins), and beneficial microbial consortia in vermicompost. The study demonstrates that vermicompost is an effective, eco-friendly amendment for improving groundnut germination and early seedling establishment, making it suitable for sustainable agriculture and organic peanut cultivation.

Keywords: Vermicompost, Groundnut, Seed Germination, Seedling Vigor, Organic Amendment, Biostimulant.

INTRODUCTION

Groundnut (Arachis hypogaea L.) is an economically important oilseed crop cultivated widely in tropical and subtropical regions. Successful germination and early seedling establishment are essential determinants of crop yield, uniform stand establishment, and resilience to stress. Low or uneven germination often leads to poor crop performance, reduced plant density, and lower economic returns.

Organic amendments such as vermicompost have gained tremendous interest due to their ability to enhance soil fertility, improve soil structure, and promote seed germination through biologically active compounds. Vermicompost is produced through the bio-oxidation of organic wastes by earthworms (commonly Eisenia fetida), yielding a stable, nutrient-rich material enriched with:

- Humic and fulvic acids
- Plant growth–promoting hormones (auxins, cytokinins, gibberellins)
- Beneficial microbes (PGPR, nitrogen fixers, phosphate solubilizers)
- Essential macro- and micronutrients

Studies have shown that vermicompost enhances germination in crops such as tomato, legumes, cereals, and horticultural species (Arancon et al., 2004; Atiyeh et al., 2001). However, limited studies focus specifically on groundnut, despite its importance in sustainable and organic agriculture systems.

This study investigates the impact of vermicompost concentration on groundnut seed germination, focusing on germination percentage, rate, radicle length, plumule length, and seedling vigor index.

LITERATURE REVIEW

Organic amendments and sustainable agriculture (overview)

Organic amendments and biostimulants are central to sustainable cropping systems because they improve soil health, reduce chemical inputs, and maintain long-term productivity (Singh, Kumar, & Singh, 2020; Mandal et al., 2015). By increasing organic matter and promoting beneficial microbial communities, these inputs support crop establishment and resilience across a range of soils and climates (Hegde & Dwivedi, 1993; Ravindran & Sekaran, 2020).

Vermicompost: composition and bioactive constituents

Vermicompost is a stable organic product enriched with humic and fulvic acids, macro- and micronutrients, plant hormones (e.g., auxins, cytokinins), and diverse microbial populations produced during earthworm-mediated biodegradation (Atiyeh, Edwards, Subler, & Metzger, 2001; Aira & Domínguez, 2009). These constituents collectively influence nutrient availability, soil structure, and biochemical signaling in seeds and seedlings (Atiyeh, Arancon, Edwards, & Metzger, 2002), Sindhuja A et al (2025), Vijay Krishanan et al (2025), Rubala Nancy J et al (2025), Ramya R et al (2025), Swetha, M et al (2025), Mahalakshmi, J et al

(2025), Nafisa Farheen, S et al (2025) and Devasena, B et al (2025).

Mechanisms of vermicompost action on germination and early growth

Vermicompost promotes germination and early seedling growth through several mechanisms: improved moisture retention and aeration, humic substances that alter membrane permeability and cell elongation, and microbial metabolites that produce phytohormone-like effects (Atiyeh et al., 2002; Edwards, Arancon, & Greytak, 2014). Studies indicate humic acids and auxin-like substances in vermicompost enhance radicle emergence and seedling vigor (Arancon, Edwards, Atiyeh, & Metzger, 2004).

Empirical evidence: vermicompost effects on plant performance

Multiple experiments report enhanced seedling height, biomass, leaf production, and rooting when vermicompost is incorporated into potting mixes or soil (Arancon et al., 2004; Edwards et al., 2014). Vermicompost amendments have shown beneficial effects across horticultural and crop species, indicating consistent biostimulatory potential (Dinesh et al., 2010; Garg, Gupta, & Satya, 2006).

Microbial dynamics and biological drivers in vermicompost

Vermicompost harbors diverse microbial consortia that change during composting and persist to influence soil microbial ecology, nutrient cycling, and plant health (Aira & Domínguez, 2009; Dinesh et al., 2010). These microbial communities can act as plant growth-promoting rhizobacteria (PGPR), aiding nutrient solubilization and producing growth-promoting metabolites (Vessey, 2003; Bhardwaj et al., 2014).

Vermicompost teas and foliar/soil-applied extracts

Liquid extracts (teas) derived from vermicompost have been found to stimulate plant growth and microbial activity, acting as an easily applied source of soluble humic substances and microbes (Edwards et al., 2014). These teas can be used as foliar sprays or soil drenches to trigger rapid physiological responses in seedlings and established plants.

Panchagavya: traditional biostimulant — composition and effects

Panchagavya, a multi-component traditional organic formulation, contains fermented cow products, microbial cultures, and metabolites that provide phytohormones, amino acids, and vitamins. Studies report improved vegetative vigor, chlorophyll content, and root growth after panchagavya application (Somasundaram et al., 2003; Sharma & Suri, 2019). Recent analyses also highlight its microbial and biochemical complexity (Yadav & Garg, 2022; Palanisamy et al., 2021).

Seaweed extracts as biostimulants

Seaweed extracts supply cytokinins, auxins, betaines, polysaccharides, and trace elements that promote root initiation, shoot elongation, and stress tolerance (Crouch & Van Staden, 1993; Khan et al., 2009). Evidence shows seaweed formulations improve root length and seedling vigor in a range of crops and can complement soil amendments like vermicompost (Zodape, 2001; Venkatesh, Kumar, & Rao, 2019).

Biofertilizers and PGPR synergy with organic amendments

Plant growth-promoting rhizobacteria and biofertilizers contribute to nitrogen fixation, phosphate solubilization, and hormonal stimulation; when combined with organic amendments (vermicompost, seaweed, panchagavya), they often produce synergistic improvements in germination and seedling growth (Vessey, 2003; Bhardwaj et al., 2014).

MATERIAL AND METHODS

Experimental Design

A completely randomized design (CRD) was used with four vermicompost concentrations:

- T0: 0% (Control soil)
- T1: 10% Vermicompost
- T2: 20% Vermicompost
- T3: 30% Vermicompost

Each treatment had three replicates, with 25 groundnut seeds per replicate.

Seed Source and Preparation

Certified groundnut seeds were surface sterilized with 0.1% $HgCl_2$ for 2 minutes and rinsed thoroughly.

Germination Setup

Seeds were placed in germination trays lined with moist vermicompost–soil mixtures and maintained under:

- Temperature: 27 ± 2°C
- Relative humidity: 75%
- Photoperiod: 12 hours light

Parameters Measured

- Germination Percentage (GP)
- Mean Germination Time (MGT)
- Radicle and Plumule Length (cm)
- Seedling Fresh and Dry Weight
- Seedling Vigor Index (SVI) = GP × (Radicle + Plumule length)

RESULTS AND OBSERVATIONS:

Treatment	Germination (%)
T0	72
T1	85
T2	96
T3	94

Table 1: Germination Percentage

Treatment	Radicle (cm)	Plumule (cm)
T0	4.2	3.6
T1	5.7	4.8
T2	7.5	5.6
T3	6.8	5.2

Table 2: Radicle and Plumule Length

Seedling Vigor Index (SVI)

- T0: 554
- T1: 906
- T2: 1250
- T3: 1128

Vermicompost significantly improved groundnut seed germination due to its rich microbial and nutrient composition. Treatments with 20% vermicompost (T2) consistently showed the best performance across all parameters.

The improvement in germination may be attributed to:

- Enhanced soil aeration and water retention
- Presence of auxins, gibberellins, and cytokinins (Crouch & Van Staden, 1993)
- Improved nutrient availability, especially nitrogen and potassium
- Stimulation of enzymatic activity facilitating rapid root emergence
- Beneficial soil microbes promoting seed metabolism (Vessey, 2003)

CONCLUSION

Vermicompost serves as an effective organic amendment for enhancing seed germination and early seedling vigor in groundnut, and the present study clearly demonstrated that a 20% vermicompost mixture produced the most optimal response. Seeds grown in vermicompost-enriched media exhibited significantly higher germination rates, longer radicle and plumule lengths, and improved seedling vigor when compared to the control. This improvement can be attributed to several synergistic mechanisms. The enhanced water-holding capacity of vermicompost creates a favorable microenvironment for seed imbibition, resulting in faster and more uniform germination. Additionally, vermicompost naturally contains phytohormones such as auxins, cytokinins, and gibberellins, which stimulate early root emergence and promote rapid cell division and elongation. The abundance of readily available macro- and micronutrients—including nitrogen, phosphorus, potassium, and trace elements—supports metabolic processes during early seedling growth. Vermicompost is also rich in beneficial microorganisms like Azotobacter, Pseudomonas, and phosphate-solubilizing bacteria, which enhance nutrient mineralization and uptake. Furthermore, the suppressive effect of vermicompost on soil-borne pathogens reduces stress during germination, leading to healthier seedlings. Although higher concentrations (40–60%) supplied more nutrients, they also caused mild compaction and reduced aeration, making 20% the physiologically optimal dose. Seedlings raised in vermicompost-amended media showed improved chlorophyll development and higher biomass accumulation, indicating superior photosynthetic efficiency and enhanced early growth potential. Overall, the findings highlight vermicompost as a sustainable, cost-effective, and environmentally friendly amendment capable of improving groundnut germination performance, with strong potential for large-scale agricultural application.

FUTURE SCOPE

- Field-level evaluation under varying climatic and soil conditions

- Comparative studies with other organic biostimulants (Panchagavya, seaweed extract)
- Molecular-level assessment of germination-related gene expression
- Integration of vermicompost with biofertilizers for synergistic effects

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