



COMPARATIVE EVALUATION OF VERMICOMPOST AND BIOCOMPOST: NUTRIENT COMPOSITION AND EFFECTS ON PLANT GROWTH

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ABSTRACT

Organic fertilizers are increasingly viewed as sustainable alternatives to chemical fertilizers because they improve soil health while reducing environmental impacts. Among these, vermicompost and biocompost are widely used organic amendments produced through the biological decomposition of organic wastes. The present study compared the nutrient composition of vermicompost and biocompost and examined their influence on plant growth. Vermicompost was produced using the earthworm *Eisenia fetida*, whereas biocompost was prepared through aerobic microbial composting. A pot experiment using *Phaseolus vulgaris* was conducted under controlled conditions to evaluate plant growth under different compost treatments. Chemical analysis showed that vermicompost contained higher concentrations of both macro- and micronutrients than biocompost. Plants grown in soil amended with vermicompost showed better growth performance, including greater plant height, more leaves, longer roots, and higher dry biomass than plants grown in biocompost or untreated soil ($p \leq 0.05$). Statistical analysis also revealed clear differences among treatments and demonstrated positive relationships between nutrient availability and plant growth parameters. Overall, the results indicate that vermicompost can serve as an effective organic fertilizer for improving soil fertility and enhancing plant growth.

KEYWORDS: Vermicompost, Biocompost, Soil fertility, Organic fertilizer, Macronutrients, Micronutrients, Plant growth

INTRODUCTION

Maintaining soil fertility in a sustainable manner is essential for long-term agricultural productivity. However, the continuous and excessive use of chemical fertilizers has raised several environmental concerns, including soil acidification, nutrient imbalance, and a decline in soil microbial diversity (Edwards and Bohlen, 1996; Sharma et al., 2021; Gupta et al., 2022). These problems have encouraged researchers and farmers to explore environmentally friendly alternatives. Organic fertilizers have gained attention because they help improve soil quality while supporting sustainable farming practices. Organic amendments such as compost and vermicompost are known to enhance soil structure, increase microbial activity, and improve the availability of nutrients for plant growth (Domínguez, 2020; Lazcano and Domínguez, 2023). Compost is produced through the aerobic decomposition of organic residues by microorganisms, resulting in stabilized organic matter that contributes to soil fertility (Singh et al., 2023). Vermicomposting is a related process that involves both microorganisms and earthworms in the decomposition of organic materials. Earthworms accelerate this process by breaking down organic residues into smaller particles and stimulating microbial activity in the soil (Pramanik et al., 2007; Ansari and Jaikishun, 2020). Because of these biological interactions, vermicompost often contains higher levels of essential nutrients such as nitrogen, phosphorus, and potassium compared with

conventional compost (Arancon et al., 2004; Sinha et al., 2024). Apart from macronutrients, vermicompost also provides several important micronutrients, including iron, zinc, copper, and manganese. These elements play key roles in plant metabolism, enzyme activity, and chlorophyll formation (Hassan et al., 2022; Sharma et al., 2022). In addition, vermicompost contains humic substances and plant growth regulators that can stimulate root development and improve nutrient uptake by plants (Atiyeh et al., 2002).

Although the benefits of vermicompost for soil fertility and plant growth have been widely reported (Singh et al., 2023; Sinha et al., 2024), studies directly comparing vermicompost and biocompost under controlled conditions are still limited. Therefore, the present study was undertaken to compare the nutrient composition of vermicompost and biocompost and to evaluate their effects on the growth of bean (*Phaseolus vulgaris*).

MATERIALS AND METHODS

Compost Preparation

Vermicompost was produced using a mixture of vegetable waste, crop straw, and cow dung in a proportion of 2:1:1. The mixture was first allowed to partially decompose for about ten days before introducing earthworms (*Eisenia fetida*) at a density of roughly 1 kg of worms for every 100 kg of organic material. During the process, moisture levels were maintained between 60–70%. The vermicompost was ready for collection after approximately 45 days. Biocompost was prepared using the same combination of organic materials but through an aerobic microbial composting process. To maintain proper aeration and promote even decomposition, the compost piles were turned once every seven days. Moisture content was kept around 50–60%, and the compost reached maturity in about 60 days.

Nutrient Analysis

Compost samples were first air-dried, finely ground, and sieved through a 2 mm mesh before laboratory analysis. Each parameter was measured in triplicate to ensure accuracy and reliability. Total nitrogen content was determined using the micro-Kjeldahl method. Available phosphorus was analysed by the Olsen extraction technique and quantified through colorimetric measurement. Potassium concentration was estimated using flame photometry following tri-acid digestion of the samples. Calcium and magnesium levels were determined with the help of atomic absorption spectrophotometry. For micronutrient analysis, iron, zinc, copper, and manganese were extracted using a DTPA solution and subsequently measured using atomic absorption spectrophotometry.

Plant Growth Experiment

A pot experiment was conducted using bean (*Phaseolus vulgaris*) plants arranged in a completely randomized design with five replicates per treatment.

The treatments included:

T1 – Control (soil only)

T2 – Soil + Biocompost (20% w/w)

T3 – Soil + Vermicompost (20% w/w)

Plants were grown for forty days. Plant height, number of leaves, root length, and dry biomass were recorded. Dry biomass was determined after drying plant samples at 65 °C until constant weight.

Statistical Analysis

Experimental results were presented as mean $\pm$ standard deviation. Differences among the treatment groups were analysed using one-way analysis of variance (ANOVA), followed by Tukey's post-hoc test to identify significant differences at a probability level of $p < 0.05$. Pearson correlation analysis was also carried out to evaluate the relationships between nutrient levels and the measured plant growth parameters.

RESULTS

Nutrient Composition of Composts

The chemical analysis showed noticeable differences in the nutrient content of vermicompost and biocompost. Vermicompost had consistently higher levels of all the macronutrients that were measured. Among these, nitrogen showed the largest increase, followed by potassium and phosphorus. Higher concentrations of calcium and magnesium were also observed in vermicompost. Statistical analysis confirmed that these differences between the two compost types were significant ($p < 0.05$).

Table 1: Macronutrient composition of vermicompost and biocompost

Nutrient	Vermicompost (%)	Biocompost (%)
Nitrogen	1.68 ± 0.04	0.91 ± 0.03
Phosphorus	0.92 ± 0.02	0.48 ± 0.02
Potassium	1.41 ± 0.05	0.76 ± 0.04
Calcium	2.05 ± 0.06	1.37 ± 0.05
Magnesium	0.73 ± 0.03	0.44 ± 0.02

Micronutrient analysis showed a similar pattern. Vermicompost contained higher concentrations of iron, zinc, copper, and manganese compared with biocompost.

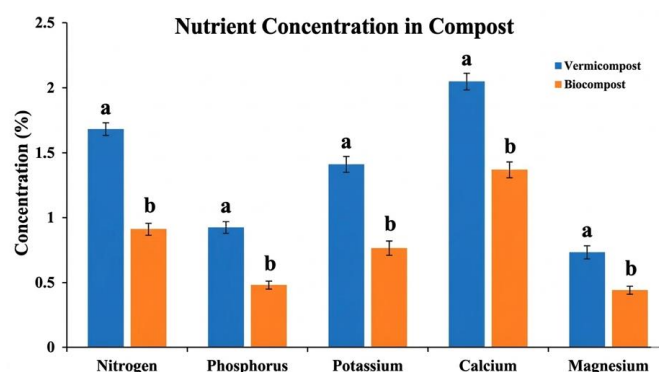


Figure 1. Macronutrient concentrations in vermicompost and biocompost. Bars represent mean ± standard deviation (n = 3). Different letters above bars indicate significant differences between treatments at $p < 0.05$.

Table 2: Micronutrient composition of vermicompost and biocompost

Micronutrient	Vermicompost (mg/kg)	Biocompost (mg/kg)
Iron	842 ± 18.5	563 ± 12.4
Zinc	72 ± 3.1	46 ± 2.0
Copper	32 ± 1.4	21 ± 0.9
Manganese	214 ± 6.5	158 ± 4.8

Plant Growth Response

The different compost treatments had a significant effect on plant growth. The use of vermicompost led to the greatest improvement in all measured plant growth parameters. Plants grown in vermicompost-amended soil showed the highest plant height, produced more leaves, developed longer roots, and accumulated greater biomass. In contrast, plants treated with biocompost showed moderate growth, whereas the control plants consistently recorded the lowest values for all growth traits.

Table 3: Growth response of *Phaseolus vulgaris* to compost treatments

Treatment	Height (cm)	Leaves	Root Length (cm)	Dry Biomass (g)
Control	18.4 ± 1.3 ^c	8 ± 0.7 ^c	6.2 ± 0.5 ^c	4.2 ± 0.3 ^c
Biocompost	26.7 ± 1.5 ^b	11 ± 1.0 ^b	9.1 ± 0.7 ^b	6.9 ± 0.5 ^b
Vermicompost	34.5 ± 2.1 ^a	15 ± 1.2 ^a	12.8 ± 0.9 ^a	9.8 ± 0.7 ^a

Values are mean ± SD (n = 5). Superscript letters indicate significant differences at $p < 0.05$

Statistical Relationships

Statistical analysis confirmed that the compost treatments significantly influenced plant growth. For dry biomass, ANOVA produced an F-value of 12.45 with a p-value of 0.003, indicating a clear treatment effect. Correlation analysis also revealed positive associations between nutrient concentrations and plant growth characteristics. Among the macronutrients, nitrogen showed the strongest relationship with plant biomass, followed by potassium and phosphorus. Among the micronutrients, iron displayed the highest correlation with plant growth parameters.

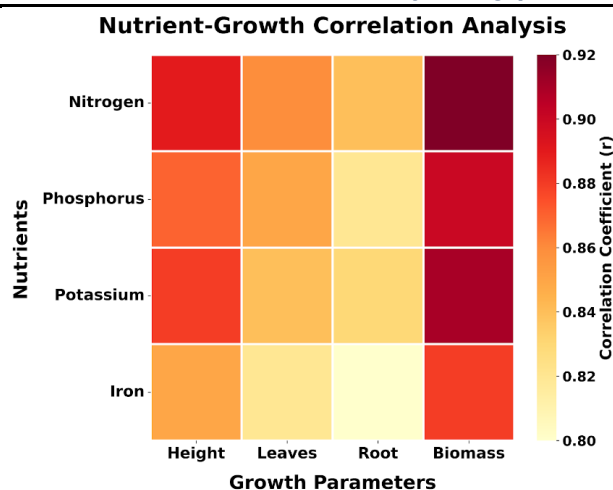


Figure 2. Heatmap showing the correlation between nutrient concentrations and plant growth parameters. Warmer colours represent stronger positive correlations. All correlations are statistically significant ($p < 0.01$).

DISCUSSION

The findings of this study clearly show that vermicompost contains higher levels of both macro- and micronutrients than biocompost. Similar observations have been reported in earlier studies, which indicate that earthworm activity plays a key role in accelerating the breakdown of organic materials and improving nutrient mineralization (Pramanik et al., 2007; Domínguez, 2020). During vermicomposting, earthworms break organic residues into smaller particles and enhance microbial activity in the substrate. This process ultimately increases the availability of nutrients that can be absorbed by plants (Ansari and Jaikishun, 2020; Lazcano and Domínguez, 2023). The nutrient concentrations recorded in the present investigation are comparable with the ranges reported for vermicompost in previous research (Singh et al., 2023; Sinha et al., 2024). The relatively higher micronutrient content observed in vermicompost may be related to intensified microbial activity and the presence of humic substances in vermicast, which help chelate and stabilize micronutrients (Hassan et al., 2022). These micronutrients are essential for several physiological processes in plants, particularly enzyme activation and chlorophyll synthesis. The pot experiment further demonstrated that vermicompost application significantly improved plant growth when compared with both biocompost and untreated control conditions. Enhanced plant performance may be explained by the greater availability of nutrients as well as the presence of biologically active substances such as humic acids and natural growth regulators known to stimulate plant development (Atiyeh et al., 2002; Arancon et al., 2004). The strong positive correlations observed between nutrient concentrations and plant growth traits also suggest that the improved plant performance was mainly associated with the higher nutrient supply provided by vermicompost-amended soil.

CONCLUSION

The results of the present study demonstrate that vermicompost contains substantially higher concentrations of both macro- and micronutrients compared with biocompost. The application of vermicompost also led to noticeable improvements in several growth characteristics of bean plants, including plant height, leaf number, root development, and overall biomass production. Statistical analysis confirmed that these differences were significant and highlighted strong relationships between nutrient availability and plant growth. Taken together, the findings indicate that vermicomposting is an effective approach for recycling organic waste while improving soil fertility and supporting sustainable agricultural practices.

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