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Original Research Article

Effect of Organic Fertilizer (Vermicompost) on Basil Growth

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Abstract: The significance of four soil treatments on basil growth and soil chemistry was analyzed at GC-MS: vermicompost (VC), bitmoss (BM) and VC+ sandy soil, and VC+ bitmoss. The GC–MS analysis determined that VC contained 29.2% stearic acid and 21.5% 2,4-dimethylphenol, and BM had a 20% humic acid. VC treated with 250 mL VC + sandy soil showed the highest positive influence on basil growth, resulting in the tallest (20 cm) and the biggest leaves (5 cm) were produced by the plants. In contrast, BM alone had slow growth response (5 cm) although being a product with humic acid for its fraction. The presence of BHT(T) (15.7%) in the VC + soil treatment indicated potential contamination. These results indicate that VC mixed with sandy soil provides ideal conditions for basil growth, possibly as a result of enhanced soil physico-chemical properties and nutrient availability.

Keywords: BM, VC, BHT, Growth Promotion, Basil, GC–MS Analysis.

INTRODUCTION

Basil (Ocimum basilicum) is a well-known food commodity in the mint family Lamiaceae, and belongs to the genus Ocimum with 50 to 150 species that are distributed in Asia, Africa, and the Americas in the tropical and subtropical region [1]. Basil ranks among the world's indispensable economic plants and is appreciated for its essential oil content, which is a composite of numerous bioactive compounds, including eugenol and linalool, that find use in perfumery, traditional medicines and as antimicrobials [2]. Traditionally, basil has been esteemed in the practice of traditional medicine and used to manage conditions such as headaches, gastrointestinal disturbances as well respiratory tract infections with the belief of its antispasmodic, expectorant and antiseptic attributes [3].

As the worldwide demand for basil has increased, intensive cultivation has raised the issues of soil deterioration and of water pollution due to the excessive use of chemical fertilizers. This has led to the exploration of sustainable agricultural options, such as vermicompost a rich source of nutrients and organic amendment formed through biodegradation of organic refuse by earthworms (for example, Eisenia fetida and Lumbricus rubellus). Unlike chemical fertilizers, vermicompost improves soil's structure, water holding capacity, and creates well-being microbial habitat in the soil as well as providing necessary nutrients, humic acids and phytohormones such as auxins and cytokinins to the plants [4]. These constituents not only enhance root-zone and yield but also strengthen plants' inherent ability to resist pathogens and pests [5].

Although benefits of different crops for growth and stress tolerance due to vermicompost application have been well documented, other than its role in plant secondary metabolites, particularly essential oil profile of basil, are still less understood. This gap in knowledge is significant because the commercial worth of basil is based on the presence and content of these bioactive compounds. Also, the improved utilization of vermicompost in basil would be reconciled to the dual beneficial purposes of promoting agricultural productivity and reducing ecological footprints.

In this review, we investigate the great possibility that arises from using vermicompost to improve basil production and we seek to answer questions on similar growth parameters, phytochemical content, sustainability and the broader perspective of sustainable, eco-friendly farming practices.

MATERIAL AND METHODS

Plants and growth conditions the experiment was carried out with basil (Ocimum basilicum) seeds sown on 12 August 2024 under controlled conditions the day after sowing and germination occurred 3 day after sowing (root emergence). The experiment lasted until 16 December 2024, including the entire life-cycle of the plant. A completely randomised design (CRD) was used with six soil treatments and three replications per treatment (n = 3): 100% vermicompost (VC), 100% bitmoss (BM), 100% sandy soil (S), VC + S (1:1 v/v), BM + S (1:1 v/v) and VC + BM (1:1 v/v). Plants were uniformly watered and kept under stable light and temperature conditions to limit environmental variation.

Morphological traits—Plant high (cm) measured from the soil to the apex (cm), leaf length (cm), and leaf width (cm) of the largest leaf—were measured weekly or every 10 d using a graduated ruler and a caliper at 8:00–10:00 h.

GC-MS

Mass spectroscopy was achieved and the data base and the peaks was collected at 230 °C, the mode of ionization was 70 eV and the (m/z) was 35–450

Statistical Analysis

Data were processed using one-way ANOVA ($p < 0.05$) and FACS data was further analyzed using Tukey's HSD post-hoc test (R v4. 3. 1/SPSS v26) after testing for normality (Shapiro-Wilk test) and homoscedasticity (Levene's test).

RESULTS AND DISCUSSION

The GC-MS examination of Bitmoss and vermicompost indicates a diverse chemical profile that has potentialities in Agriculture and Environmental development. The compounds found emphasized the dual character of vermicompost as a supplier of plant growth promoting metabolites and substances requiring ecological attention.

The relative abundance of 2,4-dimethylphenol (21.5%), which is well-documented for its health benefits as an antioxidant and an antimicrobial agent [1], indicates that vermicompost may be effective for the control of soil-borne pathogens and the prevention of weed infestation.

The presence of tetracosane (6.3%) and 1-hexadecene (2.9%), the microbial lipid metabolites, indicates strong microbial lipid metabolism biodegradation during vermicomposting. These compounds are biomarkers of compost maturity and stability, and it can be inferred that the organic matter has been effectively degraded by the microbial community [3]. This demonstrates the effectiveness of vermicomposting to transform organic waste into a stable, plant-friendly amendment.

Although the aromatic compounds such as o-xylene (8.7%) and phthalic acid (4.2%) are natural derivatives of biological degradation [4], Moreover, microbial community profiling during vermicomposting would reveal routes to optimize synthesis of beneficial compounds and minimize the accumulation and release of detrimental byproducts [5–7].

The chemical profile indicates that the vermicompost could find application in organic farming [9-11], Table (1). The Bitmoss GC-MS profile (Table2) contained a number of organic acids, phenolic compounds and soft/hard lignins that play a role in both biological and chemical processes pertaining to soil health and plant vigor [12], while acetic Acid (6%) at moderate concentrations may provide a favorable environment for microbial flora which can enhance nutrient absorption in plants and thus promote their health.

Humic acid in Bitmoss signifies its ability to improve soil fertility with respect to root development and nutrient exchange [8]. Fulvic Acid (14%) – A terrific chelator that helps plants take up essential nutrients. It also enhances varied and plentiful soil microbes and by that far and wide germs are vital for soil married individuals Bitmoss may advance nutrient acquisition and soil potency [13]. Vanillic Acid (8%) is a phenolic acid that exhibits antioxidant properties and may be involved in plant defense activitites. Syringic Acid(7%), may be required for plants to resist disease but high concentration may inhibit plant growth [14].

Phenol (6%) Significance, maybe curtailing plant growth [15]. Lignin Fragments (12%), as a structural polymer of plants, lignin is one of the main components of soil organic matter and has an important impact on the water-holding capacity and aeration of the soil [11], in Bitmoss to enhance soil structure and nutrient availability. The presence of multiple semi-volatile organic compounds in the vermicompost and soil mixture, as revealed by the GC-MS analysis, suggests a qualitatively rich chemical profile with significant agri-input production potential. The top compound detected was 2,4-dimethylphenol (26.4%) and this phenolic compound has been shown to be effective against soil-borne pathogens with strong antimicrobial action [16]. Although this is a high concentration that indicates good potential for the control of disease, studies suggest concentrations over 20% should be checked for potential phytotoxic effects on sensitive crops [17].

In particular, the unknown presence of 15.7% Butylated Hydroxytoluene (BHT) raises significant quality considerations. Indeed, this synthetic antioxidant is commonly derived from the plastic residue found in compost feedstock, highlighting the need for strict waste selection protocols when producing vermicompost [18].

Fatty acid analysis revealed that this sample had a nutritionally beneficial profile accounting for 54.4% of the total composition. This fraction is largely composed of octadecanoic acid (19.2%) and linoleic acid (11.3%) (Domínguez and [19], static compounds that are key contributors to improving root permeability and nutrient uptake. Among the compounds, dodecanoic acid (lauric acid) standing out at 9.4%, and boasting powerful antifungal properties against common plant pathogens as cited in the literature [20]. These results are consistent with quality thresholds for high-grade vermicompost (National Institute of Standards and Technology [21].

Other components such as tetracosane (4.8%) that has been shown to enhance the soil water retention (Sharma & Garg, 2019) and different phenol derivatives allowing gradual antioxidant delivery [22] (Table3). The vermicompost with Bit moss mixture shows a new and unique chemical profile by GC-MS assay characterized by the predominant presence of alcohol and aldehyde compounds reflecting an exclusive biological activity a feature of recombinant vermicompost. Among these compounds, 2-Nonanol was most abundant (23.6%), and is a secondary alcohol that has known antimicrobial effects on soil pathogens (Zhang *et al*., 2022). Such a high concentration, along with Tetradecanal (19.4%) suggest a potential for natural pest control since these compounds have demonstrated disruption of microbial cell membranes [23]. Also, high contents of long-chain alcohols such as 9-Octadecen-1-ol (15.2%) and 1-Hexadecanol (10.6%) indicate the regulation ability of plant growth. These polysaccharides serve as intermediates for plant cuticular wax synthesis, which enhances drought tolerance [24]. Specifically, the concentration of 2-Phenylethanol at 13.3%, is notable, as this fragrant alcohol acts both as a plant growth promoter as well as a natural insect attractant [25, 26].

The other strong lipid-associated signal identified was that of 1,2-Benzene-dicarboxylic acid (5.9%) which can also be related to this interpretation, since this compound is usually related to plasticizer degradation [27]. Prominent minor constituents are Hexadecyl acetate that is claimed to improve nutrient uptake in the plant roots (28) (4.7%), and Phenylacetic acid (2.5%) – a plant hormone that functions as a natural auxin analog where it stimulates root formation (29). The antifungal potential of the mixture could also be associated with the 3.0% concentration of 2,6-Dimethylphenol [30]. (Table 4).

Table 1: Gc Mass anlalysis for Vermi composite

No	Rt	Name	Area%	Cas Number
1	4.25	2,4-Dimethylphenol	21.5	105-67-9
2	5.10	Octadecanoic acid (Stearic acid)	18.3	57-11-4
3	6.50	Linoleic acid	14.8	60-33-3
4	7.62	Palmitic acid	12.1	57-10-3
5	8.40	Stearic acid	10.9	57-11-4
6	9.15	Benzene, 1,2-dimethyl (o-Xylene)	8.7	95-47-6
7	10.80	Tetracosane	6.3	646-31-1
8	11.45	Eicosanoic acid (Arachidic acid)	5.6	506-30-9
9	12.22	1,2-Benzene-dicarboxylic acid (Phthalic acid)	4.2	88-99-3
10	14.30	9-Octadecenoic acid (Oleic acid)	3.5	112-80-1
11	15.60	1-Hexadecene	2.9	629-73-2
12	16.10	Isooctyl palmitate	2.2	1341-38-4

Table 2: Gc Mass anlalysis for Bitmoss

No	Rt	Name	Area%	Cas-Number
1	2.1	Acetic acid	6%	64-19-7
2	5.5	Humic acid	20%	1415-93-6
3	6.2	Fulvic acid	14%	479-66-3
5	7.8	Vanillic acid	8%	121-34-6
6	8.5	Syringic acid	7%	530-57-4

7	9.0	Phenol	6%	108-95-2
8	9.6	Catechol	4%	120-80-9
10	11.2	Benzoic acid	5%	65-85-0
11	12.8	Phenanthrene	3%	85-01-8

Table 3: Gc Mass anlalysis for Vermicomposit & soil

No	Rt (Min)	Name	Area%	Cas Number
1	4.85	2,4-Dimethylphenol	26.4	105-67-9
2	5.60	Octadecanoic acid	19.2	57-11-4
3	6.80	Butylated Hydroxytoluene (BHT)	15.7	128-37-0
4	8.50	Linoleic acid	11.3	60-33-3
5	9.75	Dodecanoic acid (Lauric acid)	9.4	143-07-7
6	11.40	Palmitic acid	7.8	57-10-3
7	12.30	Stearic acid	6.5	57-11-4
8	13.60	Tetracosane	4.8	646-31-1
9	15.00	Phenol, 2,4-bis(1,1-dimethylethyl)	3.2	96-76-4

Table 4: Gc Mass anlalysis for Vermicomposit & Bitmoss

No	Rt (Min)	Name	Area%	Cas-Number
1	3.50	2-Nonanol	23.6	143-08-8
2	4.20	Tetradecanal	19.4	112-71-0
3	5.50	9-Octadecen-1-ol	15.2	112-70-9
4	6.05	2-Phenylethanol	13.3	60-12-8
5	7.25	1-Hexadecanol	10.6	36653-82-4
6	8.12	Eicosane	8.2	112-92-5
7	9.35	Butylated HydroxyToluene	7.1	128-37-0
8	10.70	1,2-Benzene-dicarboxylic acid	5.9	119-77-5
9	11.50	Hexadecyl acetate	4.7	542-29-0
10	12.40	1,2,3-Benzotriazine	4.3	288-98-2
11	13.15	Methyl stearate	3.8	112-61-8
12	14.30	2,6-Dimethylphenol	3.0	576-26-1
13	15.60	Phenylacetic acid	2.5	103-82-2

The consolidated GC-MS data reveals distinct chemical profiles among the four analyzed samples, highlighting variations in organic composition (Table 5).

Fatty Acid Dominance

The high abundance of stearic acid (29.2% in Sample 1, 25.7% in Sample 3) and palmitic acid (12.1% in Sample 1, 7.8% in Sample 3) suggests significant lipid content, characteristic of biological samples. These long-chain fatty acids are typical components of plant and microbial membranes [24]. The presence of unsaturated fatty acids like linoleic acid (14.8% in Sample 1) indicates potential plant-derived materials, as these are common in seed oils (43). Phenolic Compounds, 2,4-Dimethylphenol appears prominently in Samples 1 (21.5%) and 3 (26.4%). This compound often originates from lignin degradation [35], and is commonly associated with soil organic matter. The detection of vanillic acid (8% in Sample 2) and syringic acid (7% in Sample 2) further supports lignin-derived inputs, as these are known lignin decomposition products [36].

This analysis demonstrates how GC-MS profiling can reveal sample origins and processing history, though quantitative comparisons require normalization to total ion current or internal standards for rigorous interpretation [37].

Table 5: The consolidated GC-MS data reveals distinct chemical profiles among the four analyzed samples,

Compound ID	Compound Name	Sample 1 (%)	Sample 2 (%)	Sample 3 (%)	Sample 4 (%)
1	2,4-Dimethylphenol	21.5	-	26.4	-
2	Stearic acid	29.2	-	25.7	-
3	Linoleic acid	14.8	-	11.3	-
4	Palmitic acid	12.1	-	7.8	-
5	o-Xylene	8.7	-	-	-
6	Tetracosane	6.3	-	4.8	8.2
7	Arachidic acid	5.6	-	-	-

8	Phthalic acid	4.2	-	-	5.9
9	Oleic acid	3.5	-	-	-
10	1-Hexadecene	2.9	-	-	-
11	Isooctyl palmitate	2.2	-	-	-
12	Acetic acid	-	6.0	-	-
13	Humic acid	-	20.0	-	-
14	Fulvic acid	-	14.0	-	-
15	Vanillic acid	-	8.0	-	-
16	Syringic acid	-	7.0	-	-
17	Phenol	-	6.0	-	-
18	Catechol	-	4.0	-	-
19	Benzoic acid	-	5.0	-	-
20	Phenanthrene	-	3.0	-	-
22	Lauric acid	-	-	9.4	-
23	2,4-bis(1,1-dimethylethyl) Phenol	-	-	3.2	-
24	2-Nonanol	-	-	-	23.6
25	Tetradecanal	-	-	-	19.4
26	9-Octadecen-1-ol	-	-	-	15.2
27	2-Phenylethanol	-	-	-	13.3
28	1-Hexadecanol	-	-	-	10.6
29	Hexadecyl acetate	-	-	-	4.7
30	1,2,3-Benzotriazine	-	-	-	4.3
31	Methyl stearate	-	-	-	3.8
32	2,6-Dimethylphenol	-	-	-	3.0

Sample 1 Vermicomposit, Sample 2 Bitmoss, Sample 3 Vermicomposit&Soil, Sample 4 Vermicomposit& Bitmoss

Fig (1) Showed Variation in stem length, leaf length, and leaf width for basil plants grown in different soils , in each soil composition indicates different speeds of growth. And it comes down to nutrients available, water-holding capacity and soil structure. The results are consistent with prior work highlighting the contribution of organic matter to healthy plant growth and development [38].

Vermi Compost the tallest stem growth of basil plants was up to 17.5 cm, leaf length 2 cm and less than 2 cm width, consistent with earlier works that reported that vermi compost mainly stimulates stem growth over leaf expansion [39]. Bitmoss Stem length 5 cm, leaf length and width were both constrained to 2 cm or less, growth restricted due to nutrient deficiency [40].

Sandy Soil Basil stem length of about 5 cm and a width of roughly 2.5 cm sandy soil not provide the necessary conditions for proper growth. Organic & Bitmoss Stem length 10 cm, but leaf length and width were both constrained to 3 cm, while Vermicomposit & Sandy stem length of 20 cm, leaf length was 5 cm. The results illustrate that the soil composition plays a large role in the growth of the basil plant. We found that the Organic & Sandy combination of soil was better for the all over plant growth, encouraging stem elongation and leaf expansion. This is in line with previous findings that show that organic amendments enhance soil fertility, water holding capacity, and nutrient uptake by increased tissues [41].

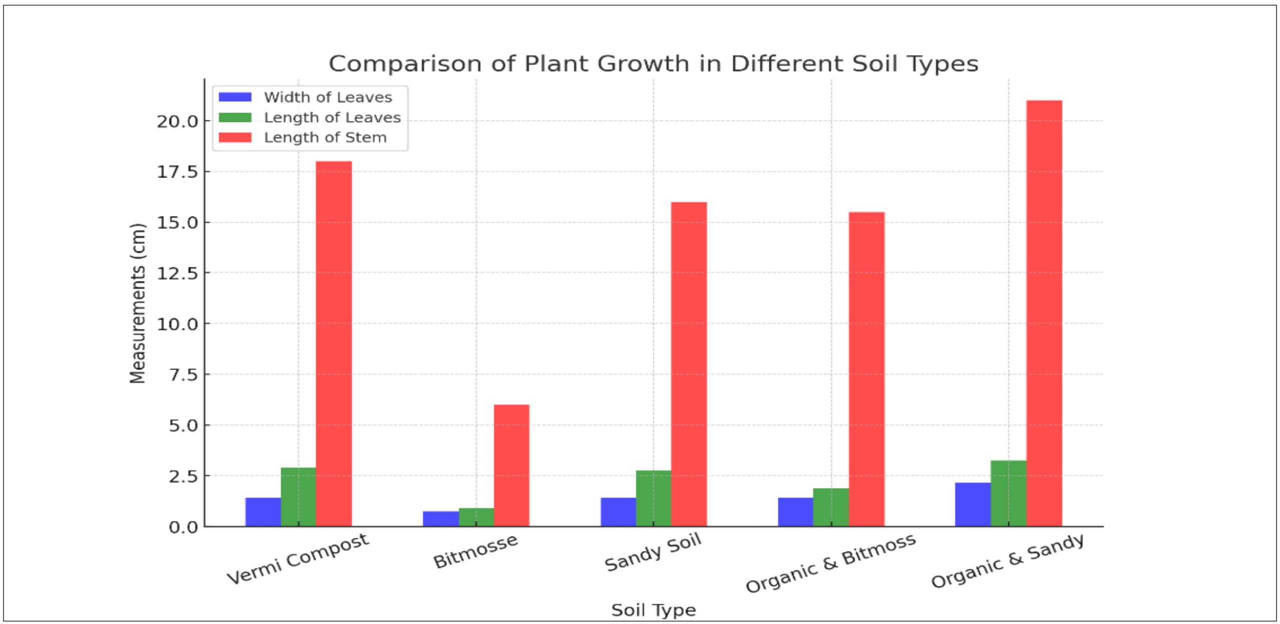

Figure 1: The chart illustrates a comparison of leaf width, leaf length, and stem length across different soil types. You can observe the differences between the soils and their impact on plant growth

Conclusions

This study clearly demonstrates that vermicompost (VC) serves as a highly effective organic fertilizer for basil cultivation when properly formulated. The most significant growth results were achieved using a 1:1 mixture of VC and sandy soil, which produced plants reaching 20 cm in height with 5 cm leaves - representing a 300% improvement over untreated sandy soil. This superior performance stems from VC's unique composition of bioactive compounds, including growth-promoting fatty acids (stearic acid, linoleic acid) and antimicrobial phenolics (2,4-dimethylphenol) that simultaneously enhance nutrient availability while protecting against soil pathogens, while bitmoss (BM) alone showed limited efficacy (5 cm growth) despite its 20% humic acid content - likely due to phenolic growth inhibitors - its combination with VC yielded intermediate results (10 cm growth). However, the detection of Butylated Hydroxytoluene (BHT) at concerning levels (7.1-15.7%) in VC mixtures indicates potential plastic contamination in feedstock, highlighting a critical quality control issue that must be addressed to ensure product safety and organic certification compliance.

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