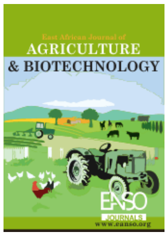


East African Journal of Agriculture and Biotechnology
eajab.eanso.org
Volume 8, Issue 1, 2025
p-ISSN: 2707-4293 | e-ISSN: 2707-4307
Title DOI: https://doi.org/10.37284/2707-4307

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Evaluation of the effectiveness of leachates derived from the vermicomposting of different organic wastes on the growth of mint (mentha sp.) in hydroponic culture in Senegal

Dr. Issa Alé Ndiaye, PhD[1], Dr. Oumar Seydi, PhD[1], Amadou Baldé[1], Dr. Etienne Tendeng, PhD[1], Dr. Serigne Sylla, PhD[1] & Prof. Karamoko Diarra, PhD[1]*

[1] Cheikh Anta Diop University, BP 5005 Dakar-Fann, Senegal.
* Author's ORCID ID; https://orcid.org/0009-0001-4312-0999; Email:zafissa92@gmail.com

Article DOI: https://doi.org/10.37284/eajab.8.1.3050

Date Published:

26 May 2025

Keywords:

Vermicomposting, Horse Manure, Cow Dung, Poultry Droppings, Green Wastes, Urban Agriculture, Soilless Culture, Dakar, Senegal.

ABSTRACT

This study evaluates the effectiveness of different vermicompost leachates derived from various organic sources (horse manure, cow dung, green wastes, and poultry droppings) on the growth of mint in hydroponic cultivation. For each type of leachate, the plants were subjected to three different doses (D1, D2, D3), along with a chemical control (Tc) and a neutral control (Te). The parameters assessed included the number of leaves, plant height, and fresh leaf biomass. The results show that treatments based on vermicompost leachates produced a number of leaves comparable to the chemical control, with approximately 140 leaves per plant. Regarding plant height, the D2ch treatment exhibited the best growth, reaching 30 cm. For fresh aerial biomass, the D2ch, D2va, and Tc treatments yielded similar weights, ranging between 30 and 35 g. These findings highlight the potential of vermicompost leachates as viable alternatives to liquid chemical fertilizers in hydroponic systems.

APA CITATION

Ndiaye, I. A., Seydi, O., Baldé, A., Tendeng, E., Sylla, S. & Diarra, K. (2025). Evaluation of the effectiveness of leachates derived from the vermicomposting of different organic wastes on the growth of mint (mentha sp.) in hydroponic culture in Senegal. *East African Journal of Agriculture and Biotechnology*, *8*(1), 313-327. https://doi.org/10.37284/eajab.8.1.3050.

CHICAGO CITATION

Ndiaye, Issa Alé, Oumar Seydi, Amadou Baldé, Etienne Tendeng, Serigne Sylla and Karamoko Diarra. 2025. "Evaluation of the effectiveness of leachates derived from the vermicomposting of different organic wastes on the growth of mint (mentha sp.) in hydroponic culture in Senegal". *East African Journal of Agriculture and Biotechnology* 8 (1), 313-327. https://doi.org/10.37284/eajab.8.1.3050.

HARVARD CITATION

Ndiaye, I. A., Seydi, O., Baldé, A., Tendeng, E., Sylla, S. & Diarra, K. (2025) "Evaluation of the effectiveness of leachates derived from the vermicomposting of different organic wastes on the growth of mint (mentha sp.) in hydroponic culture in Senegal", *East African Journal of Agriculture and Biotechnology* 8(1), pp. 313-327. doi: 10.37284/eajab.8.1.3050

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

IEEE CITATION
I. A., Ndiaye, O., Seydi, A., Baldé, E., Tendeng, S., Sylla & K., Diarra “Evaluation of the effectiveness of leachates derived from the vermicomposting of different organic wastes on the growth of mint (mentha sp.) in hydroponic culture in Senegal”, *EAJAB*, vol. 8, no. 1, pp. 313-327, May. 2025.

MLA CITATION
Ndiaye, Issa Alé, Oumar Seydi, Amadou Baldé, Etienne Tendeng, Serigne Sylla & Karamoko Diarra. “Evaluation of the effectiveness of leachates derived from the vermicomposting of different organic wastes on the growth of mint (mentha sp.) in hydroponic culture in Senegal”. *East African Journal of Agriculture and Biotechnology*, Vol. 8, no. 1, May. 2025, pp. 313-327, doi:10.37284/eajab.8.1.3050.

INTRODUCTION

Modern agriculture is currently facing several major challenges, including the decline in soil fertility, the excessive use of chemical fertilizers, and the urgent need to adopt environmentally sustainable practices (Alabi *et al*., 2023; Rehman *et al.*, 2023; Alarcón-Zayas *et al*., 2024). These issues are particularly critical in the Global South and Sahelian regions, where horticultural and market gardening crops play a decisive role in ensuring food security (Loera-Muro *et al*., 2021; Kaur *et al*., 2022). Unfortunately, existing farming systems are often poorly adapted to local constraints (soil degradation, limited water resources), and the intensive use of chemical inputs often expensive and of uncertain quality further contributes to soil fertility loss and environmental pollution (Ardisana *et al*., 2020; Kosem *et al*., 2022). At the same time, increasing urbanization is leading to a reduction in available agricultural land, limiting production opportunities in rural areas and calling for alternative solutions in urban and peri-urban zones (Magwaza *et al*., 2020; Mupambwa *et al*., 2024). Climate change, by amplifying extreme weather events (drought, water stress), reinforces the need to explore new agricultural production systems that are more resilient and resource-efficient (Ezziddine *et al*., 2021; da Silva *et al*., 2022). In this context, hydroponics emerges as a promising approach: it partly circumvents the issue of soil quality, allows for more efficient water use, and enables precise control of nutrient supply (Phibunwatthanawong & Riddech, 2019; Ahmed *et al*., 2021; Juárez-Rangel *et al*., 2023). Moreover, the increase in organic waste in urban areas presents a major environmental challenge, but also an opportunity for valorization through circular practices such as vermicomposting (Torres-García *et al*., 2024). This process, which relies on earthworms to transform organic waste into a nutrient-rich amendment, generates a liquid by-product called "leachate" a resource often underutilized despite its promising potential as a liquid biofertilizer (Loera-Muro *et al*., 2021). Its use can improve plant growth while reducing reliance on synthetic fertilizers (Rehman *et al*., 2023; Alarcón-Zayas *et al*., 2024). Combining hydroponics with the application of vermicompost leachates therefore appears to be a sustainable and efficient alternative, especially in urban and peri-urban environments where space is limited and soil quality is poor (Kaur *et al*., 2022; Mupambwa *et al*., 2024). In this perspective, mint (Mentha sp.), a widely appreciated species for both culinary and medicinal uses and known for its sensitivity to growing conditions (Loera-Muro *et al*., 2021), is particularly well-suited for evaluation in hydroponic systems. Integrating mint into such systems enriched with vermicompost leachates could not only address the issue of nutrient availability but also contribute to circular agriculture development and food security in the regions concerned (Alabi *et al*., 2023). However, the effectiveness of leachates, dependent on the nature of the organic waste used and the vermicomposting process itself, remains a significant agronomic limitation, as the nutrient concentration may impact yield. The objective of this study is to evaluate the effectiveness of vermicompost leachates derived from different types of organic waste on the growth of mint (Mentha sp.) under hydroponic cultivation.

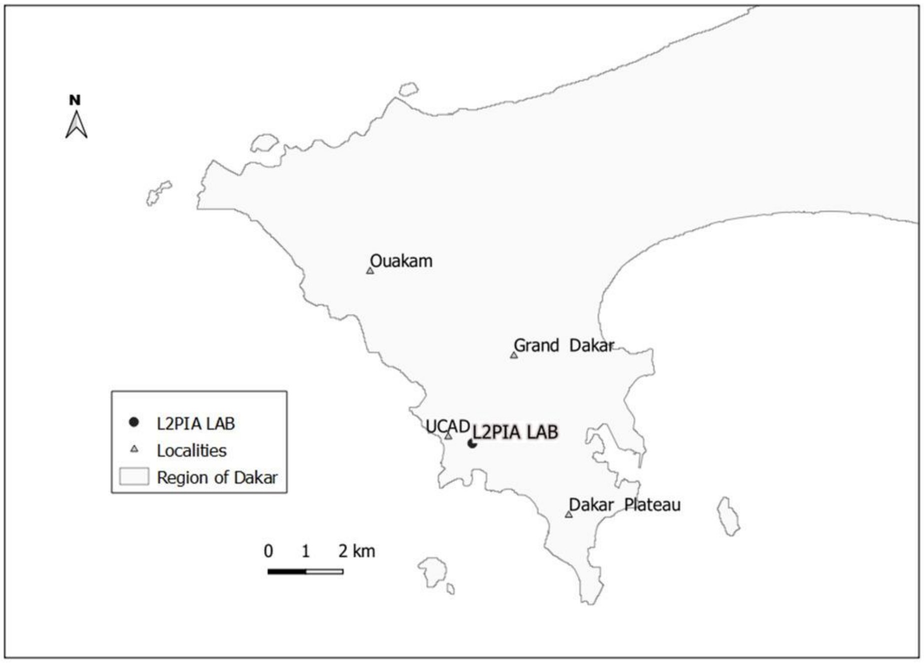
Article DOI : https://doi.org/10.37284/eajab.8.1.3050

MATERIALS AND METHODS

Study Site

The experiments were conducted at the Research Laboratory for Integrated Production and Protection of Agroecosystems (L2PIA), Faculty of Science and Technology, Cheikh Anta Diop University (UCAD). The laboratory is equipped with a greenhouse for plant production and a trial area.

Figure 1: Study Site Dakar/Senegal (Laboratory of Integrated Production and Protection in Agroecosystems (L2PIA))



Materials

The experiment was conducted in a greenhouse under natural photoperiod conditions, with average daytime temperatures ranging between 28°C and 34°C, and relative humidity maintained between 60% and 75%. No artificial lighting was used during the experiment**.** The mint plants used in this study, of the sage variety, were obtained through stem cuttings. Horse manure, cow dung, poultry droppings, and green waste were pre-composted separately and then transferred to vermicomposting beds with the following dimensions: L = 1.2 m; W = 1 m; H = 0.4 m. Prior to vermicomposting, all organic materials (horse manure, cow dung, poultry droppings, and green waste) were subjected to a 2-week pre-composting phase. This step involved placing the materials in open piles, regularly turned every 3 days to promote aerobic microbial activity and initiate the breakdown of organic matter. The process helped reduce the initial temperature and remove pathogens before introducing earthworms. Two earthworm species were used: *Eisenia foetida* (Haplotaxida: Lumbricidae) and *Eudrilus eugenia* (Haplotaxida: Eudrilidae). The beds were watered once a week to maintain the moisture required for the vermicomposting process, which lasted 60 days. The leachate produced during vermicomposting was collected by percolation for each type of waste.

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

Figure 2: Vermicompost and Leachate Production Setup

Experimental Design

The experiment was conducted using a hydroponic system set up in polystyrene boxes (Figure 3). Mint cuttings of the sage variety were inserted into the box lids. The plants were subjected to three different treatments: D1 (30% vermicompost leachate), D2 (60% vermicompost leachate), and D3 (100% vermicompost leachate). These treatments were compared to a chemical control (Tc) and a neutral control. Each treatment was replicated three times, with the main variable being the type of leachate used.

Figure 3: Polystyrene Boxes

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

Sampling Method

To assess the effectiveness of vermicompost leachate on the agronomic parameters of mint, a completely randomized design using polystyrene boxes was implemented. Five mint cuttings with two leaves each were transplanted into the box lids and left in water for one week. Once the first roots appeared, the treatments were applied three times per week. Each treatment was replicated three times, and 1 litre of leachate was applied per box at each application. Sampling was carried out once a week for 11 weeks. During each sampling, the number of leaves was counted manually, and plant height was measured from the collar to the last leaf. After 77 days of monitoring, the plants were harvested, and the aerial parts were weighed using a precision balance.

Figure 4: Experimental Setup

In this study, to compare the effectiveness of different types of leachate on mint growth, the following parameters were evaluated: number of leaves, plant height, and fresh leaf weight. For each type of leachate, plants were subjected to three different doses (D1, D2, D3), in addition to a chemical control (Tc) and a neutral control (Te). For each parameter studied (number of leaves, plant height, fresh leaf weight), the highest value observed among the three doses (D1, D2, D3) was selected as representative of the maximum effectiveness of that particular leachate type. This maximum value was then used for direct comparison with the other leachate types, as well as with the control treatments (Tc and Te) (Figure 4).

Statistical Analysis

The collected data were recorded in an Excel spreadsheet and analysed using XLSTAT 2016 software. Analysis of variance (ANOVA) followed by Fisher's test was performed to evaluate the effectiveness of vermicompost leachate on the agronomic parameters of mint. Differences were considered statistically significant when $P < 0.05$.

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

RESULTS

The table presents the results obtained for two mint growth parameters: number of leaves and plant height, according to different types of vermicompost leachate (horse manure, green waste, cow dung, poultry droppings) and control treatments.

Effects of Leachate Derived from Various Types of Vermicompost Based on Organic Waste on the Number of Leaves

Number of Leaves According to Doses for Each Type of Leachate

The following table presents the number of leaves per plant as a function of the applied doses for each type of leachate studied.

Table 1: Number of Leaves According to Doses for Each Type of Leachate

Doses	Horse Manure	Cow Dung	Poultry Droppings	Green Waste
D1	113.0 (a)	101.0 (b)	73.0 (b)	131.0 (a)
D2	118.0 (a)	139.0 (a)	131.0 (a)	120.0 (a)
D3	135.0 (a)	103.0 (b)	110.0 (a)	124.0 (a)
Tc	135.0 (a)	135.0 (a)	135.0 (a)	135.0 (a)
Te	119.0 (a)	119.0 (ab)	119.0 (a)	119.0 (a)

D1 corresponds to 30% vermicompost leachate, D2 to 60%, and D3 to 100%. Tc represents the chemical control, and Te corresponds to the neutral control (pure water). Degrees of freedom (df): 4.

The analysis of variance (ANOVA) revealed significant differences in the number of leaves for the cow dung leachate ($P = 0.001$) and poultry droppings leachate ($P < 0.0001$). In contrast, no significant differences were observed for the horse manure leachate ($P = 0.395$) and green waste leachate ($P = 0.539$) (Table 1).

The analysis reveals overall homogeneous performance for some leachates and dose-dependent variations for others. Regarding the leachate derived from horse manure vermicompost, all doses (D1, D2, D3) and the control treatments (Tc, Te) belong to the same statistical group (a). This indicates no significant difference between doses and controls for this type of leachate. The performances are stable and high, with mean values ranging slightly from 113.0 for D1 to 135.0 for D3 and Tc (Table 1).

For the leachate obtained from cow dung vermicompost, significant differences emerge among the doses. Dose D2 (139.0) and the chemical control Tc (135.0) are part of the same group (a), indicating similarly high and optimal performance. In contrast, doses D1 (101.0) and D3 (103.0) belong solely to group (b), reflecting significantly lower performance compared to D2 and Tc. The neutral control Te (119.0) shares both groups (ab), positioning it as an intermediate alternative. These results indicate that D2 is the most effective dose for this leachate, without being significantly different from the chemical control (Table 1).

For the leachate from poultry droppings vermicompost, the results show a clear distinction between doses and controls. Dose D2 (131.0), D3 (110.0), the chemical control Tc (135.0), and the neutral control Te (119.0) all belong to group (a), indicating no significant differences among them. However, D1 (73.0), which falls exclusively within group (b), shows markedly lower performance. This suggests that for poultry droppings leachate, all doses except D1 provide comparable and satisfactory results (Table 1).

Regarding the leachate derived from green waste vermicompost, all doses and control treatments belong to the same statistical group (a). This indicates no significant differences between doses (D1, D2, D3) and the controls (Tc, Te). The performances are homogeneous and relatively high, with mean values ranging from 119.0 to 135.0. This

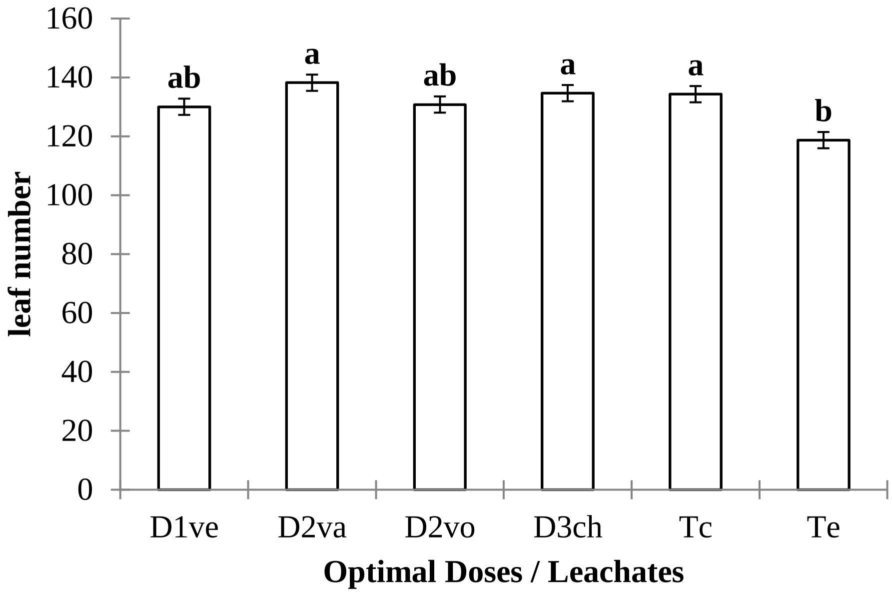
Article DOI : https://doi.org/10.37284/eajab.8.1.3050

leachate appears to deliver consistent results, regardless of the applied dose or control (Table 1).

Determination of the Best Leachate Type for the Leaf Number Parameter

For this parameter, the highest values observed among the three doses (D1, D2, D3) for each type of leachate were compared with the control treatments (Tc and Te) (Figure 5).

Figure 5: Average Number of Leaves in Mint Plants



D1ve: 30% diluted vermicompost leachate from green waste; D2va: 60% diluted vermicompost leachate from cow dung; D2vo: 60% diluted vermicompost leachate from poultry droppings; D3ch: 100% pure vermicompost leachate from horse manure; Tc: liquid chemical control; Te: pure water control. df = 5, F = 0.425, Pr > F = 0.830.

The results show that treatments D1ve, D2va, D2vo, D3ch, and Tc produced a similar number of leaves, with values close to 140 leaves per plant. These treatments did not differ significantly from one another, indicating comparable performance in promoting leaf growth. In contrast, the Te treatment, which consisted of pure water application, resulted in a significantly lower number of leaves (Figure 5).

Effects of Leachate Derived from Various Types of Vermicompost Based on Organic Waste on Plant Height (cm)

Measurement of Plant Height According to Doses for Each Type of Leachate

The following table presents the results of plant height measurements as a function of the applied doses for each type of leachate studied.

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

Table 2: Plant Height (cm) According to Doses for Each Type of Leachate

Dose	Horse Manure	Cow Dung	Poultry Droppings	Green Waste
D1	26 (b)	27 (a)	13 (c)	17 (a)
D2	31 (a)	27 (a)	14 (b c)	17 (a)
D3	15 (c)	11 (d)	14 (b c)	17 (a)
Tc	17 (c)	17 (b)	17 (a)	17 (a)
Te	16 (c)	16 (c)	16 (a b)	16 (b)

D1 corresponds to 30% vermicompost leachate, D2 to 60%, and D3 to 100%. Tc refers to the chemical control, and Te represents the neutral control (pure water). Degrees of freedom (df): 4.

The analysis of variance (ANOVA) revealed highly significant differences in plant height for the horse manure leachate ($P < 0.0001$), cow dung leachate ($P < 0.0001$), and poultry droppings leachate ($P = 0.0001$). Significant differences were also observed for the green waste leachate ($P = 0.021$) (Table 2).

The analysis of plant height data revealed significant differences between doses and leachate types. For the leachate derived from horse manure vermicompost, dose D2 (31 cm) stood out with significantly greater plant height, belonging to group (a). Dose D1 (26 cm) was slightly lower and fell within group (b). In contrast, D3 (15 cm), the chemical control Tc (17 cm), and the neutral control Te (16 cm) all belonged to group (c), indicating similarly lower performances. These results show that for this leachate, D2 was the most effective dose in promoting plant height (Table 2).

For the leachate obtained from cow dung vermicompost, doses D1 and D2 (27 cm each) shared group (a), indicating no significant difference and optimal performance. The chemical control Tc (17 cm) fell into group (b), reflecting intermediate performance. The neutral control Te (16 cm) and dose D3 (11 cm) were classified into groups (c) and (d), respectively, reflecting lower performance levels. These findings suggest that for this leachate, D1 and D2 were the most effective doses (Table 2).

For the leachate from poultry droppings vermicompost, the chemical control Tc (17 cm) and the neutral control Te (16 cm) fell into groups (a) and (a b), respectively, indicating optimal and relatively uniform performance. Doses D2 and D3 (14 cm each) belonged to group (b c), indicating moderate performance. In contrast, D1 (13 cm) belonged solely to group (c), reflecting lower effectiveness. This shows that, for this leachate, the control treatments outperformed the applied doses (Table 2).

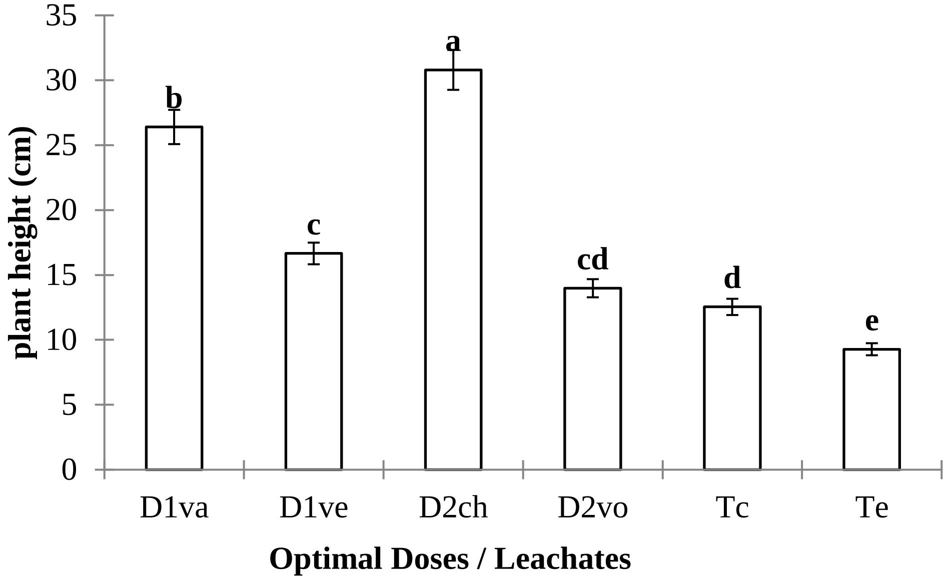
Regarding the leachate derived from green waste vermicompost, all treatments and controls (D1, D2, D3, Tc, Te) belonged to the same statistical group (a), indicating complete homogeneity in performance. Plant heights were consistent, averaging around 17 cm for most treatments, except for the neutral control Te (16 cm), which was slightly lower but not statistically different (Table 2).

Determination of the Best Leachate Type for the Plant Height Parameter

For this parameter, the highest values observed among the three doses (D1, D2, D3) for each type of leachate were compared with the control treatments (Tc and Te) (Figure 6).

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

Figure 6: Average Height (cm) of Mint Plants



D1va: 30% diluted vermicompost leachate from cow dung; D1ve: 30% diluted vermicompost leachate from green waste; D2vo: 60% diluted vermicompost leachate from poultry droppings; D2ch: 60% vermicompost leachate from horse manure; Tc: liquid chemical control; Te: pure water control. df = 5, F = 144.100, Pr > F = < 0.000.

The results indicate that the D2ch treatment (60% diluted horse manure leachate) produced the tallest plants, with an average height of approximately 30 cm. The D1va treatment (30% diluted cow dung leachate) also showed notable plant height, around 25 cm.

Plants treated with D1ve (30% diluted green waste leachate) had a lower average height, around 18 cm. Those treated with D2vo (60% diluted poultry droppings leachate) exhibited slightly shorter plants, with an average height of about 15 cm. The chemical control (Tc) produced even shorter plants, with an average height of approximately 12 cm. Finally, the neutral control (Te) resulted in the shortest plants, with an average height of around 8 cm (Figure 6).

Effects of leachate derived from various types of vermicompost based on organic waste on fresh aerial biomass (g)

Fresh Aerial Biomass (g) According to Doses for Each Type of Leachate

The following table presents the results of fresh aerial biomass measurements of the plants according to the applied doses for each type of leachate studied.

Table 3: Fresh Aerial Biomass (g) According to Doses for Each Type of Leachate

Dose	Horse Manure	Cow Dung	Poultry Droppings	Green Waste
D1	21 (b)	19 (b)	8 (b)	20 (a)
D2	29 (a)	29 (a)	15 (a b)	12 (b)
D3	14 (b c)	8 (d)	13 (a b)	10 (b)
Tc	16 (b c)	16 (b c)	16 (a)	16 (a b)
Te	11 (c)	11 (c d)	11 (a b)	11 (b)

D1 corresponds to 30% vermicompost leachate, D2 to 60%, and D3 to 100%. Tc refers to the chemical control, and Te represents the neutral control (pure water). Degrees of freedom (df): 4.

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

The analysis of variance (ANOVA) revealed highly significant differences in fresh aerial biomass for horse manure leachate ($P < 0.0001$) and cow dung leachate ($P < 0.0001$). Significant differences were also observed for poultry droppings leachate ($P = 0.040$) and green waste leachate ($P = 0.020$).

For the leachate derived from horse manure vermicompost, dose D2 (29 g) provided the best performance, falling into group (a), while D1 (21 g) was in group (b), indicating slightly lower performance. Doses D3 (14 g) and the chemical control Tc (16 g) shared group (b c), indicating moderate effectiveness. The neutral control Te (11 g) belonged to group (c), reflecting the lowest performance. These results show that for this leachate, D2 is the most effective dose, followed by D1, while the other treatments were significantly less effective (Table 3).

For the leachate from cow dung vermicompost, doses D2 (29 g) and D1 (19 g) showed distinct performances. D2 was classified in group (a) and showed the highest effectiveness, while D1 fell into group (b), reflecting lower performance. The chemical control Tc (16 g) and the neutral control Te (11 g) belonged to groups (b c) and (c d), respectively, suggesting weaker performance. Finally, dose D3 (8 g) was in group (d), showing the lowest effectiveness. Therefore, D2 was the optimal dose for this leachate (Table 3).

For the leachate from poultry droppings vermicompost, the chemical control Tc (16 g) was the most effective, falling into group (a). Doses D2 (15 g), D3 (13 g), and the neutral control Te (11 g) shared groups (a b), indicating intermediate performance. In contrast, dose D1 (8 g) belonged exclusively to group (b), reflecting the weakest performance. This indicates that the poultry droppings leachate is more effective at higher doses (D2 and D3) and comparable to the control treatments, while D1 should be avoided (Table 3).

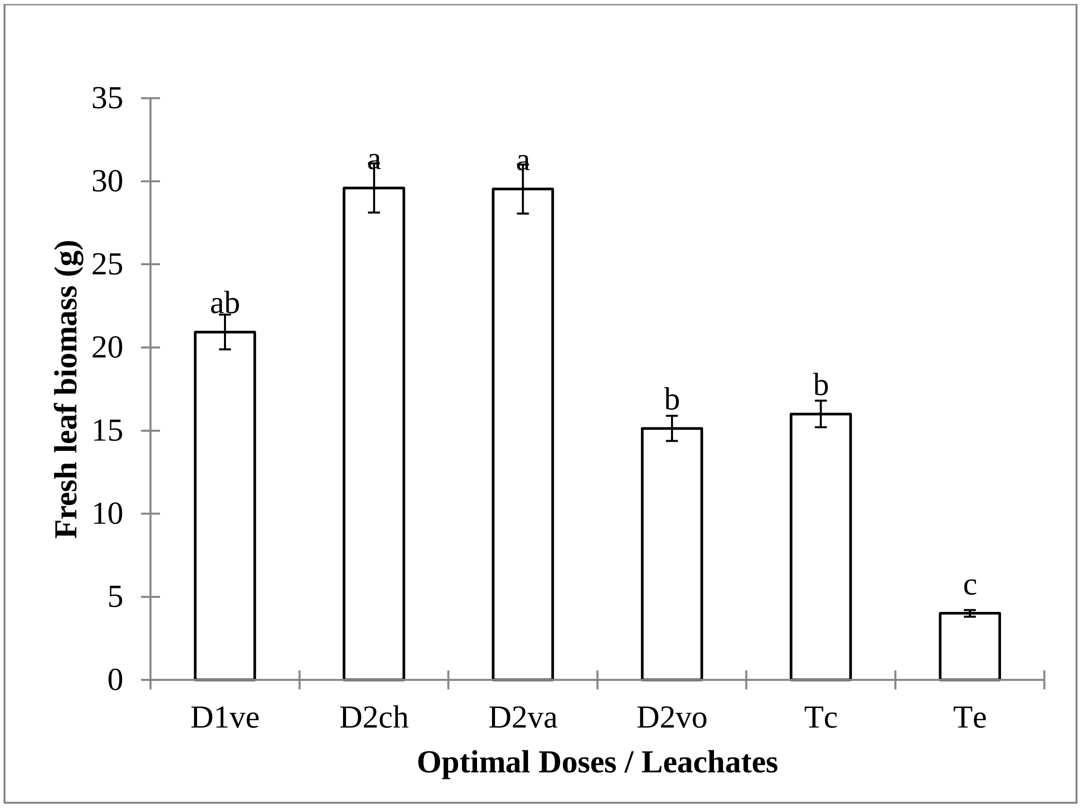
Regarding the leachate derived from green waste vermicompost, dose D1 (20 g) and the chemical control Tc (16 g) fell into group (a b), indicating relatively high and similar performance. Doses D2 (12 g), D3 (10 g), and the neutral control Te (11 g) shared group (b), reflecting lower but homogeneous performance. These results suggest that D1 and Tc provided the best outcomes for this leachate (Table 3).

Determination of the Best Leachate Type for the Fresh Aerial Biomass Parameter

For this parameter, the highest values observed among the three doses (D1, D2, D3) for each type of leachate were compared with the control treatments (Tc and Te) (Figure 7).

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

Figure 7: Fresh Leaf Biomass (g) of Mint Plants



D2ch: 60% diluted vermicompost leachate from horse manure; D1ve: 30% diluted vermicompost leachate from green waste; D2va: 60% diluted vermicompost leachate from cow dung; D3vo: 100% pure vermicompost leachate from poultry droppings; Tc: liquid chemical control; Te: pure water control. df = 5, F = 13,90, Pr > F = < 0.0001

The results show that treatments D2ch (60% diluted horse manure leachate) and D2va (60% diluted cow dung leachate) produced the highest fresh aerial biomass, approximately 30 g, and were statistically similar (a). The D1ve treatment (30% diluted green waste leachate) yielded a slightly lower biomass (21 g) but remained statistically comparable to the best treatments. Treatments D2vo (60% poultry droppings leachate) and Tc (chemical control) resulted in moderate biomass values (16 g) (ab), showing no significant difference from the top treatments. The lowest biomass was recorded with the neutral control (Te), around 11 g, which, despite being significantly lower than the highest values, remained statistically grouped with D2vo and Tc (ab) (Figure 6).

DISCUSSION

The results obtained highlight the capacity of various vermicompost leachates (D1ve, D2va, D2vo, and D3ch) to support the growth of mint in hydroponic culture, compared to both a chemical control and a neutral control. Previous studies have already demonstrated the value of organic amendments in hydroponic systems, showing that they can reduce the reliance on synthetic fertilizers while enhancing plant productivity (Majid *et al*., 2020; Richa *et al*., 2021). Similarly, it has been reported that the addition of vermicompost-derived solutions promotes nutrient uptake and beneficial microbial activity, leading to improved vegetative performance (Benazzouk *et al*., 2020; Atherton et Li, 2023;). Regarding leaf production, our observations are consistent with several authors

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

who emphasize the effectiveness of macro- and micronutrients present in vermicompost extracts (Čabilovski *et al*., 2023). Moreover, it has been shown that "pure water alone cannot support optimal plant development in the absence of a balanced nutrient supply" (Wongkiew *et al*., 2023). With respect to plant height, our findings corroborate those of Naik *et al*. (2024), who observed that horse manure contains natural phytohormones capable of stimulating vegetative growth. In addition, Bhatt *et al*. (2023) reported that humic acids present in certain vermicompost extracts promote the synthesis of photosynthetic pigments, thereby supporting increased biomass. However, some treatments, such as D2vo, proved to be less effective. This aligns with the conclusions of Çiçek *et al*. (2022) and Saldinger *et al*. (2023), who noted that excessive concentrations of salts or potentially phytotoxic compounds can limit growth. Similarly, Becagli *et al*. (2021) reported that a proper nutrient balance and moderate salinity are essential to ensure good foliar and root development. The findings of Lau et Mattson (2021) and Abioye *et al*. (2024) further support this, indicating that inappropriate dosing can lead to osmotic stress and reduced agronomic performance. Indeed, Stegelmeier et al. (2022) found that the presence of nitrogen-fixing bacteria and hydrolytic enzymes in vermicompost extracts significantly improved root architecture. Furthermore, data from Elmulthum *et al*. (2023) indicate that poorly adjusted dilution rates can increase root toxicity, particularly in extracts derived from poultry residues. To prevent such imbalances, several studies recommend optimizing dosage and carefully managing the nutrient flow (Baiyin *et al*., 2021; Wimmerova *et al*., 2022;). Our findings are therefore in line with this body of research, emphasizing that the organic source of the vermicompost and the dilution level significantly influence plant response. Future research could focus on optimizing input levels, including the addition of targeted biofertilizers or more precise hydroponic nutrient management, as suggested by Richa *et al*. (2021) and Atherton & Li (2023). Altogether, these studies underscore the potential of vermicompost leachates as valuable inputs for sustainable and resilient agriculture.

CONCLUSION

This study highlights the potential of vermicompost leachates as an alternative to liquid chemical fertilizers in hydroponic mint cultivation. The results show that these biofertilizers, derived from various organic sources, can achieve growth performances comparable to those of the chemical control. In particular, the 60% diluted horse manure leachate (D2ch) stood out by promoting optimal vegetative growth and yielding a fresh leaf biomass similar to that of the chemical control. These findings confirm the relevance of vermicompost leachates as sustainable fertilization solutions in hydroponic agriculture, offering a viable alternative to chemical inputs while valorizing organic waste. However, further research is needed to optimize their application methods, assess their long-term stability, and better understand their interactions with abiotic factors in the hydroponic system.

Author Contributions

All authors contributed significantly to the intellectual development, design, and structuring of the study, as well as to the analysis and interpretation of the data (where applicable), and the writing of the manuscript.

Conflict of Interest Statement

The authors declare that they have no financial or personal relationships that could have influenced the work presented in this article.

Acknowledgements

The authors would like to express their sincere gratitude to the L2PIA Laboratory (Laboratory of Integrated Production and Protection in Agroecosystems) at UCAD, Senegal, for providing infrastructure and technical support for this research.

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

REFERENCES

Abioye, O. M., Amodu, M. F., Raphael, D. O., Olasehinde, D., Yusuf, K. O., & Olosho, A. (2024). An overview of the role of vermicompost in reducing greenhouse gas emissions, improving soil health, and increasing crop yields. Applied Science and Engineering Progress. https://doi.org/10.14416/j.asep.2024.09.011

Ahmed, Z. F. R., Alnuaimi, K. H., Askri, A., & Tzortzakis, N. (2021). Evaluation of lettuce (Lactuca sativa L.) production under hydroponic system: nutrient solution derived from fish waste vs. inorganic nutrient solution. Horticulturae, 7(9), 292. https://doi.org/10.3390/horticulturae7090292

Alabi, O. D., Coopoosamy, R., Mbanjwa, S., & Tshapha, L. (2023). Response of vermicompost leachate on seed germination and crop growth. Journal of Eco-Friendly Agriculture. https://doi.org/10.5958/2582-2683.2023.00001.1

Alarcón-Zayas, A., Hernández-Montiel, L., Medina-Hernández, D., Rueda-Puente, E., Ceiro-Catasú, W., & Holguín-Peña, R. J. (2024). Effects of Glomus fasciculatum, Azotobacter chroococcum and vermicompost leachate on the production and quality of tomato fruit. Microbiology Research, 15, 0013. https://doi.org/10.3390/microbiolres15010013

Ardisana, E. F. H., Torres García, A. T., Fosado Téllez, O. F., Cedeño Guerra, J. L. C., & Alcívar, J. B. Z. (2020). Effect of a bovine manure vermicompost leachate on yield of pepper (Capsicum annuum L.) hybrid Nathalie. International Journal of Recycling of Organic Waste in Agriculture, 9, 249–257. https://doi.org/10.30486/ijrowa.2020.1885386.1008

Atherton, H. R., & Li, P. (2023). Hydroponic cultivation of medicinal plants—Plant organs and hydroponic systems: techniques and trends. Horticulturae, 9, 349. https://doi.org/10.3390/horticulturae9030349

Baiyin, B., Tagawa, K., Yamada, M., Wang, X., Yamada, S., Yang, S., An, P., Yamamoto, S., & Ibaraki, Y. (2021). Effect of nutrient solution flow rate on hydroponic plant growth and root morphology. Plants, 10, 1840. https://doi.org/10.3390/plants10091840

Becagli, M., Guglielminetti, L., & Cardelli, R. (2021). Effects of combined biochar and vermicompost solution on leachate characterization and nitrogen balance from a greenhouse tomato (Solanum lycopersicum) cultivation soil. Communications in Soil Science and Plant Analysis, 52(17), 1879–1893. https://doi.org/10.1080/00103624.2021.1900225

Benazzouk, S., Dobrev, P. I., Djazouli, Z.-E., Motyka, V., & Lutts, S. (2020). Positive impact of vermicompost leachate on salt stress resistance in tomato (Solanum lycopersicum L.) at the seedling stage: a phytohormonal approach. Plant and Soil, 446, 145–162. https://doi.org/10.1007/s11104-019-04361-x

Bhatt, N., Buddhi, D., & Suthar, S. (2023). Synthesizing biochar-based slow-releasing fertilizers using vermicompost leachate, cow dung, and plant weed biomass. Journal of Environmental Management, 326, 116782. https://doi.org/10.1016/j.jenvman.2022.116782

Čabilovski, R., Manojlović, M., Popović, B. M., Radojčin, M., Magazin, N., Petković, K., Kovačević, D., & Lakićević, M. (2023). Vermicompost and vermicompost leachate application in strawberry production: impact on yield and fruit quality. Horticulturae, 9, 337. https://doi.org/10.3390/horticulturae9030337

Çiçek, N., Erdogan, M., Yücedağ, C., & Çetin, M. (2022). Improving the detrimental aspects of salinity in salinized soils of arid and semi-arid

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

areas for effects of vermicompost leachate on salt stress in seedlings. Water, Air, and Soil Pollution, 233. https://doi.org/10.1007/s11270-022-05677-8

da Silva, A. A. R., Sousa, P. F. N., de Lima, G. S., Gheyi, H. R., Soares, L. A., & de Azevedo, C. A. V. (2022). Hydrogen peroxide reduces the effect of salt stress on growth and postharvest quality of hydroponic mini watermelon. Water, Air, and Soil Pollution, 233. https://doi.org/10.1007/s11270-022-05669-8

Elmulthum, N., Zeineldin, F., Al-Khateeb, S. A., Al-Barrak, K. M., Mohammed, T. A., Sattar, M. N., & Mohmand, A. S. (2023). Water use efficiency and economic evaluation of the hydroponic versus conventional cultivation systems for green fodder production in Saudi Arabia. Sustainability, 15, 822. https://doi.org/10.3390/su15010822

Ezziddine, M., Liltved, H., & Seljåsen, R. (2021). Hydroponic lettuce cultivation using organic nutrient solution from aerobic digested aquacultural sludge. Agronomy, 11, 1484. https://doi.org/10.3390/agronomy11081484

Juárez-Rangel, A. P., Solís Oba, A., Martínez-Casares, R. M., Castro Rivera, R., & Solís-Oba, M. (2023). Greenhouse lettuce production fertilized with sargassum extract or vermicompost leachate. Mexican Journal of Biotechnology, 8, 21–36. https://doi.org/10.29267/mxjb.2023.8.1.21

Kaur, A., Pati, P. K., Ohri, P., & Kaur, A. (2022). Effects of vermicompost and vermicompost leachate on the biochemical and physiological response of Withania somnifera (L.) Dunal. Journal of Soil Science and Plant Nutrition. https://doi.org/10.1007/s42729-022-00880-2

Kosem, H., Koçak, M. Z., Kaysim, M. G., Çelikcan, F., & Kulak, M. (2022). Liquid leachate produced from vermicompost effects on some agronomic attributes and secondary metabolites of sweet basil (Ocimum basilicum L.) exposed to severe water stress conditions. Horticulturae, 8, 1190. https://doi.org/10.3390/horticulturae8121190

Lau, V. M., & Mattson, N. S. (2021). Effects of hydrogen peroxide on organically fertilized hydroponic lettuce (Lactuca sativa L.). Horticulturae, 7, 106. https://doi.org/10.3390/horticulturae7050106

Loera-Muro, A., Troyo-Diéguez, E., Murillo-Amador, B., Barraza, A., Caamal-Chan, G., Lucero-Vega, G., & Nieto-Garibay, A. (2021). Effects of vermicompost leachate versus inorganic fertilizer on morphology and microbial traits in the early development growth stage in mint (Mentha spicata L.) and rosemary (Rosmarinus officinalis L.) plants under closed hydroponic system. Horticulturae, 7, 100. https://doi.org/10.3390/horticulturae7050100

Magwaza, S. T., Magwaza, L. S., Odindo, A., & Mditshwa, A. (2020). Hydroponic technology as decentralised system for domestic wastewater treatment and vegetable production in urban agriculture: A review. Science of the Total Environment, 698, 134154. https://doi.org/10.1016/j.scitotenv.2019.134154

Majid, M., Khan, J. N., Shah, Q. M. A., Masoodi, K. Z., Afroza, B., & Parvaze, S. (2020). Evaluation of hydroponic systems for the cultivation of lettuce (Lactuca sativa L., var. Longifolia) and comparison with protected soil-based cultivation. Agricultural Water Management, 245, 106572. https://doi.org/10.1016/j.agwat.2020.106572

Mupambwa, H. A., Nyambe, G. I., Matomola, B., Handura, B., Howoses, V. A., Hausiku-Ikechukwu, M., & Gawanab, W. (2024). Goat and sheep manure based vermicompost and vermi-leachate as a nutrient source in drip hydroponic tomatoes (Solanum lycopersicum)

Article DOI : https://doi.org/10.37284/eajab.8.1.3050

and Swiss chard (Beta vulgaris). Journal of Sustainable Agriculture and Environment. https://doi.org/10.1002/sae2.70011

Naik, M. M., Mohan, K. C., Janardhana, K., Aruna, C., Mohan, M. R., & Kiran, V. U. (2024). Vermicompost (traditional methods) is an important component of agricultural productivity and an efficient tool for environmental and economic sustainability. International Journal of Biological and Environmental Investigation. https://doi.org/10.33745/ijzi.2024.v10i01.007

Phibunwatthanawong, T., & Riddech, N. (2019). Liquid organic fertilizer production for growing vegetables under hydroponic condition. International Journal of Recycling of Organic Waste in Agriculture, 8, 369–380. https://doi.org/10.1007/s40093-019-0257-7

Richa, A., Fizir, M., & Touil, S. (2021). Advanced monitoring of hydroponic solutions using ion-selective electrodes and the internet of things: A review. Environmental Chemistry Letters, 19, 1–19. https://doi.org/10.1007/s10311-021-01233-8

Rehman, S. ur, Castro, F. D., Aprile, A., Benedetti, M., & Fanizzi, F. P. (2023). Vermicompost: Enhancing plant growth and combating abiotic and biotic stress. Agronomy, 13(4), 1134. https://doi.org/10.3390/agronomy13041134

Saldinger, S. S., Rodov, V., Kenigsbuch, D., & Bar-Tal, A. (2023). Hydroponic agriculture and microbial safety of vegetables: Promises, challenges, and solutions. Horticulturae, 9, 51. https://doi.org/10.3390/horticulturae9010051

Stegelmeier, A. A., Rose, D. M., Joris, B. R., & Glick, B. R. (2022). The use of PGPB to promote plant hydroponic growth. Plants, 11, 2783. https://doi.org/10.3390/plants11202783

Torres-García, A., Héctor-Ardisana, E., León-Aguilar, R., Zambrano-Gavilanes, F., & Fosado Téllez, O. (2024). Vermicompost leachate-based biostimulant and its effects on physiological variables and yield of different crops in Manabí, Ecuador. Ciencia y Tecnología Agropecuaria, 25(1). https://doi.org/10.21930/rcta.vol25_num1_art:3388

Wimmerova, L., Keken, Z., Solcova, O., Bartos, L., & Spacilova, M. (2022). A comparative LCA of aeroponic, hydroponic, and soil cultivations of bioactive substance producing plants. Sustainability, 14, 2421. https://doi.org/10.3390/su14042421

Wongkiew, S., Polprasert, C., Noophan, P., Koottatep, T., Kanokkantapong, V., Surendra, K. C., & Khanal, S. K. (2023). Effects of vermicompost leachate on nitrogen, phosphorus, and microbiome in a food waste bioponic system. Journal of Environmental Management, 339, 117860. https://doi.org/10.1016/j.jenvman.2023.117860