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Efficacy of Vermicast from Local Earthworms as Growing Media of Eggplant (*Solanum melongena* L.)

Anecito M. Anuada
Agricultural Systems Institute – College of Agriculture and Food Science
University of the Philippines Los Baños
College, Laguna 4031 Philippines
amanuada@up.edu.ph

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Abstract

The study aimed to determine the effectiveness of vermicast from local earthworms as a growing medium for eggplant, with the goal of exploring the potential of organic fertilizers in boosting vegetable yields and promoting sustainable agriculture practices. It investigated the efficacy of vermicast derived from local earthworms in enhancing seed germination and seedling growth of eggplant using a randomized complete block design with four treatments and three replications. The experiment compared garden soil, vermicast, carbonized rice hull, and combinations of these growing media, evaluating germination percentage, seedling height, number of leaves, and leaf area. Results showed significant differences among treatments, with vermicast and carbonized rice hull exhibiting superior performance compared with garden soil. Carbonized rice hull showed the highest germination percentage in the second and third weeks, while vermicast from local earthworms led to the tallest seedlings and highest leaf area in subsequent weeks, suggesting its preference for cultivating eggplant seedlings. The study highlights the potential of vermicast from local earthworms as a sustainable and effective organic soil amendment for enhancing eggplant growth.

***Keywords**:* beneficial microbes, growth, organic amendments, vermicast

1. Introduction

Eggplant (*Solanum melongena* L.) is a crucial, cost-effective, and widely consumed vegetable crop in Asia (Hautea *et al*., 2016). In 2020, the Philippines ranked among the top producers of eggplant in the Asia-Pacific region (Statista Research Department, 2023), and eggplant cultivation serves as a significant income source for small, resource-constrained farmers.

The use of appropriate growing media or substrates is vital for producing high-quality horticultural crops impacting the establishment and maintenance of a robust root system (Abad *et al*., 2002). A healthy root substrate provides adequate anchoring and support, acting as a reservoir for nutrients and water while facilitating oxygen access to the roots and gaseous exchange with the surroundings.

Certain plants depend on seed propagation, and their survival hinges on successful germination. Factors such as physical seed dormancy or poor seedling vigor can hinder germination (Fajinmi *et al*., 2021). Growing media, serving as both a growing medium and nutrient source, influence seedling quality (Wilson *et al*., 2001). Various factors, including substrate, environmental conditions (oxygen, water, temperature), and light, affect seed germination (Hartmann *et al*., 2001). The composition of the growing medium affects seedling quality (Wilson *et al*., 2001). The choice of growing media significantly affects seed germination. Commonly known as potting mix or substrate, growing media create the physical and chemical environment for seed planting, impacting moisture retention, aeration, nutrient availability, and overall seedling health.

Vermicast, a promising organic amendment in agriculture, has drawn attention. Produced by earthworms from organic matter, vermicast boasts lower contamination and higher nutrient saturation than vermicompost (Ndegwa *et al*., 2000). Used as a growing medium amendment, particularly in vegetable and fruit cultivation, vermicast improves soil physical properties including low bulk density and soil structure (Bellitürk *et al*., 2017). Additionally, it is rich in organic matter, macro- and micronutrients, with a low C:N ratio (Sanchez *et al*., 2016; Sriakilam *et al*., 2016; Lv *et al*., 2018).

Vermicast serves as an organic fertilizer beneficial for the environment. Experts recommend its use to enhance soil improvement and promote healthy crops (Bellitürk *et al*., 2016). This organic fertilizer has demonstrated effectiveness in improving soil fertility, crop productivity, and quality while preventing certain plant diseases (Arancon *et al*., 2006; Bellitürk *et al*., 2015). Vermicompost can be utilized as a plant growth medium and soil conditioner, fostering soil microbial biodiversity by introducing beneficial microbes into the soil (Edwards and Arancon, 2004; Broz *et al*., 2016).

Further research has explained the significant role of vermicast's biochemical properties in eggplant development and growth (Gandhi and Sundari, 2012).

Adiloğlu *et al.* (2015) observed substantial changes in plant macronutrient elements such as nitrogen, phosphorus, potassium, calcium, and magnesium.

The Philippines is home to diverse earthworm species; however, comprehensive local studies investigating the use of indigenous earthworm species and their cast in enhancing soil fertility and crop productivity, including their impact on eggplant growth, were lacking. This study aimed to assess the effectiveness of vermicast from local earthworms on the growth of eggplant seedlings, specifically focusing on germination, plant height, number of leaves, and leaf area.

2. Methodology

The experiments were conducted at National Crop Protection Center Dormitory, University of the Philippines Los Baños (UPLB). The experiments were carried out using a randomized complete block design (RCBD) with three replications. The seedling tray, with a total of 128 holes, was divided into four to accommodate the four treatments. The treatments were garden soil, vermicast from local earthworms, carbonized rice hull (CRH), and combination (0.5 L of vermicast + 1.25 L of CRH + 0.25 L of garden soil). The garden soil, also known as topsoil or soil, is the natural upper layer of the Earth's surface that promotes plant growth. One seed was sown per hole. Each treatment had four rows of eight holes each, for a total of 32 holes. To reduce border effects, data were collected primarily from the two middle rows of each treatment resulting in a total of 10 sample seedlings per treatment.

The CRH used in the study was obtained from PhilRice in Los Baños, and the vermicast from local earthworms was collected on the UPLB grounds. The source of the eggplant seeds, Dumaguete Long Purple (DLP) variety used in the study, was the National Seeds Foundation, Institute of Plant Breeding, College of Agriculture and Food Science, UPLB.

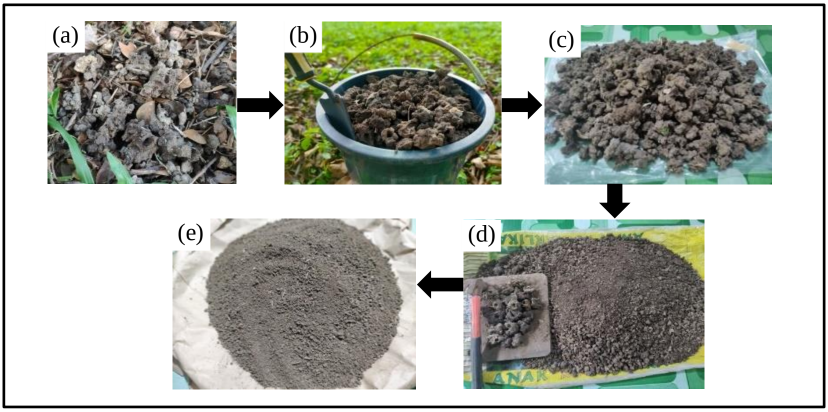
2.1 Preparation of Vermicasts

2.1.1 Collection

The vermicasts for local earthworms were harvested in dense vegetation, primarily beneath the canopy of trees on the premises of the UPLB. These earthworm castings, often clayey in nature, were manually gathered using gloves and plastic containers from protruding vermicasts on the ground. The collected castings had already undergone natural drying.

2.1.2 Processing

Subsequent to collection, all vermicast samples were consolidated in a single area for cleaning, involving the removal of leaves, stones, and other debris. As the collected vermicast was already dry, misting with a hand sprayer was applied to facilitate pulverization using a hammer. The vermicast underwent further refinement through sieving, utilizing an Amazon Net with a mesh size of #5. The entire process of collecting and processing vermicast from local earthworms is illustrated in Figure 1.



Dried vermicast in the ground (a); collected vermicast (b); consolidated vermicast in a designated area for cleaning, which included the removal of leaves, stones, and other debris (c); pulverized the vermicast using a hammer (d); and pulverized vermicast that was ready for use as a growing media (e)

Figure 1. Processing of vermicast's from local earthworms

2.2 Calculation of Germination Percentage

Normal seedlings that germinated in the first, second, and third weeks after sowing were counted and expressed as a percentage. The germination percentage was determined using the following formula (Equation 1).

$$\text{Germination percentage} = \frac{\text{Number of seeds that germinated in a treatment}}{\text{Total number of seeds in the treatment}} \times 100 \qquad (1)$$

2.3 Measurement of Height of the Seedling

The height of the seedling was measured in the third, fourth, and fifth weeks after sowing, and the average length was measured and expressed in cm. The measurement covered the distance from the ground soil to the tip of the shoot.

2.4 Number of Leaves

In the third, fourth, and fifth weeks after sowing, the total number of leaves on the plants were counted and recorded.

2.5 Measurement of Leaf Area

In the fourth and fifth weeks after sowing, the leaf area was calculated using Ambasht's (1998) formula (Equation 2).

$$Actual\ area = L \times B \times K \tag{2}$$

where L is the length of the leaf; B is the breadth of the leaf; and K is the constant factor (0.9 for narrow leaves and 0.6 for broadleaves). Leaf area was expressed in cm.

2.6 Data Analysis

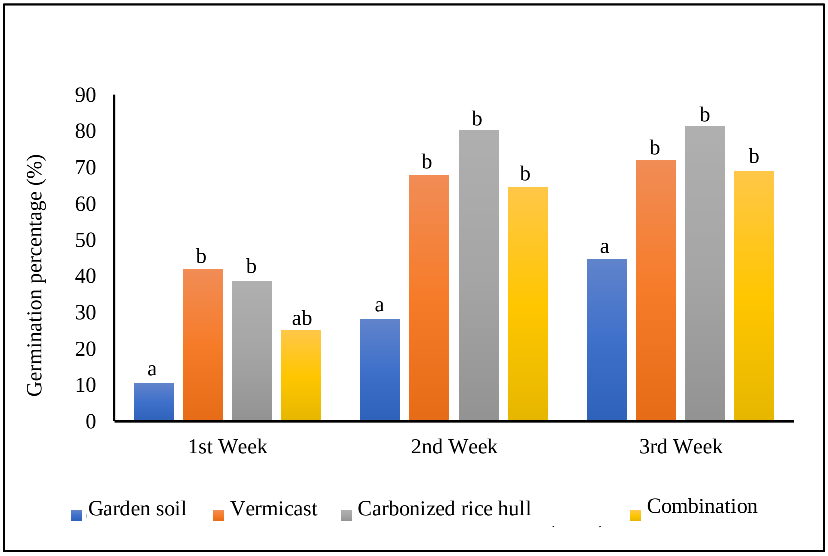
The data was subjected to an analysis of variance (ANOVA) using the Statistical Package for the Social Sciences (SPSS) version 16.0 (SPSS Inc., 2007). The means were compared using the least significant difference (LSD) test. The effects were considered statistically significant at $p \leq 0.05$.

3. Results and Discussion

3.1 Effect of Different Growing Media on Germination

Seedling germination and establishment constitute critical stages in the field performance of crop plants. Numerous environmental and inherent factors influence seed germination in the field, often subjecting seeds to unfavorable conditions that impact seedling establishment (Sang, 2008). Various research studies have been conducted to explore the effects of different planting media on the growth and yield performance of horticultural crops. As illustrated in

Figure 2, significant differences were observed between treatments during the first, second, and third weeks.



Combination: 0.25 L of garden soil + 0.5 L of vermicast + 1.25 L of CRH means with the same letter(s) are not significantly different at $p < 0.05$.

Figure 2. Germination percentage of eggplant using different growing media

In the first week, there were notable distinctions between treatments using garden soil and vermicast, as well as CRH. However, during the second and third weeks, significant differences were evident not only between garden soil and vermicast but also among CRH and their combination. Notably, CRH exhibited the highest germination percentages in the second (80.2%) and third (81.3%) weeks. In contrast, garden soil recorded the lowest germination percentages in the first (10.4%), second (28.1%), and third (44.8%) weeks. Furthermore, during the first, second, and third weeks, no significant differences in germination percentage were observed among seeds sown in vermicast, CRH, and the combination.

The stages of germination and seedling emergence constitute the most vulnerable phases in a crop's life before establishment, as emphasized by Onemli (2004). Water was a critical factor essential for germination, facilitating seed imbibition, enzymatic activation, degradation, translocation, and the utilization of reserve storage materials. Given that germination initiates with seed imbibition, water was recognized as the primary regulator of this process necessitating an adequate moisture supply (Haj Sghaier, 2022).

Research studies indicate that a primary constraint affecting seed germination is the lack of water availability (Ramírez-Tobías *et al.*, 2014; Luna and Chamorro, 2016). Additionally, challenges such as insufficient soil water content, imprecise seed placement, and extreme soil temperatures (both low and high) (Forbes and Watson, 1992) along with factors like inadequate seed-soil contact (Wuest *et al*., 1999), soil insects or soilborne diseases, soil compaction or smearing (Nasr and Selles, 1995), surface crusting post-sowing, and subpar seed quality (Ahmad, 2001) all contribute to these limitations. Furthermore, Belletti (1990) found that seed aging had a marginal impact on the germination percentage in peppers, with a slight decrease observed at lower water content levels.

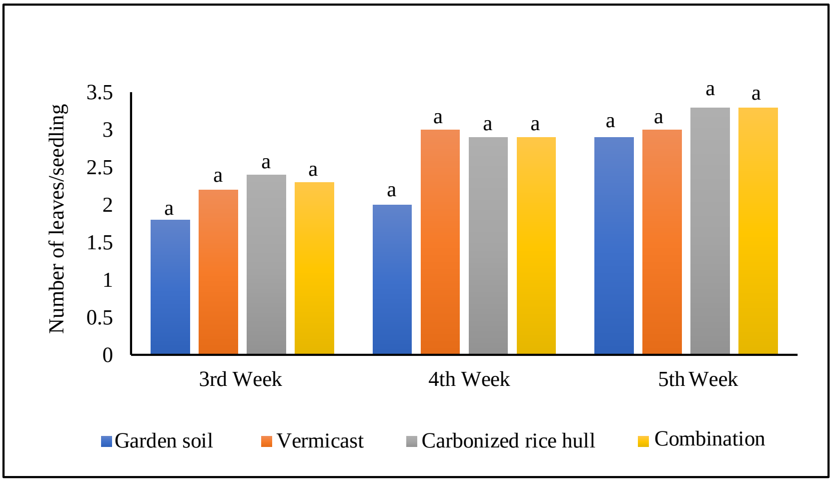
In addition to this, unsuitable growing media can lead to delays in germination, as demonstrated by a study testing different vinegar concentrations as seed priming agents for eggplant germination (Gonzales, 2015).

The elevated phosphorus content found in CRH may contribute to their superior germination rate observed in the third and fourth weeks. Phosphorus, being a primary nutrient for plant growth, is essential for cell division and the formation of new tissues (Epstein and Bloom, 2004). In a study evaluating the efficacy of CRH as a medium in the production of angico vermelho seedlings (*Anadenanthera peregrina* [L.] Speg), Fonseca *et al*. (2017) discovered that using 100% CRH resulted in better germination performance.

Furthermore, findings from Guerrini and Trigueiro (2004), De Freitas *et al*. (2013), and Watthier *et al*. (2017) indicate that substrates with CRH percentages ranging from 15 to 35% produced higher quality seedlings compared to substrates with CRH percentages exceeding this range.

3.2 Effect of Different Growing Media on Number of Leaves

No significant differences were observed in the number of leaves during the third, fourth, and fifth weeks among the treatments (Figure 3).



Combinations: 0.25 L of garden soil + 0.5 L of vermicast + 1.25 L of CRH; means with the same letter(s) are not significantly different at p <0.05.

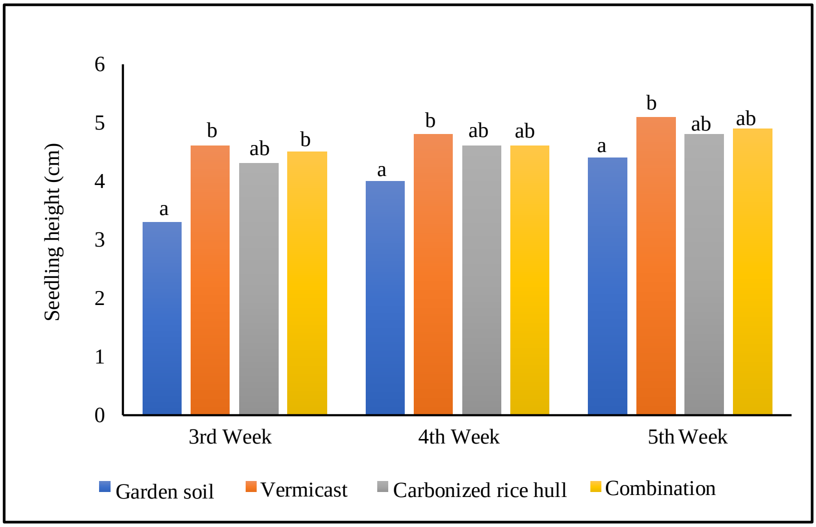
Figure 3. Number of leaves of eggplant using different growing media

3.3 Effect of Different Growing Media on Seedling Height

Significant differences were evident between garden soil and vermicast in all the weeks, with vermicast consistently yielding the highest seedling height, 4.6 cm in the third week, 4.9 cm in the fourth week, and 5.1 cm in the fifth week (Figure 4). Conversely, garden soil exhibited the lowest seedling height across all weeks, measuring 3.3 cm in the third week, 4 cm in the fifth week, and 4.4 cm in the sixth week.

Moreover, a significant difference was observed between garden soil and the combination treatment in the third week. The vermicast treatments consistently demonstrated higher seedling height serving as an indicator of robust plant growth and biomass production (Ebrahimi *et al*., 2021). Furthermore, vermicast exhibited the tallest seedling height, likely attributed to the readily available nitrate form of nitrogen released, which remains accessible for plant uptake even over extended periods (Eswaran and Mariselvi, 2016). Additionally, vermicasts boast a higher content of fine particles, increased microbial activity, and greater organic matter compared with surrounding soils (Bolan and Baskaran, 1996; Aira *et al*., 2010; Haynes *et al*., 2003).

However, no significant differences were observed between garden soil and CRH in the third week, as well as between garden soil and the combinations of garden soil and CRH in the fourth and fifth weeks.



Combination: 0.25 L of garden soil + 0.5 L of vermicast + 1.25 L of CRH; Means with the same letter(s) are not significantly different at $p < 0.05$.

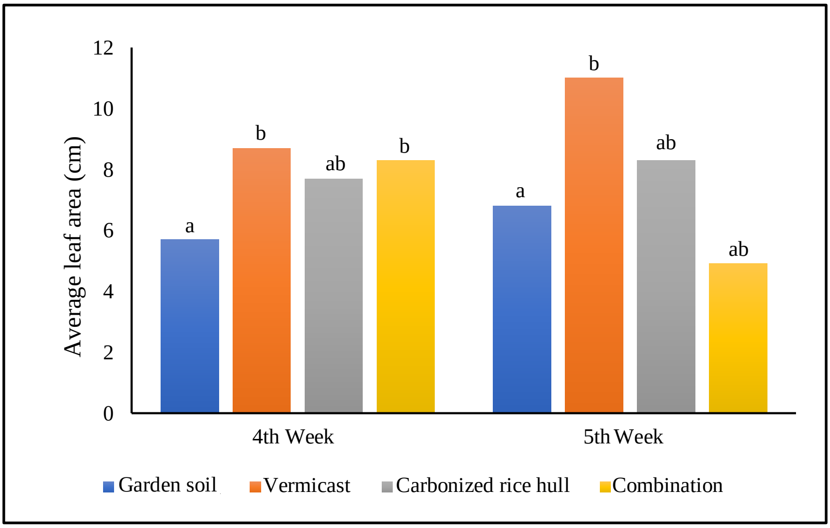
Figure 4. Seedling height of eggplant using different growing media

3.4 Effect of Different Growing Media on the Leaf Area

Significant differences were evident among the treatments on garden soil compared with vermicast for leaf area during the fourth and fifth weeks (Figure 5). Vermicast consistently achieved the highest leaf area measuring 8.7 cm in the fourth week and 11 cm in the fifth week.

In contrast, garden soil exhibited the smallest leaf area across all weeks, registering 5.7 cm in the fourth week and 6.8 cm in the fifth week. Furthermore, there was a notable difference between garden soil and the combination treatment in the fourth week. Additionally, no significant differences were observed between vermicast, CRH, and combination treatment during the fourth and fifth weeks.

The study's findings align with previous research, conducted by Edwards *et al*. (2004) and Kumar *et al*. (2018), indicating that vermicast enhances vegetative growth, promotes shoot and root development, and modifies seedling morphology by increasing leaf area and root branching. Additionally, Bellitürk *et al*. (2017) discovered that the positive impact of vermicast extends to an increase in phosphorus and potassium content in vegetable crops, including eggplant and pepper.



Combination: 0.25 L of garden soil + 0.5 L of vermicast + 1.25 L of CRH; means with the same letter(s) are not significantly different at $p < 0.05$.

Figure 5. Leaf area of eggplant using different growing media

4. Conclusion and Recommendation

Significant differences were observed in germination percentage, seedling height, and leaf area among the eggplant plants grown in different media. Notably, vermicast, CRH, and combination of different growing media outperformed garden soil. Carbonized rice hull exhibited the highest germination rates in the second and third weeks, while garden soil showed the lowest rates during the same period. Vermicast from local earthworms significantly differed from garden soil in terms of its impact on germination.

Regarding growth characteristics, seedlings treated with vermicast from local earthworms displayed the highest height and leaf area during the third, fourth, and fifth weeks of the study. Specifically, the vermicast-treated seedlings reached 5.1 cm in height and 11 cm in leaf area. These findings suggested that vermicast, particularly from local earthworms, could be a superior option for growing eggplant seedlings compared to other media investigated in the study, as it consistently demonstrated enhanced growth parameters. Overall, the results highlighted the potential of vermicast as an effective and low-cost organic amendment for improving soil fertility and promoting the growth of eggplant seedlings.

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