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# INVESTIGATING WORM FOOD DIVERSITY ON VERMICAST MACRONUTRIENT COMPOSITION

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## ABSTRACT

This study evaluated the amount of vermicast production from earthworms (Eudrilus eugeniae) and the primary macronutrient composition using different worm foods. Six treatments were examined, containing various combinations of topsoil, cow manure, goat manure, and banana pseudostem. The study was conducted over 57 days. Each treatment had three replicates, each containing 5 kilograms of worm food and approximately 250 grams of earthworms. The results revealed that topsoil with cow and goat manure yielded more vermicast, with 3.97 kg dry weight produced. All other treatments possessed essential primary macronutrients for plant growth, with variations based on concentrations. Notably, the mixture of topsoil and goat manure exhibited the highest nitrogen content (1.71%), meeting the standard nutrient range of 1.5% to 2.5%. Moreover, a mixture of topsoil and goat manure (1.99%), a mixture of topsoil with goat manure and banana pseudostem (1.62%), a mixture of topsoil with cow manure and goat manure (1.35%), and a mixture of topsoil with cow manure and banana pseudostem (1.12%) also met the standard potassium range of 1% to 2%. Hence, these worm food combinations provide sufficient nutrients for plant growth and development and promote sustainable farming methods.

**Keywords:** Banana pseudostem, Cow manure, Earthworms (Eudrilus eugeniae), Goat manure, Nitrogen, Potassium

## I. INTRODUCTION

Synthetic fertilization has been a common agricultural practice. It has been used due to its dramatic effects on the yield of high-value vegetable crops. However, long-term fertilization of synthetic fertilizers can result in soil acidification. This only further resulted in nutrient imbalance, making the soil less fertile and limiting plant growth and biochemical ingredient formation. Nowadays, using organic fertilizers is an efficient method to achieve sustainable agricultural development. It is a fertilizer that is derived from organic sources. Vermicomposting is an ideal organic fertilizer for better growth and yield of many fruits and vegetables. This can boost plant crop production without synthetic fertilizers that pollute the environment and decrease the health of people and plants.

This study aims to determine the weight in kg of oven-dried vermicast produced from the different worm foods. The following are the different worm foods or treatments: first, topsoil (a controlled treatment). Second, a mixture of topsoil and cow manure (treatment 1). Third, a mixture of topsoil and goat manure (treatment 2). Fourth, a mixture of topsoil, cow manure, and goat manure (treatment 3). Fifth, a mixture of topsoil, cow manure, and banana pseudostem (treatment 4). And lastly, a mixture of topsoil, goat manure, and banana pseudostem (treatment 5). The study assesses whether there are significant differences in the weights of oven-dried vermicast across the various worm food combinations. Moreover, the research further analyzes the percentage of primary macronutrients in the vermicast from these different treatments.

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The significance of this research has many important aspects. It provides practical insights into sustainable agricultural practices. Furthermore, this research offers an alternative to costly and environmentally harmful synthetic fertilizers. The study is essential for advancing eco-friendly farming methods. It also benefits crop growth and reduces reliance on chemical inputs. Additionally, it serves as an educational resource for students and teachers in environmental and agricultural science classes. Farmers and backyard gardeners can also apply the actionable knowledge gained from this study. This makes agriculturists adopt more sustainable and cost-effective farming practices. It also helps improve crop yields and quality while supporting personal food production and environmental sustainability.

## II. REVIEW OF LITERATURE

### VERMICOMPOSTING

**Manohar et al. (2016):** Vermicomposting is the process of producing organic fertilizer or vermicompost from bio-degradable materials with earthworms. It is an eco-friendly alternative fertilizer to chemical fertilizers which is an excellent growth promoter and protector for crop plants.

**Ramnarain et al. (2018):** The use of organic sources of fertilizers like vermicompost could be an effective solution to the problem where it could substitute the chemical inputs in crop productivity and reduce the economic cost.

**Usmani et al. (2019):** All beneficial effects of vermicompost include stimulation of root and shoot development, increasing seed germination, leaf area, root branching, fruit yield, nutritional quality, stimulation of plant flowering, affecting the biomass, photosynthetic pigments, photosynthesis and respiration rates.

**Olle (2019):** Vermicast is a biologically active mound containing thousands of bacteria, enzymes, and residues of plant materials that were not digested by the worms. This contains nutrients that are readily available to plants. Its activity is like a miniature composting tube that mixes immunized residues.

### EARTHWORM (EUDRILUS EUGENIAE)

**Singh et al. (2018):** Earthworm species Eudrilus eugeniae, Eisenia fetida, Perionyx sansibaricus, Pontoscolex corethrurus, and Megascolex chinensis were compared for their efficiencies in biodegrading organic wastes and Eudrilus eugeniae was found to be superb of all these.

**Pradnya et al. (2023):** Eudrilus eugeniae is commonly known as the African worm or Night Crawler and is an epigeic earthworm that is considered the most efficient composting agent in the tropics because it grows faster and has a higher appetite than red worms. They eat organic matter equivalent to their body weight per day. Thus, the addition of worms to the composting process can increase compost production.

### ROLE OF MACRONUTRIENTS OF VERMICAST IN PLANT GROWTH

**Mistry et al. (2015):** During vermicomposting, the nutrients in vermicast are released and converted into soluble and available forms, providing essential nutrients such as nitrogen, potassium, and phosphorus.

**Mensah et al. (2020):** All the essential plant nutrients, N, P, and K are the most limiting macronutrients for plant growth and development.

**Santosa and Priyono (2023):** Nitrogen is the main nutrient for plant growth in vegetative formation, such as leaves, stems, and roots. The use of nitrogen for plants increases plant growth, raises protein levels, and improves the quality of leafproducing plants.

**Razaq et al. (2017):** Phosphorus ($P_2O_5$) plays an important role in lateral root morphology and root branching and influences not only root development but also the availability of nutrients. Therefore, plants have developed various strategies for obtaining optimum. Phosphorus including increases in root surface area, specific root length, and rootshoot ratio.

**Xu et al. (2020):** Potassium, $K_2O$, is an essential mineral nutrition for plant growth and development and is required in large amounts by plants. Furthermore, potassium has a significant effect on the growth and development of plant roots.

Philippines National Standard (2020): Total N-P2O5-K2O ranges between 5%-10%. This signifies richness in nitrogen, phosphorus, and potassium. This abundance offers plants robust growth and development. Actual

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moisture content should be less than or equal to 35%. Additionally, a recommended nutrient analysis of casts is 1.5%–2.5% N, 1.25%–2.25% $P_2O_5$, and 1%–2% $K_2O$.

**WORM FOOD USED IN VERMICOMPOSTING**

**Frouz (2021):** Topsoil improves soil conditions and helps transfer beneficial plant materials and soil organisms, making it an effective method for restoring natural habitats.

**Alwaneen (2016):** Cow manure vermicompost supplies essential nutrients to plants for stimulating growth as well as increasing the organic matter contents of soil beneficial for higher plant production.

**Gichaba, Muraya, and Ndukhu (2020):** Goat manure is more useful when composted rather than when applied directly and composting can be done using earthworms to produce vermicompost.

**Khatua et al. (2018):** banana plant–derived wastes can also be utilized for recycling through vermicomposting. This process can transform the waste into manure, providing an alternative to chemical fertilizers.

## III. RESEARCH METHODOLOGY

**RESEARCH SCHEME AND LOCALE**

This study employed a quantitative descriptive research approach. This assesses the percentage of primary macronutrients in vermicast from various worm food treatments. The study was conducted at the Naawan LGU Department of Agriculture, where diverse worm foods were used in vermicomposting to produce vermicasts. Subsequently, vermicast samples were analyzed for primary macronutrient levels at the Regional Director, DA RFO X.

**DATA GATHERING PROCEDURE**

Data for the study were collected through structured observation and experimentation. Adequate tools and materials were gathered to ensure proper handling and protection against contaminants during the vermicomposting process. Each treatment consisted of three replicated containers, totaling 15 containers. Each container contained 5 kilograms of diverse worm foods (e.g., topsoil, cow manure, goat manure, banana pseudostem), and about 250 grams of earthworms (Eudrilus Eugeniae). Monitoring of worm food treatments was diligently carried out to maintain optimal moisture levels. The process was conducted for 25 days.

**Table 1:** Formulation of Different Treatments

| Treatments | Worm Foods |
|---|---|
| Controlled Treatment | 4 kg of Topsoil and approximately 250g of earthworm |
| Treatment 1 (1:4) | 1 kg of Topsoil + 4 kg of Cow Manure and approximately 250g of earthworm |
| Treatment 2 (1:4) | 1 kg of Topsoil + 4 kg of Goat Manure and approximately 250g of earthworm |
| Treatment 3 (1:2:2) | 1 kg of Topsoil + 2 kg of Cow Manure + 2 kg of Goat Manure and approximately 250g of earthworm |
| Treatment 4 (1:2:2) | 1 kg of Topsoil + 2 kg of Cow Manure + 2 kg of Banana Pseudostem and approximately 250g of earthworm |
| Treatment 5 (1:2:2) | 1 kg of Topsoil + 2 kg of Goat Manure + 2 kg of Banana Pseudostem and approximately 250g of earthworm |

**DATA ANALYSIS**

Mean calculations were employed to assess differences in oven-dried vermicast production between treatments.

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## IV. RESULTS AND DISCUSSION

### WEIGHT (KG) OF OVEN-DRIED VERMICAST PRODUCED AMONG VARIOUS WORM FOOD

A mixture of topsoil, cow manure, and goat manure produced the most vermicast, with an average weight of 3.97 kg, followed by a mixture of topsoil and goat manure with an average weight of 3.84 kg, a mixture of topsoil and cow manure with an average weight of 3.18 kg, a mixture of topsoil, goat manure, and banana pseudostem with an average weight of 2.82 kg, and a mixture of topsoil, cow manure, and banana pseudostem with the lowest average weight of 2.41 kg. Furthermore, pure topsoil showed no signs of vermicast production during or after the vermicomposting process. Moreover, dry vermicast is used as yield data due to its consistency, ease of handling, and reduced microbial activity. By using dry vermicast, researchers can standardize conditions across different studies or replicates, enhancing the reliability and comparability of results.

### MACRONUTRIENTS CONTENT OF THE VERMICAST

**Nitrogen content of vermicast from various worm foods:** Treatment 2 has the highest nitrogen content at 1.71%, followed by Treatment 5 (1.45%), Treatment 3 (1.17%), Treatment 1 (0.71%), and Treatment 4 (0.56%), which shows the lowest nitrogen content. These treatments can serve as organic fertilizers due to the presence of nitrogen content essential for plant growth; however, their effectiveness relies on the nitrogen concentration in the vermicast. According to the Philippine National Standard (2020), the standard nitrogen content in casts ranges from 1.5% to 2.5%. Hence, Treatment 2 meets this standard, providing sufficient nitrogen nutrients to increase plant growth, raising protein levels, and improving the quality of leaf-producing plants (Santosa & Priyono, 2023). Treatment 5, while slightly lower, still approaches this range, providing moderately sufficient nitrogen for plant development [Figure 1].

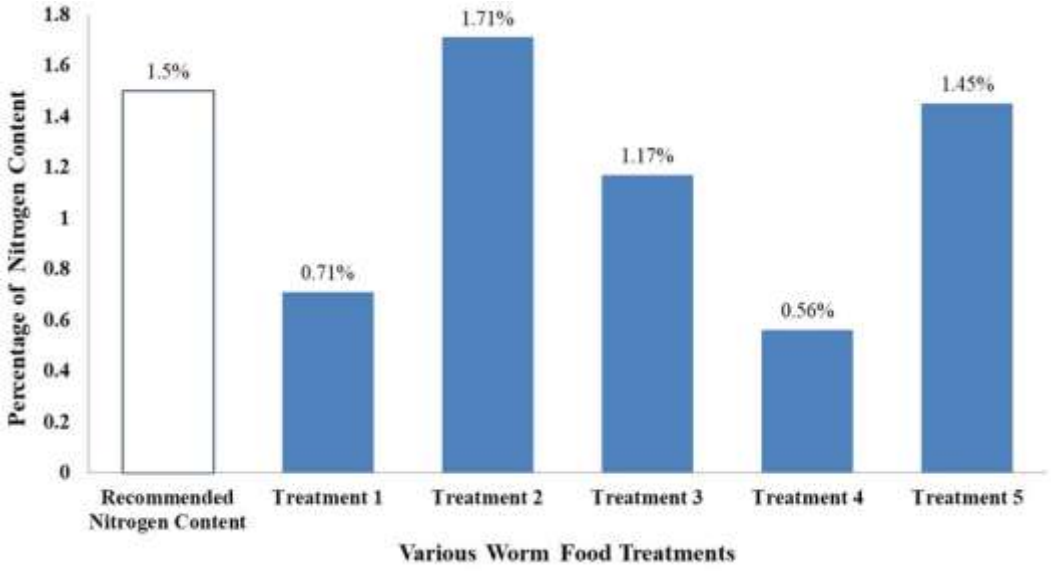


**Figure 1:** Percentage of nitrogen (N) content among various vermicast

**Phosphorus content of vermicast from various worm foods:** Treatment 5 exhibits the highest phosphorus content at 1.13%, closely followed by Treatment 2 (1.12%), Treatment 3 (0.80%), Treatment 1 (0.56%), and Treatment 4 (0.53%), which displays the lowest phosphorus content. These treatments can function as organic fertilizers due to the presence of phosphorus nutrients needed for plant growth. However, their effectiveness depends on the phosphorus concentration in the vermicast. According to the Philippine National Standard (2020), the standard phosphorus content in casts falls within the range of 1.25% to 2.25%. The result shows that none of the treatments meet this standard; however, Treatment 5 and Treatment 2 come close to reaching the standard phosphorus level, providing moderately sufficient phosphorus by increasing root surface area, specific root length, and root-shoot ratio, as highlighted by Razaq et al. (2017) [Figure 2].

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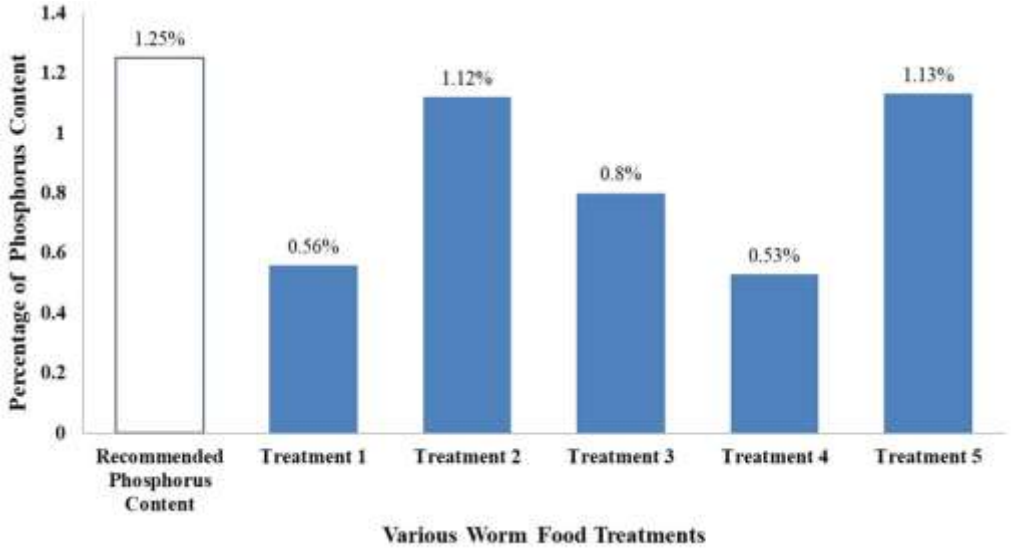


**Figure 2:** Percentage of phosphorus ($P_2O_5$) content among various vermicast

**Potassium content of vermicast from various worm foods:** Treatment 2 shows the highest potassium content at 1.99%, followed by Treatment 5 (1.62%), Treatment 3 (1.35%), Treatment 4 (1.12%), and Treatment 1 (0.99%), which has the lowest potassium content. These treatments can be used as organic fertilizers as they contain potassium nutrients for plant growth; however, their effectiveness depends on the concentration of potassium present in the vermicast. According to the Philippine National Standard (2020), the standard potassium content in casts falls within the range of 1% to 2%. Therefore, treatments 2, 5, 3, and 4 meet this standard and provide sufficient potassium nutrients that affect the growth and development of plant roots (Xu et al., 2020). Treatment 1 almost reached the standard potassium content, providing moderately sufficient potassium for plant growth [Figure 3].

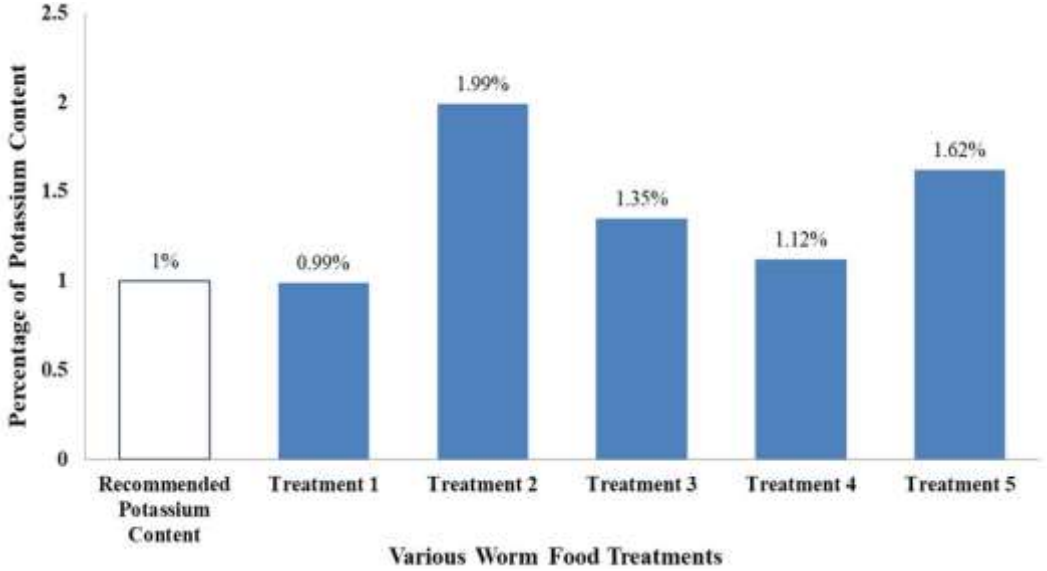


**Figure 3:** Percentage of potassium ($K_2O$) content amongst various vermicast

**Primary macro-nutrients content of vermicast from various worm foods:** Treatment 2 has the highest NPK content at 4.82%, followed by Treatment 5 (4.20%), Treatment 3 (3.32%), Treatment 1 (2.26%), and Treatment 4 (2.21%). These treatments can function as organic fertilizers, containing essential nutrients for plant growth; however, their effectiveness depends on the primary macronutrient concentration in the vermicast. While none meet the standard NPK content range of 5% to 10% according to the Philippines National Standard (2020), Treatment 2 and Treatment 5 come close, offering moderately sufficient nutrients to enhance plant growth and improve overall plant health. Nutrient content of goat manure can be influenced by

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what the goats eat as goats have efficient digestive systems that break down organic matter effectively, resulting in nutrient-dense manure. A study showed that goat manure had high total N, medium available P, medium exchangeable K, and was moderately alkaline (Gichaba et al., 2020). As a result, when goats' manure is used in vermicomposting, it provides a wide range of nutrients that are beneficial for soil health and plant growth [Figure 4].

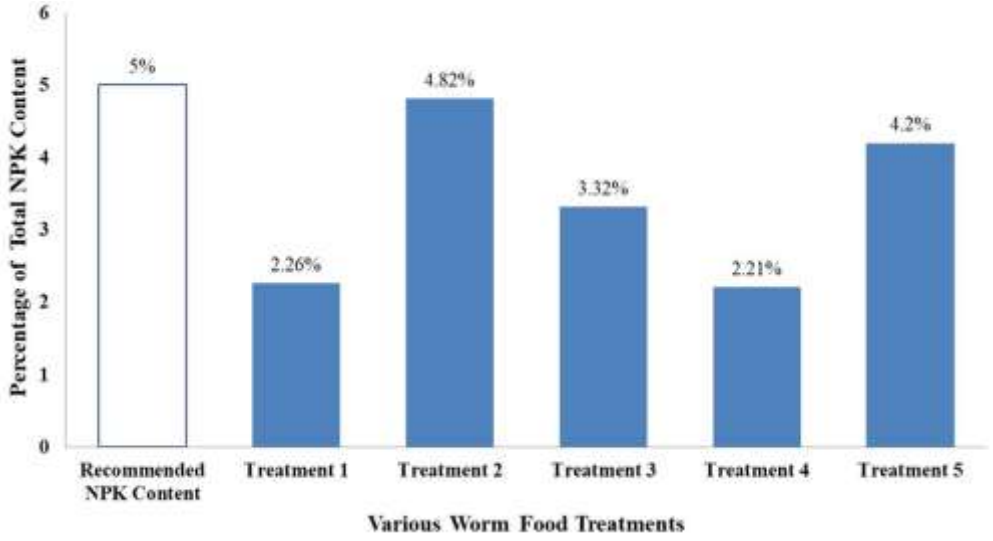


**Figure 4:** Percentage of primary macro-nutrients (N $P_2O_5$ $K_2O$) content amongst various vermicast

## V. CONCLUSION

The study showed that topsoil with cow and goat manure produced the most vermicast, while pure topsoil was impractical. All treatments acted as organic fertilizers, with varying effectiveness based on nutrient concentrations. Topsoil with goat manure had the highest nitrogen and potassium content, meeting nutrient standards and promoting plant growth and health. Other treatments nearly met NPK standards, providing moderately sufficient nutrients for plant growth and crop yields.

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## VI. REFERENCES

[1] Alwaneen, W. S. (2016). Effect of cow manure vermicompost on some growth parameters of alfalfa and Vinca rosa plants. Asian Journal of Plant Sciences, 15(3–4), 81–85. https://doi.org/10. 3923/ajps. 2016. 81. 85.

[2] Frouz, J. (2021). Soil recovery and reclamation of mined lands. In Elsevier eBooks (pp. 161–191). https://doi.org/10.1016/b978-0-12-813193-0.00006-0.

[3] Gichaba, V. M., Muraya, M. M., & Ndukhu, H. O. (2020). Effects of Goat Manure-Based Vermicompost on Growth and Yield of Garlic (Allium sativum L.). International Journal of Horticulture, Agriculture and Food Science, 4(3), 62–72. https://doi.org/10.22161/ijhaf.4.3.1.

[4] Khatua, C., Sengupta, S., Balla, V. K., Kundu, B., Chakraborti, A., & Tripathi, S. (2018). Dynamics of

organic matter decomposition during vermicomposting of banana stem waste using Eisenia fetida. Waste Management, 79, 287–295. https://doi.org/10.1016/j.wasman.2018.07.043.

[5] Manohar, A., Tulasi, T., Gajjela, L., Prasad, M., Gopi, N., Mobeema, S., Rajesh, K., Srinivas, S., & Parasa, L. (2016). Vermicompost Preparation from Plant Debris, Cattle Dung and Paper Waste by Using Three Varieties of 32 Earthworms in Green Fields Institute of Agriculture, Research and Training, Vijayawada(AP), India. Current Agriculture Research Journal, 4(1), 102–107. https://doi.org/10. 12944/carj.4.1.11.

[6] Mensah, S. T., Ochekwu, E. B., Mgbedo, U. G., & Uzoma, M. C. (2020). Effect of N : P : K (15 : 15 : 15) on the Growth of Punica granatum L. Seedlings. International Journal of Agronomy, 2020, 1–7. https://doi.org/10.1155/2020/4653657.

[7] Mistry, J., Mukhopadhyay, A. P., & Baur, G. N. (2015). Status of N P K in Vermicompost Prepared from Two Common Weed and Two Medicinal Plants. International Journal of Applied Sciences and Biotechnology, 3(2), 193–196. https://doi.org/10.3126/ijasbt.v3i2.12533.

[8] Olle, M. (2019). Review : vermicompost, its importance and benefit in agriculture. Agraarteadus, 30(2), 93–98. https://doi.org/10.15159/jas.19.19.

[9] Philippine National Standard. (2020). Organic Soil Amendments. Bureau of Agriculture and Fisheries Standards. https://bafs.da.gov.ph/bafs_admin/admin_page/pns_file/PNS %20BAFS % 201 83.2020% 20O rganic%20Soil%20Ammendments.pdf.

[10] Pradnya, I. N., Imani, N. a. C., Kusumaningrum, M., Ardhiansyah, H., Nugraha, D. D., & Syakila, A. F. (2023). The Potential of Earthworms (Eudrilus eugeniae) in Vermicompost Production from Vegetable Market of Waste Cabbage and Fruit Skins. Sainteknol, 21(1), 18–27. https://doi.org/10. 15294/ sainteknol. v21i1.43485.

[11] Ramnarain, Y. I., Ansari, A. A., & Ori, L. (2018). Vermicomposting of different organic materials using the epigeic earthworm Eisenia foetida. International Journal of Recycling of Organic Waste in Agriculture, 8(1), 23–36. https://doi.org/10.1007/s40093-018-0225-7.

[12] Razaq, M., Zhang, P., Shen, H., & Salahuddin. (2017). Influence of nitrogen and phosphorous on the growth and root morphology of Acer mono. PloS One, 12(2), e0171321. https://doi.org/10. 1371/journal. pone.0171321.

[13] Santosa, S. J., & Priyono, N. (2023). The Scientific Study of Urea Fertilizer and Cow Manure Composition on the Growth and Yield of Kailan Plants. Acitya Wisesa, 20–31. https://doi.org/10. 56943/jmr. v2i1.233.

[14] Singh, J., Singh, S., Vig, A. P., & Kaur, A. (2018). Environmental Influence of Soil toward Effective Vermicomposting. In InTech eBooks. https://doi.org/10.5772/intechopen.75127.

[15] Usmani, Z., Kumar, V., Gupta, P., Gupta, G., Rani, R., & Chandra, A. (2019). Enhanced soil fertility, plant growth promotion and microbial enzymatic activities of vermicomposted fly ash. Scientific Reports, 9(1). https://doi.org/10.1038/s41598-019-46821-5.

[16] Xu, X., Du, X., Wang, F., Sha, J., Chen, Q., Tian, G., Zhu, Z., Ge, S., & Jiang, Y. (2020). Effects of potassium levels on plant growth, accumulation and distribution of carbon, and nitrate metabolism in apple dwarf rootstock seedlings. Frontiers in Plant Science, 11. https://doi.org/10.3389/fpls.2020.00904.