***Original Research Article***

**Growth performance of Moringa (*Moringa oleifera*) seedlings as affected by organic fertilizer under nursery condition**

**ABSTRACT**

|  |
| --- |
| Moringa is a plant of great importance because of its industrial, medicinal and food uses. The leaves, pods, flowers, fruits, roots, bark, and seeds of *Moringa oleifera* can be used to treat water, as a nutritional supplement and as an extract to treat bacterial or fungal skin problems. The plant is not very demanding in terms of fertilizer, but a minimal intake improves its yield. During the nursery stage, the nutrient content of the soil should be high enough to sustain the plant's life cycle. This study was conducted to assess the growth response of *Moringa oleifera* to different rates of organic fertilizer, with the objective of determining the rate that supports optimum plant growth under nursery condition. Varying rates of poultry manure compost (0 g, 100 g, 200 g and 300 g) were added in a treatment pot at 14 and 30 days after transplant. The experimental design was Randomized Complete Block Design (RCBD) with four replications. Growth parameters measured include plant height, stem girth, leaf area, fresh and dry weight of leaves, stem and root. The results revealed that seedling height at 8th weeks after transplant showed a significant difference between the organic treatment and the control. The highest plant height was obtained from the treatment applied with 200 g organic fertilizer (123.25 cm), followed by 300 g (122.10 cm) and 100 g (115.35 cm). The fertilizer treatments also significantly affected the stem girth with the highest value for 200 g organic fertilizer (1.44 cm) and the control having the lowest value of 0.94 cm. The leaf area was significantly affected by organic fertilizer; however, there was no significant difference (P< 0.05) between 200 g and 300 g of organic fertilizer. Other than that, 300 g of organic fertilizer recorded the highest value of fresh and dry weight of leaves and stem but no significant difference with the 200 g. The result revealed that organic fertilizer appeared as an effective amendment to enhance the growth and vigour of *Moringa oleifera* in the nursery. This study concluded that the growth of *Moringa oleifera* was maximized using 300 g of organic fertilizer which is statistically significant (P<0.05) as compared to other treatments, but as increases from 200 to 300 g were small, 200 g may be optimal. |

*Keywords: poultry manure, growth response, nursery stage, nutrient, organic fertilizer.*

**1. INTRODUCTION**

In recent times, *Moringa oleifera* has gained a lot of popularity due to recent discoveries of its usefulness to humankind, leading to a rapid growth in interest for the plant. *M. oleifera* belongs to the monogeneric family of shrubs and trees, called Moringaceae and called the “Miracle Tree” for good reasons. Moringa is a plant of great importance because of its industrial, medicinal and food uses. The leaves, pods, flowers, fruits, roots, bark, and seeds of *Moringa oleifera* can be used to treat water, as a nutritional supplement and as an extract to treat bacterial or fungal skin problems. Moringa leaves, seeds, and roots are also used in treating diseases like lung diseases, diabetes, hypertension and skin infection (WHO, 2012).

*Moringa oleifera* as a fast-growing, deciduous and drought resistant plant can be grown in fields either by direct seeding or seedlings. However, during nursery time, the nutrient amount in soil should be high enough to sustain the plant life cycle (Wilson *et al.* 2001). The plant is not very demanding in terms of fertilizer, but a minimal intake improves its yield. Fertilizer helps in the fast growth of *Moringa oleifera*, enhanced its ability to produce a healthy plant (Jones,1999). Physical characteristics are the visually determinable attributes of tree seedlings in the nursery. The major morphological criteria often used to describe seedling potentials are seedling height, leaf area and seedling stem girth. These are some of the bases to qualify good seedlings for nursery establishment (Egbewole *et al*., 2018).

The Food and Agriculture Organization of the United Nations (FAO) has agreed that organic agriculture is a form of agriculture that is an environmentally sustainable growing system (Polat *et al*., 2010). Organic fertilizers which are from organic sources such as cow dung are known to improve long term soil fertility as well as soil physical and microbial properties, most studies therefore, focus more on solid organic fertilizers (Yang et al., 2013). The use of organic manure as fertilizer releases many important nutrients into the soil and also nourishes soil organisms, which in turn slowly and steadily make minerals available to plants (Erin, 2007). Furthermore, organic fertilizers improve the biological activity of soil, promoting the growth of beneficial microorganisms such as nitrogen-fixing bacteria and mycorrhizal fungi. These microorganisms assist in nutrient cycling, making nutrients more accessible to Moringa seedlings. They not only enhance soil health and nutrient content but also improve the sustainability of agricultural practices. Organic amendments are particularly important in nursery conditions, where the controlled environment allows for optimized nutrient management and growth performance. Additionally, the use of organic amendments can reduce the occurrence of soil-borne diseases and enhance the seedlings' resilience to environmental stresses (Joyce et al.,2025).

Despite the economic and medicinal importance of this crop, its cultivation still remains low. The information is still scanty on the fertilizer requirement that will bring about proper growth of Moringa seedlings. In order to encourage its large scale cultivation, there is a need to develop agronomic practices, hence the need for the present study. Consequently, this study was conducted to assess the growth response of *Moringa oleifera* to different rates of organic fertilizer, with the objective of determining the rate that supports optimum plant growth under nursery conditions.

**2. material and methods**

**2.1 Planting materials**

*Moringa oleifera* seeds were collected from farmer’s plot, which is located in the Serdang, Selangor, Malaysia. The seeds were sown directly into seedling trays. Media used were mixtures of topsoil, sand and compost with a 3:2:1 ratio. Seeds were planted in seedling trays at a depth of up to 2 cm. Following germination, which occurred between 7 to 10 days after sowing, only one vigorous seedling was selected and transplanted into polybag filled with soil mix as the growth medium. The polybags were watered daily to maintain adequate moisture levels for seedling growth. The polybags were placed in nursery environment for optimal growth conditions.

**2.2 Fertilizer applications**

The organic fertilizers used in this study were derived from compost made using poultry manure as the primary component. The chemical properties of organic fertilizers derived from poultry manure compost can vary depending on factors such as the composting process, the feedstock used, and the age of the compost. However, in general, poultry manure compost is rich in essential macronutrients and some micronutrients. These composts served as a source of essential nutrients, including nitrogen, phosphorus, and potassium, which are vital for plant growth. The chemical composition of the commercial bio-organic fertilizer (Jutani Super), as specified in the product description, is based on nutrient analysis, indicating an NPK content of more than 10% along with trace elements (TE).

**2.3 Experimental design and treatments**

The trials were conducted using a Randomized Complete Block Design (RCBD), which included four different rates of organic fertilizer treatments with four replications. The treatments were formulated as follows: T1: 0 g of organic fertilizer (control), T2: 100 g of organic fertilizer, T3: 200 g of organic fertilizer and T4: 300 of organic fertilizer (control). Each treatment consisted of 10 plants per replication, resulting in total of 160 plants being involved in this study. The experimental units consisted of polybags measuring 20 x 25 cm, each containing 1.0 kg of soil mix. Depending on the treatment, commercial bio-organic fertilizer was added in varying amounts. The fertilizer was applied 14 and 30 days after transplanting.

**2.4 Data Collections**

Growth measurements were taken for various variables, including plant height, stem diameter (measured 1 cm above the surface of the growing medium) and leaf area. Plant height was measured using a meter rule, while stem diameter was determined using a vernier caliper. Leaf area per plant was measured using a LI-3100C leaf area meter. The seedlings were observed at 8 weeks after transplanting (WAT). Plant biomass was assessed by carefully removing the seedlings from the growing medium, thoroughly removing soil particles and measuring the weight of the different plant parts. Fresh biomass was weighed using a digital balance. To determine dry biomass, the roots and aerial parts of the plants were dried in an oven at 75°C for 72 hours, then weighed using an electronic scale with an accuracy of 0.001 g.

**2.5 Statistical analysis**

The data obtained were subjected to analysis of variance (ANOVA) using the SAS software (Version 9, SAS Institute Inc. Cary, North Carolina, USA). The differences between treatment means were compared using Least Significant Difference (LSD) at p ≤ 0.05.

**3. results and discussion**

The application of organic fertilizer demonstrated a consistent increase in plant height by the 8th week after transplanting, with a significant difference observed between the organic treatments and the control. As shown in Figure 1, the tallest plants were recorded in the treatment with 200 g of organic fertilizer (123.25 cm), followed by 300 g (122.10 cm) and 100 g (115.35 cm). Leaf area measurements showed significant variations across treatments; however, there was no statistically significant difference (P < 0.05) between the 200 g and 300 g organic fertilizer treatments. Overall, the results of this study indicated a general trend of increased plant height, leaf area, and leaf fresh weight with higher rates of organic fertilizer application. Studies have shown that *Moringa oleifera* seedlings grown with organic fertilizers exhibit superior growth performance compared to those without fertilizer. This includes increased seedling height, leaf area, biomass production, and overall vigour. The nutrient-dense nature of organic fertilizers also aligns with sustainable agricultural practices, minimizing the environmental impact and promoting long-term soil health.

This observation agreed with earlier reports of Baiyeri (2008), Ndukwe (2011) and Aba (2011) that animal manure is a valuable source of crop nutrients and organic matter, which can improved the soil biophysical conditions making the soil more productive and sustainable for plant growth. Chukwuka *et. al,* (2009) specifically noted that application of organic fertilizers significantly improves the soil chemical properties and nutrient uptake in plants, thereby enhancing plant growth. Organic fertilizers can significantly enhanced seedling development by supplying essential macronutrients (nitrogen, phosphorus, and potassium) and micronutrients in a form that is readily available and easily absorbed by the plant. Nitrogen, in particular, is crucial for leaves and shoot development, while phosphorus supports root establishment and energy transfer. Potassium contributes to photosynthesis, water regulation, and resistance to stress conditions.



**Fig. 1. Growth performance of moringa seedlings in terms of plant height, leaf area and leaf fresh weight at different rate of organic fertilizer**

Table 1 indicates that the fertilizer treatments significantly influenced stem girth, with the highest value recorded for the 200 g organic fertilizer treatment (1.44 cm), while the control showed the lowest value (0.94 cm). Additionally, the 300 g organic fertilizer treatment produced the highest fresh and dry weight of leaves and stems, although this was not significantly different from the 200 g treatment. These findings suggest that organic fertilizer is an effective amendment for enhancing *Moringa oleifera* production in nursery conditions by boosting the vigour of this valuable plant. According to Stoffella *et al.* (1997), compost and other organic fertilizers have been reported to improve soil nutrient levels, as fertilizers provide a ready source of carbon and nitrogen for soil microorganisms, improve soil structure, reduce erosion, lower soil temperatures, facilitate seed germination and increase soil water retention capacity. Fertilizers stabilized soil pH, increased soil organic matter, and improved the growth and yields of plants (Roe *et al*. 1997).

**Table 1: Growth performance of moringa seedlings at different rate of organic fertilizer**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Fertilizer rate (g)** | **Stem girth (cm)** | **Leaf dry weight (g)** | **Stem fresh weight (g)** | **Stem dry weight (g)** | **Root fresh weight (g)** | **Root dry weight (g)** |
| 0 | 0.94b | 1.24b | 25.73c | 11.65b | 31.12b | 13.39b |
| 100 | 1.29a | 2.13b | 58.73b | 16.68b | 46.11ab | 16.36b |
| 200 | 1.44a | 3.55a | 77.84ab | 24.02a | 60.71a | 23.18a |
| 300 | 1.43a | 4.30a | 89.99a | 24.83a | 54.67a | 19.57ab |

*\*Mean values in the same column followed by the same letter are not significantly different at p < 0.05*

Increased plant yields may also be due to an improvement in soil aggregate stability that may have favoured the multiplication of beneficial microorganisms that helped in improving biomass production (Basso and Ritchie 2005). In related research, a positive response of *M. oleifera* plants was obtained after fertilizers application (Haouvang *et al*. 2017). Similarly, a trial to determine the influence of organic fertilizers on the growth and nutritional quality of *M. oleifera* in Egypt has revealed the beneficial effect of amendments to the plant (Mona 2012).

The application of organic fertilizers has a profound impact on plant growth, primarily through improving soil fertility, enhancing nutrient availability, and fostering beneficial soil microorganisms. Organic fertilizers, derived from natural sources such as compost, animal manure, green manure, and plant residues, release nutrients gradually, ensuring a consistent supply to plants throughout their growth cycle. This slow nutrient release reduces the risk of nutrient leaching and enhances soil structure, water retention and aeration, creating an ideal environment for root development and overall plant growth.

In nursery conditions, where environmental factors such as temperature, humidity and light are controlled, the effect of organic fertilizers is even more pronounced. The controlled environment ensures that nutrients provided by organic fertilizers are utilized efficiently, leading to optimal growth and development of Moringa seedlings. Consequently, organic fertilizers not only support the cultivation of *Moringa oleifera* but also contribute to sustainable agricultural systems by enhancing plant growth while protecting the environment.

The regression analysis presented in Figure 2 (A) demonstrates a significant positive linear relationship between fertilizer rate and fresh yield. The regression equation (y=0.054x + 5.595) and a high coefficient of determination (R2=0.868) indicate that 86.8% of the variability in fresh yield can be explained by changes in fertilizer application within the tested range. The results suggest that increasing fertilizer rates proportionally enhance fresh yield, highlighting fertilizer rate as a key determinant of productivity. However, further investigation is necessary to determine whether this trend persists at higher fertilizer rates or if diminishing returns and potential adverse effects, such as nutrient toxicity or environmental degradation.

In contrast, Figure 2 (B) illustrates the relationship between fertilizer rate and dry yield. The regression model (y=0.0106x + 1.2233) also demonstrates a positive relationship, though the coefficient of determination is moderately strong (R2=0.7811), explaining 78.1% of the variability in dry yield. The smaller slope (0.0106) compared to fresh yield indicates that the increase in dry yield per unit increase in fertilizer rate is less pronounced, which is consistent with the water content reduction in dry matter. Moreover, greater variability in dry yield responses, particularly at lower fertilizer rates, suggests the influence of additional factors such as environmental conditions, crop physiological limitations or interactions with soil nutrient dynamics.

**B**

**A**

**Fig. 2. Regression graph for the effect of at different rate organic fertilizer rate on fresh yield (A) and dry yield (B)** **of moringa seedlings**

**4. CONCLUSION**

In conclusion, the growth performance of *Moringa oleifera* seedlings is significantly influenced by the rate of organic fertilizer application. The findings of this study, consistent with previous research, demonstrate that moderate to high rates of organic fertilizers, particularly poultry manure, enhance the growth parameters of *Moringa oleifera* seedlings when compared to lower application rates or untreated controls. This study identified 300 g of organic fertilizer as the application rate resulting in maximum growth, while the optimal application rate may be 200 g. Both, resulting significant improvements in the growth performance of *Moringa oleifera*. These findings underscored the critical role of optimized organic fertilizer application in promoting the sustainable cultivation of *Moringa oleifera* while maximizing its agronomic potential.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

**REFERENCES**

Aba, S.C., P.K. and Tenkouano, A. (2011). Impact of poultry manure on growth behaviour, black sigatoka disease response and yield attributes of two plantains (Musa spp. AAB) genotypes. Tropicultura, 29(1), 20-27.

Baiyeri, K.P., Tenkouano, A. (2008). Manure placement effects on root and shoot growth and nutrient uptake of „PITA 14‟ Plantain hybrid (Musa sp. AAAB). Afr. J. Agric. Res., 3(1), 13-21.

Basso B, Ritchie J.T. (2005) Impact of compost manure and inorganic fertilizer on nitrate leaching and yield for a 6-year maize alfalfa rotation in Michigan. Agric Ecosystem Environment 108:309–341. https ://doi.org/10.1016/j.agee.2005.01.011.

Chukwuka, K.S. and Omotayo, O.E. (2009). Soil fertility restoration potentials of Tithonia green manure and water hyacinth compost on nutrient depleted soil in southwestern Nigeria using *Zea mays* L. as test crop. Res. J. Soil Biol., 1(1), 20 -30.

Egbewole, Z. T., Falade, L. O., Rotowa, O. J. and Clement, S. A. (2016). Seed germination and early growth trial of *Ceiba patandra* (L. Gaertn). Proceedings of the 38th annual conference of the forest Association of Nigeria held in Port Harcourt Rivers State. 868-880.

Haouvang L.C, Ngakou A, Yemefack M, Mbailao M. (2017) Growth response of *Moringa oleifera* Lam. as affected by various amounts of compost under greenhouse conditions. AOAS 62:221–226. <https://doi.org/10.1016/j.aoas.2017.12.004>.

Jones P.D, (1999). Journal on the propagation and growing of multipurpose trees, vol. 19, 56: 60-78. In: Vegetative and Reproductive tissue of the Multipurpose tree, *Moringa oleifera*, Journal of Agriculture and Food Chemistry 51:3546-3553.

Joyce C. M., Beth M., Steven J. V., Esther W. G., John O. O., Steven J. F. (2025). Long-term organic matter inputs enhance soil health and reduce soil-borne pathogen pressure in maize-bean rotations in Kenya. Agriculture, Ecosystems & Environment. 380:109402

Mona S.Z. (2012) Improvement of growth and nutritional quality of *Moringa oleifera* using different biofertilizers. AOAS 57(1):53 62. <https://doi.org/10.1016/j.aoas.2012.03.004>.

Ndukwe O.O, Muoneke C.O, Baiyeri K.P, Tenkouano A. (2011). Growth and yield responses of plantain genotypes as influenced by organic and inorganic fertilizers. Journal of Plant Nutrition, 34(5), 700-716.

Olayinka O. (2016). Effects of Cow dung and N.P.K Fertilizer at different levels on the growth performance and Nutrient Composition of *Moringa oleifera*. Ann. Exp. Bio., 4(1):35-39.

Polat E, Demiri, H. and Erler, F. (2010). Yield and quality criteria in organically and conventionally grown tomatoes in Türkiye. Sci Agricola, 67(4): 424-429.

Roe N.E., Stoffella P.J., Graetz D.A. (1997) Compost from various munici pal waste feedstocks affect vegetable crops II growth, yield and fruit quality. Journal of the American Society for Horticultural Science. 122:433–437. https ://doi. org/10.21273/JASHS.122.3.433.

Stoffella P.J., Li Y.C., Roe N.E., Ozores-Hampton M., Graetz D.A. (1997) Utilization of organic waste composts in vegetable crop pro duction systems. In: Morris RA (ed) Managing soil fertility for intensive vegetable production systems in Asia. Asian Vegetable Research and Development Centre, Shanhua, 12.

WHO (2012). Miracle Tree Foundation. Retrieved from <http://miracletrees.org/>.

Wilson S.B., Stoffella P.J., Graetz D.A. (2001). Use of compost as a media amendment for containerized production of two subtropical perennials. J Environ Hortic 19(1):37–42.

Yang, J., Liu, X. and Shi, Y. (2013). Effect of different mixed fertilizer on yield, quality and economic benefits in *Stevia rebaudiana bertoni*. Adv J Food Sci Tech, 5(5):588-591.