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IMPACT OF GROWTH MEDIA ON VEGETATIVE GROWTH AND NUTRIENT UPTAKE OF ORNAMENTAL PALM SEEDLINGS

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ABSTRACT

The efficiency of nursery production of ornamental palms is largely dependent on the quality of growth medium used during early establishment. This study evaluated the impact of different growth media on vegetative growth and nutrient uptake of ornamental palm seedlings under screenhouse conditions at the Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria. Six-month old golden palm seedlings were grown in three growth media: topsoil only (TS), topsoil + poultry manure (TSPM), and topsoil + sawdust (TSSD), arranged in a completely randomized design with six replications. Data on plant height, number of leaves, stem girth, and nutrient uptake were collected and subjected to Analysis of Variance (ANOVA) using SAS statistical software (2009) and treatment means separated by least significance difference at 5% probability level. Results showed that growth media significantly ($P \leq 0.05$) influenced all vegetative growth parameters and nutrient uptake. Seedlings grown in TSPM consistently recorded the highest plant height (45.63 cm), stem girth (4.57 cm), leaf number, and nutrient uptake. TSSD produced moderate growth responses while Topsoil alone resulted in the lowest growth performance and nutrient uptake. The findings conclude that organic-enriched media, particularly topsoil amended with poultry manure, significantly enhance vegetative growth and nutrient acquisition in ornamental palm seedlings. The use of topsoil + poultry manure is therefore recommended for sustainable and cost-effective nursery production of ornamental palms in the study area.

KEYWORDS: *Ornamental palm, growth, nutrient uptake, growth media*

INTRODUCTION

Ornamental palms constitute an important component of landscape horticulture due to their aesthetic value, structural form, and ecological contributions within urban and peri-urban environments (Francini *et al*., 2022). Their ability to enhance environmental quality through microclimate regulation, air purification, carbon sequestration, and erosion control has positioned them as priority species in modern landscape design and green-space restoration efforts (Akbari *et al*., 2001; Abdelnaby *et al*., 2021; Diwakaran and Shruthi, 2025). In Nigeria, demand for ornamental palms continues to rise in residential estates, recreational parks, corporate environments, and institutional landscapes, making efficient propagation and nursery production increasingly important for the horticultural industry (Diwakaran and Shruthi, 2025).

Despite their growing economic relevance, the vegetative growth and nutrient uptake efficiency of many ornamental palms remain suboptimal, largely due to inadequate growth substrates and inconsistent nursery management practices.

Growth media constitute the foundational element for seedling establishment, influencing aeration, water retention, nutrient availability, and root development (Rosenani *et al*., 2016). Organic-enriched media such as compost, poultry manure, and coco peat have been widely reported to enhance fertility status, improve soil structure, and support microbial activity, thereby promoting vigorous vegetative growth (Raza *et al*., 2024; Fawole *et al*., 2025). Conversely, media composed solely of topsoil often exhibit limitations such as compaction, poor drainage, or low nutrient reserves, which restrict nutrient uptake and overall palm performance.

Nutrient uptake is a critical determinant of palm vigour, especially for slow-growing species. Efficient absorption of macronutrients such as nitrogen, phosphorus, and potassium, and essential cations including calcium and magnesium, is central to leaf initiation, chlorophyll development, root expansion, and biomass accumulation (Rosenani *et al*., 2016). Several studies have established that growth media with high organic matter content improve cation exchange capacity, enhance nutrient mobility, and increase nutrient-use efficiency in ornamental species (Broschat, 2009; Belda *et al*., 2013). However, there remains limited adequate information on how specific growth media influence nutrient uptake patterns in ornamental palm species cultivated under Nigerian conditions.

Furthermore, the integration of growth media with appropriate nursery management practices has been identified as a sustainable strategy for overcoming the slow growth habit characteristic of many ornamental palms. Although research on palms has expanded globally, studies addressing the combined effects of growth substrates and physiological growth responses in tropical environments are still insufficient. This gap is particularly evident in Nigeria where locally available organic resources could serve as cost-effective media amendments for improving palm propagation and reducing reliance on imported planting materials.

Given the increasing demand for ornamental palms and the need to improve nursery efficiency, understanding the specific impacts of growth media on vegetative growth and nutrient uptake is essential for developing reliable production protocols. This study therefore investigates the influence of selected growth media on the vegetative growth performance and nutrient uptake capacity of ornamental palm grown under nursery conditions in Ogbomoso, Nigeria.

Materials and Methods

The experiment was conducted at the Screen-house of Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH). Ogbomoso lies between latitude 8°10′ N and longitude 4°10′ E with highest rainfall (212.30mm) in August and (141.10 mm) in October. The environment recorded its average relative humidity of 72%, average maximum temperature 34.6°C and average minimum temperature of 21.5°C (NIMET, 2023).

Six-month-old golden palm seedlings were sourced from Green Point Agro-Allied, Apata, Ibadan. Cured poultry manure was collected from the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State. Dry Sawdust was collected from Ogbomoso Central Saw-mill Factory, New Waso Market, Ogbomoso, Oyo State.

Composite soil samples were collected from the experimental site prior to planting, air-dried, and sieve through a 2-mm mesh. Particle size distribution was determined using the hydrometer method as described by Bouyoucos (1962). Soil pH was measured in a 1:1 soil-to-water suspension. Exchangeable cations (Ca^{2+}, Mg^{2+}, K^+, and Na^+) were extracted using 1 N ammonium acetate (NH_4OAc) at pH 7.0. Potassium (K^+) and sodium (Na^+) concentrations were determined using a flame photometer, while calcium (Ca^{2+}) and magnesium (Mg^{2+}) were analyzed using an atomic absorption spectrophotometer (PerkinElmer Model 403). Organic carbon was determined the Walkley–Black method, and available phosphorus (P) was determined using the Bray P-1 method as described by Bray and Kurtz (1945).

Topsoil (0–15 cm depth) was collected from the LAUTECH Teaching and Research Farm, Ogbomoso, Oyo State, using a spade. Polythene pots (20 × 25 cm) were perforated at the base to enhance drainage and aeration, then filled with 10 kg of the respective growth media. For mixtures involving soil and sawdust were combined at a 3:1 ratio (by weight). A total of 108 pots were used for this experiment. Cured poultry manure collected was also analyzed for nutrient composition.

Table 1: Composition of major nutrients in poultry manure used for the experiment

Fertilizers	Nutrient contents (%) N	P	K
Poultry manure	2.90	1.32	1.69

The treatment consisted of three growth media; Top soil only (TS), Top soil + Poultry Manure (TSPM), Top soil + Sawdust (TSSD). The experiment was arranged in a completely randomized design with six replications.

One healthy ornamental palm seedling was transplanted at a depth of 5cm per pot. Watering was carried out at establishment and every three days thereafter using watering can until rain sets in. Rouging was carried out at emergence of weeds that could hinder the growth and development of ornamental palms.

Data collection commenced 8 weeks after transplanting (8 WAT) and continue at eight-week interval for 32 weeks. Data collected include plant height (cm) using measuring tape, number of fully expanded leaves were manually counted, stem girth (cm/plant) using vernier caliper and the stem girth was calculated using πd, where d is the stem diameter.

Nutrient Uptake: Three healthy leaves were collected with the use of a clean and sharp knife from each plant within every pot, thereby ensuring a representative sample. The leaves were bulked by packing them into envelopes and subsequently oven-dried at 65°C until a constant weight was reached. Potassium, calcium, and magnesium content of the plant samples were determined with an automatic Atomic Absorption Spectrophotometer (Unicam Model 929 Unicam Cambridge, England). The total N and P concentrations of the leaves were determined using Kjeldahl and photometric method, respectively (Bremner, 1996; Murphy and Riley, 1962). Data collected were subjected to Analysis of Variance (ANOVA) using SAS statistical software (2009), and treatment means were compared using the least significant difference at 5% probability level.

Result and Discussion

Effect of Growth Media on Plant Height of Ornamental Palm Seedlings:

The effect of growth media on plant height of ornamental palm seedlings at different sampling periods is presented in Table 2. Growth media significantly influenced plant height throughout the sampling period. At 8 weeks after transplanting (8 WAT), seedlings grown in topsoil (27.64 cm) and topsoil + poultry manure (TSPM) (27.43 cm) produced comparable plant heights, seedlings grown in topsoil + sawdust (TSSD) (26.25 cm) recorded the least. At 16 WAT, plant height increased across all treatments, with the tallest plants observed in TSSD (30.75 cm), followed closely by topsoil (30.43 cm) and TSPM (30.33 cm). At 24 WAT, seedlings grown in topsoil recorded the highest height (35.29 cm), while TSPM and TSSD produced slightly lower values (33.57 cm and 33.41 cm respectively). However, at 32 WAT, TSPM produced the tallest plants (45.63 cm) followed by topsoil (44.23 cm), while TSSD recorded the least plant height (41.88 cm).

Effect of Growth Media on Number of Leaves of Ornamental Palm Seedlings:

The effect of growth media on the number of leaves of ornamental palm seedlings is presented in Table 3. The number of leaves per palm was significantly influenced by growth media. Number of leaves increased steadily with plant age across all growth media, indicating continuous vegetative development of the seedlings. At 8 WAT, number of leaves was similar across treatments. Topsoil produced the highest number of leaves (2.87), followed by TSSD and TSPM (2.80 and 2.73, respectively). At 16 WAT, TSSD recorded the highest number of leaves (5.07), followed by TSPM (4.93) and Topsoil (4.87). At 24 WAT, the highest number of leaves was recorded in topsoil (6.73), followed by TSSD (6.27) and TSPM (5.67). At 32 WAT, Topsoil and TSPM recorded the highest number of leaves (7.78 and 7.60, respectively), and TSSD (7.53) produced slightly lower values.

Effect of Growth Media on Stem Girth of Ornamental Palm Seedlings:

The effect of growth media on stem girth of ornamental palm seedlings is presented in Table 4. Growth media significantly influenced stem girth at all sampling periods. At 8 WAT, Topsoil produced the largest stem girth (1.85 cm) followed by TSPM (1.81 cm), while TSSD recorded the lowest value (1.57 cm). At 16 WAT, TSPM produced the largest stem girth (2.34 cm) followed by Topsoil (2.28 cm), while TSSD remained the lowest (2.07 cm). At 24 WAT, TSPM recorded largest stem girth (3.48 cm) compared with topsoil (2.76 cm) and TSSD (2.97 cm). This trend continued at 32 WAT, where TSPM produced the highest stem girth (4.57 cm) followed by TSSD (3.90 cm) and Topsoil (3.48 cm).

Effect of Growth Media on Nutrient Uptake of Ornamental Palm Seedlings:

The effect of growth media on nutrient uptake of ornamental palm seedlings is presented in Table 5. Significant differences were observed among treatments for all nutrients measured. The TSPM treatment recorded the highest nitrogen (2.82%), phosphorus (2.44%), potassium (2.22%), magnesium (0.55%), and calcium (0.22%). The TSSD treatment also improved nutrient uptake compared with topsoil, particularly for nitrogen (2.67%) and potassium (1.79%), although the values were generally lower than those observed in the poultry manure treatment. In contrast, topsoil alone recorded the lowest nutrient uptake values, particularly for phosphorus (0.58%) and potassium (0.71%).

The improved plant height observed in seedlings grown in topsoil amended with poultry manure may be attributed to the enhanced nutrient availability and improved soil physical properties associated with organic amendments. Poultry manure is known to increase soil organic matter, improve nutrient retention, and stimulate microbial activity, thereby enhancing plant growth. Similar results have been reported by Rasool *et al*. (2023) and Agbede (2025), who observed significant improvements in plant height and vegetative growth of crops grown in soils amended with poultry manure. Likewise, organic amendments improve seedling establishment and early growth of ornamental palms by enhancing soil fertility and moisture retention. The comparatively lower plant height observed in the sawdust-amended medium may be attributed to temporary nitrogen immobilization during decomposition of the sawdust material. According to Gannett et al. (2024), high carbon amendments such as sawdust stimulate microbial scavenging of soil nitrogen, making it temporarily unavailable for plant uptake and thereby suppressing growth until decomposition stabilises.

The increase in number of leaves with plant age reflects the progressive vegetative development of ornamental palm seedlings. Leaves are the primary photosynthetic organs of plants, and increased leaf number generally indicates improved growth and productivity. The relatively higher leaf production observed in topsoil may be associated with its balanced nutrient composition and favorable physical structure for root development. These findings are consistent with the work of Rasool *et al*. (2023) and Adeyemi and Akhiwu (2022), who reported that appropriate growth media and poultry manure significantly influence leaf development and canopy expansion in crops and ornamental plants. Although poultry manure improved plant height and stem girth in the present study, its effect on leaf number was not consistently superior to topsoil. This suggests that while organic amendments improve overall growth performance, the response of specific growth parameters may vary depending on nutrient balance and plant physiological requirements.

The superior stem girth observed in the poultry manure–amended medium suggests that organic nutrient sources significantly enhance structural development in ornamental palms. Poultry manure provides essential macro- and micronutrients that support cell division, tissue expansion, and overall plant vigor. Enhanced stem girth is particularly important for ornamental palms because it improves plant stability and aesthetic quality. The results align with findings by Adeyemi and Akhiwu (2022) and Agbede (2025), who reported that poultry manure significantly improves stem growth and structural development in horticultural crops by enhancing soil nutrient status and microbial activity.

The enhanced nutrient uptake observed in the poultry manure treatment can be attributed to the high nutrient content of poultry manure and its ability to improve soil physical and biological properties. Organic amendments increase soil organic matter, enhance cation exchange capacity, and stimulate microbial activity, all of which contribute to improved nutrient availability and plant uptake. These results corroborate the findings of Agbede (2025) and Rasool et al. (2023), who reported that poultry manure significantly increases nutrient uptake and nutrient use efficiency in crops. The relatively lower nutrient uptake observed in topsoil may be due to nutrient depletion commonly associated with tropical soils, which are often characterized by low organic matter content and limited nutrient reserves. This observation is consistent with the improved soil fertility and nutrient dynamics reported under poultry manure in tropical Alfisols (Agbede, 2025).

Conclusion

The study demonstrated that growth media significantly influenced the vegetative growth, and nutrient uptake of ornamental palm. Topsoil + Poultry Manure consistently promoted superior plant height, leaf number, stem girth, and nutrient accumulation across all sampling periods, highlighting the critical role of nutrient-rich organic amendments in enhancing palm growth. Topsoil + Sawdust improved structural parameters moderately, likely due to enhanced soil aeration and moisture retention, but nutrient limitations constrained its overall performance. Topsoil alone resulted in the lowest growth and nutrient uptake, indicating that inorganic soil alone is insufficient for optimal ornamental palm development.

For optimal growth and sustainable production of ornamental palms in the study area, Topsoil + Poultry Manure is recommended as the preferred growth medium. Incorporation of poultry manure enhances vegetative vigor, leaf proliferation, structural stability, and nutrient acquisition.

Table 1: Chemical and physical properties of the top soil used for the experimental site

Soil characteristics	Values
Physical characteristics	
Sand (%)	82.95
Silt (%)	12.30
Clay (%)	4.75
Textural Class	Sandy loam
Chemical characteristics	
PH (H_2O)	6.27
Total N (%)	0.37
Available P (mg/kg)	6.38
Organic carbon	2.57

Exchangeable cations (C mol/kg)	
Ca^{2+}	2.11
Mg^{2+}	0.74
K^{+}	0.34
Na^{+}	0.25

Table 2: Effect of growth media on plant height of ornamental palm seedlings at different sampling periods

	Plant Height (cm)			
	Weeks after transplanting			
Treatment	8	16	24	32
TOPSOIL	27.64	30.43	35.29	44.23
TSPM	27.43	30.33	33.57	45.63
TSSD	26.25	30.75	33.41	41.88
LSD (0.05)	1.96	2.81	2.94	3.42

TSPM = Topsoil + Poultry manure, TSSD = Topsoil + Sawdust.
LSD (0.05) = LSD at a 5% probability level

Table 3: Effect of growth media on number of leaves of ornamental palm seedlings at different sampling periods

	Number of leaves			
	Weeks after transplanting			
Treatment	8	16	24	32
TOPSOIL	2.87	4.87	6.73	7.78
TSPM	2.73	4.93	5.67	7.60
TSSD	2.80	5.07	6.27	7.53
LSD (0.05)	0.47	0.67	0.83	1.36

TSPM = Topsoil + Poultry manure, TSSD = Topsoil + Sawdust.
LSD (0.05) = LSD at a 5% probability level

Table 4: Effect of growth media on stem girth (cm) of ornamental palm seedlings at different sampling periods

	Stem Girth (cm)			
	Weeks after transplanting			
Treatment	8	16	24	32
TOPSOIL	1.85	2.28	2.76	3.48
TSPM	1.81	2.34	3.48	4.57
TSSD	1.57	2.07	2.97	3.90
LSD (0.05)	0.28	0.29	0.50	0.63

TSPM = Topsoil + Poultry manure, TSSD = Topsoil + Sawdust.
LSD (0.05) = LSD at a 5% probability level

Table 5: Effect of growth media on nutrient uptake of ornamental palm of

	Nutrient Uptake				
Treatment	N	P	K	Mg	Ca
TOPSOIL	1.78	0.58	0.71	0.35	0.08
TSPM	2.82	2.44	2.22	0.55	0.22
TSSD	2.67	1.17	1.79	0.53	0.15
LSD (0.05)	0.008	0.23	0.51	0.113	0.004

TSPM = Topsoil + Poultry manure, TSSD = Topsoil + Sawdust.
LSD (0.05) = LSD at a 5% probability level

References

Abdelnaby, A. S. I., Meawad, A. A., Gendy, A. S. H., and Abdelkader, M. A. I. (2021). Landscape use and aesthetical value of surveyed woody ornamental plants in Cairo Festival City – Cairo – Egypt in landscape gardening. *Plant Archives*, 21(1).

Adewole, S. O., Olayemi, F. O., and Oladipo, F. O. (2018). Influence of organic and inorganic media on growth and nutrient assimilation in ornamental palms. *International Journal of Horticulture and Food Science*, 6(2), 12–21.

Adeyemi, O., and Akhiwu, B. (2022). Effects of poultry manure on the growth of Lisbon lemon (*Citrus limon*; var. Lisbon). *Scientific Journal of Biology and Life Sciences, 2*(3), Article SJBLS.MS.ID.000540. https://doi.org/10.33552/SJBLS.2022.02.000540

Agbede, T. M. (2025). Poultry manure improves soil properties and grain mineral composition, maize productivity and economic profitability. *Scientific Reports, 15*(1), Article 16501. https://doi.org/10.1038/s41598-025-00394-8

Akbari, H., Pomerantz, M., and Taha, H. (2001). Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. *Solar Energy, 70*(3), 295–310. https://doi.org/10.1016/S0038-092X(00)00089-X

Belda, R. M., Mendoza-Hernández, D., and Fornes, F. (2013). Nutrient-rich compost versus nutrient-poor vermicompost as growth media for ornamental-plant production. Journal of Plant Nutrition and Soil Science, 176(6), 827–835.

Bouyoucos, G. J. (1962). Hydrometer method improved for making particle size analyses of soils. *Agronomy Journal, 54*(5), 464–465.

Bray, R. H., and Kurtz, L. T. (1945). Determination of total, organic, and available forms of phosphorus in soils. *Soil Science, 59*(1), 39–46.

Bremner, J. M. (1996). Nitrogen—Total. In D. L. Sparks (Ed.), Methods of Soil Analysis, Part 3: Chemical Methods (pp. 1085–1122). Madison, WI: Soil Science Society of America. https://doi.org/10.2136/sssabookser5.3.c37

Broschat, T. K. (2009). Palm nutrition and fertilization. *HortTechnology*, 19(4), 690–694.

Diwakaran, M., and Shruthi, P. (2025). Ornamental palms: A role in sustainable urban landscaping. *GreenariA*, 3(10), 6–8.

Fawole, T. O., Omilabu, S. K., Bidmos, F. A., Godspower, O. O., Awodutire, O. O., and Onarinde, C. R. (2025). Effect of organic manure-enriched growth media on germination and early growth of cocoa (*Theobroma cacao* L.) seedlings in Igboora, Nigeria. International Journal of Agriculture and Agricultural Technology, 9(1). https://doi.org/10.70382/caijaat.v9i1.007

Francini, A., Romano, D., Toscano, S., and Ferrante, A. (2022). The contribution of ornamental plants to urban ecosystem services. *Earth, 3*(4), 1258–1274. https://doi.org/10.3390/earth3040071

Gannett, M., DiTommaso, A., Sparks, J. P., and Kao-Kniffin, J. (2024). Microbial nitrogen immobilization as a tool to manage weeds in agroecosystems. *Agriculture, Ecosystems and Environment, 366*, 108904. https://doi.org/10.1016/j.agee.2024.108904

Murphy, J., and Riley, J. P. (1962). A modified single solution method for the determination of phosphate in natural waters. *Analytica Chimica Acta, 27*, 31–36.

Nigerian Meteorological Agency (NIMET). (2023). Climatic data summary for Ogbomoso, Oyo State (rainfall, temperature, and humidity records). Official NIMET report/data portal.

Rasool, A., Ghani, A., Nawaz, R., Ahmad, S., Shahzad, K., Rebi, A., Ali, B., Zhou, J., Ahmad, M. I., Tahir, M. F., Alwahibi, M. S., and Elshikh, M. S. (2023). Effects of poultry manure on the growth, physiology, yield, and yield-related traits of maize varieties. *ACS Omega, 8*(29), 25766–25779. https://doi.org/10.1021/acsomega.3c00880

Raza, S. T., Feyissa, A., Li, R., Rene, E. R., Ali, Z., Sahito, Z. A., Chen, Z. (2024). Emerging technology effects on combined agricultural and eco-vermicompost. *Journal of Environmental Management* (ScienceDirect). https://doi.org/10.1016/j.jenvman.2024.

Rosenani, A. B., Rovica, R., Cheah, P. M., and Lim, C. T. (2016). Growth performance and nutrient uptake of oil palm seedling in prenursery stage as influenced by oil palm waste compost in growing media. *International Journal of Agronomy*, 2016, Article ID 6930735. https://doi.org/10.1155/2016/6930735

SAS Institute Inc. (2009). *SAS/STAT® 9.2 user's guide*. SAS Institute Inc., Cary, NC.

Unicam Instruments Ltd. (1990). Unicam 929 Atomic Absorption Spectrophotometer Instruction Manual. Cambridge, UK: Unicam Instruments Ltd.

Walkley, A., and Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science*, 37(1), 29–38.