



Rooting Ability of *Irvingia wombolu* Juvenile Stem Cuttings under Different Growth Regulators in a Mist Propagation System

O.F. OYEDEJI, G.A. ADEBUSUYI, M.O. NOLA,
O.A. IROKO, M.O. MAJOLAGBE, N.B. OBEKPA
Forestry Research Institute of Nigeria, Jericho Forest Hill, Ibadan, Nigeria.

Abstract. The domestication and large-scale propagation of *Irvingia wombolu* are constrained by poor natural regeneration and seed recalcitrance, making vegetative propagation a viable alternative for its conservation and cultivation. This study evaluated the rooting ability of juvenile stem cuttings treated with different plant growth regulators under a mist propagation system at the Tree Physiology Nursery, SFM Department, Forestry Research Institute of Nigeria (FRIN), Ibadan. A total of 150 juvenile double-node stem cuttings obtained from six-month-old seedlings were treated with IBA, NAA and GA at concentrations of 200, 250, and 300 ppm using the quick-dip method. Treated cuttings were planted in sterilized river sand and arranged in a Completely Randomized Design with three replicates and a control. Survival, rooting, callus formation, and mortality were assessed after three months and analyzed using descriptive statistics and ANOVA. Significant variation was observed among hormone treatments. NAA at 200 and 250 ppm recorded the highest survival (91.67%), while GA treatments and the control showed the lowest survival (66.67%). Overall, NAA achieved the highest mean survival (86.11%), whereas IBA produced the greatest rooting percentage (50.11%), outperforming NAA (19.44%), GA (27.78%), and the control (22.22%). NAA also induced the highest callus formation (50.00%), while GA resulted in the greatest mortality (30.56%). The findings indicate that although NAA enhances cutting survival, IBA is more effective for adventitious root induction, particularly at 200–250 ppm. The study recommends IBA as the preferred growth regulator for the vegetative propagation of *I. wombolu* to support domestication, conservation, and sustainable plantation establishment.

Keywords: *Irvingia wombolu*, juvenile stem cuttings, rooting hormones, Indole-3-butyric acid, naphthalene acetic acid, mist propagator, vegetative propagation

1. Introduction

The domestication and sustainable propagation of indigenous tropical tree species have become central to global efforts aimed at improving biodiversity conservation, climate resilience, food security, and rural livelihoods. Indigenous fruit trees contribute substantially to ecosystem functioning by enhancing carbon sequestration, improving soil fertility, conserving genetic resources, and supporting sustainable agroforestry systems. Beyond their ecological significance, these species provide fruits, nuts, medicines, fuelwood, and other non-timber forest products that serve as important sources of nutrition and income for millions of rural households across sub-Saharan Africa (Jamnadass *et al.*, 2022; Dawson *et al.*, 2023). Consequently, the promotion of priority indigenous tree species has become an important strategy for achieving several Sustainable Development Goals, particularly those related to poverty alleviation, food security, biodiversity conservation, and climate adaptation (FAO, 2022; CIFOR-ICRAF, 2023).

Among these indigenous tree species, *Irvingia wombolu* (Vermoesen), commonly known as bitter bush mango, is one of the most economically valuable fruit trees indigenous to the humid forests of West and Central Africa. Together with its closely related species *Irvingia gabonensis*, it belongs to the family Irvingiaceae and is widely recognized for producing edible kernels that command high commercial value throughout the region (Leakey, 2022). The kernels are extensively used as soup-thickening agents because of their unique mucilaginous properties and high oil content, while different parts of the plant have long been utilized in traditional medicine for the treatment of gastrointestinal disorders, fever, diabetes, and inflammatory conditions (Atangana *et al.*, 2015; Leakey *et al.*, 2022). In addition, the species contributes significantly to household income through domestic markets and regional trade, making it an important livelihood resource for forest-dependent communities (Jamnadass *et al.*, 2022).

Despite its enormous socioeconomic importance, the cultivation of *I. wombolu* remains largely dependent on harvesting naturally occurring trees rather than plantation establishment. One of the major constraints to domestication is the difficulty associated with conventional seed propagation. The species produces recalcitrant seeds that rapidly lose viability after dispersal, making long-term storage practically impossible. Furthermore, seed-derived plants exhibit considerable genetic variation because of cross-pollination, resulting in inconsistent growth performance, fruit quality, and kernel yield among progenies (Sacandé & Sanon, 2007; Kettle, 2012). These limitations hinder the rapid multiplication of superior genotypes and reduce opportunities for genetic improvement and commercial orchard development.

Vegetative propagation has therefore emerged as an effective strategy for overcoming these constraints. Clonal propagation through stem cuttings enables the rapid multiplication of genetically superior trees while preserving desirable parental characteristics such as high fruit yield, kernel quality, disease resistance, and adaptation to local environmental conditions (Hartmann *et al.*, 2022). Compared with seed propagation, vegetative techniques shorten the juvenile phase, promote uniform plantation establishment, facilitate conservation of elite germplasm, and accelerate domestication programmes for indigenous fruit trees (Leakey, 2022; Jamnadass *et al.*, 2022).

Successful rooting of stem cuttings, however, depends on a complex interaction between endogenous physiological factors and external environmental conditions. Important determinants include the physiological age of donor plants, cutting type, seasonal timing, carbohydrate reserves, rooting substrate, temperature, humidity, light intensity, and the application of exogenous plant growth regulators (Druege *et al.*, 2019; Hartmann *et al.*, 2022 and Adebuseyi, *et al.*, 2024). Among these factors, auxin application remains one of the most effective approaches for enhancing adventitious root formation in woody plant species.

Auxins such as Indole-3-Butyric Acid (IBA) and Naphthalene Acetic Acid (NAA) have consistently demonstrated superior performance in stimulating root initiation through the activation of cell division, vascular differentiation, and root primordia development. These hormones also enhance carbohydrate mobilization and regulate the expression of genes involved in adventitious root formation, thereby increasing rooting percentage, root number, and root quality in difficult-to-root species (Pacurar *et al.*, 2014; Druege *et al.*, 2019; Bellini *et al.*, 2024). Among synthetic auxins, IBA is generally regarded as the most effective rooting hormone because of its relatively low phytotoxicity, slow degradation within plant tissues, and

sustained physiological activity during root initiation (Hartmann *et al.*, 2022).

Conversely, Gibberellic Acid (GA₃) performs physiological functions that differ substantially from those of auxins. GA₃ primarily promotes stem elongation, internode expansion, and shoot development through enhanced cell elongation and division. Although gibberellins may improve overall vegetative growth after rooting has occurred, their influence on adventitious root initiation remains inconsistent across plant species. Several studies have reported inhibitory effects of excessive GA₃ concentrations on root initiation due to antagonistic interactions with endogenous auxin signalling pathways, whereas moderate concentrations have occasionally promoted rooting depending on species-specific physiological responses (Colebrook *et al.*, 2014; Druege *et al.*, 2019).

Numerous studies involving tropical hardwoods and indigenous fruit trees have demonstrated the effectiveness of auxin-based treatments in improving rooting success. Species such as *Dacryodes edulis*, *Garcinia kola*, *Allanblackia floribunda*, *Vitellaria paradoxa*, and *Irvingia gabonensis* have shown significant improvements in rooting percentage, root length, callus formation, and cutting survival following treatment with IBA and NAA under controlled propagation environments (Leakey, 2022; Jamnadass *et al.*, 2022; Asaah *et al.*, 2023). Nevertheless, relatively little information exists regarding the comparative performance of IBA, NAA, and GA₃ on juvenile stem cuttings of *Irvingia wombolu*. Available studies have largely focused on seed germination, domestication, or agroforestry utilization, while systematic investigations into hormone concentration effects on rooting physiology remain scarce.

The absence of standardized propagation protocols limits the large-scale production of true-to-type planting materials needed for plantation establishment, conservation programmes, breeding initiatives, and commercialization of the species. Developing reliable clonal propagation methods would facilitate the rapid multiplication of elite genotypes, reduce dependence on wild populations, enhance genetic conservation, and strengthen domestication efforts aimed at increasing sustainable production of bitter bush mango throughout West and Central Africa (Leakey *et al.*, 2022; Dawson *et al.*, 2023).

Therefore, this study evaluated the rooting ability of juvenile stem cuttings of *Irvingia wombolu* treated with different plant growth regulators under mist propagation conditions. Specifically, the study assessed the effects of varying hormone concentrations on cutting survival, compared the effectiveness of auxins and gibberellins, and determined their influence on rooting percentage, callus formation, and mortality. The findings are expected to contribute towards the development of

efficient vegetative propagation protocols that will support large-scale domestication, conservation, and sustainable utilization of this economically important indigenous fruit tree.

2. Materials and Methods

2.1 Study Area

The experiment was conducted at the Tree Physiology Nursery, Department of Sustainable Forest Management (SFM), Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria. Forestry Research Institute of Nigeria is located between 07°23'18"N to 07°23'43"N longitude and 03°51'20"E to 03°51'43"E latitude. The climate of the area is the West African monsoon with distinct dry and wet seasons. The dry season usually starts from November and runs through March and is generally characterized by dry wind of harmattan. The wet season on the other hand, generally runs through April to October with strong winds and thunderstorms occasionally. Mean annual rainfall falls around 1548.9 mm approximately, within 90 days. The temperature ranges from 31.9°C maximum to 24.2°C minimum, while the relative humidity is about 71.9% daily (FRIN, 2015). The propagation trial was established under a mist propagation system designed to maintain adequate humidity and minimize moisture loss from juvenile stem cuttings.

2.2 Collection and Preparation of Stem Cuttings

One hundred and fifty juvenile double-node stem cuttings of *Irvingia wombolu* were collected from six-month-old seedlings. Juvenile stem materials were selected to enhance rooting potential because juvenile tissues generally exhibit higher physiological responsiveness to root induction than mature tissues.

2.3 Hormonal Treatments and Experimental Design

The cuttings were subjected to three growth regulators: Indole-3-Butyric Acid (IBA), Naphthalene Acetic Acid (NAA), and Gibberellic Acid (GA), each prepared at 200 ppm, 250 ppm, and 300 ppm concentrations. Hormonal application was performed using the quick-dip technique before planting.

Treated cuttings were directly sown into trays containing washed and sterilized river sand as rooting medium. A control treatment without hormone application was included. Five cuttings were assigned to each treatment and replicated three times, resulting in a total of 150 cuttings. The experiment was arranged in a Completely Randomized Design (CRD) under a mist propagator.

2.4 Data Collection and Statistical Analysis

The cuttings were watered daily and monitored for survival. After three months, observations were recorded on percentage survival, rooted cuttings, callus formation, dead cuttings, and surviving cuttings without rooting or callusing. Data obtained were analyzed using descriptive statistics expressed as percentages and inference were made with the use of ANOVA. Significant means were separated with LSD.

3. Results

Survival Response of *Irvingia wombolu* Cuttings among Hormonal Concentrations

Survival percentage varied considerably among hormone concentrations (Table 1). The highest survival (91.67%) was recorded in both 200 ppm and 250 ppm NAA treatments, indicating superior effectiveness in maintaining cutting viability. Treatments involving 200 ppm IBA and 300 ppm IBA also supported relatively high survival (83.33%). However, increasing GA concentration reduced survival, with 250 ppm and 300 ppm GA treatments recording the lowest survival percentages (66.67%), similar to the control treatment.

Table 1a. Percentage survival of *Irvingia wombolu* cuttings among treatments

Treatment	200 ppm NAA	250 ppm NAA	300 ppm NAA	200 ppm IBA	250 ppm IBA	300 ppm IBA	200 ppm GA	250 ppm GA	300 ppm GA	Control
Percentage survival (%)	91.67 ^a	91.67 ^a	75.00 ^c	83.33 ^b	75.00 ^c	83.33 ^b	75.00 ^c	66.67 ^d	66.67 ^d	66.67 ^d

NB: Means with same alphabets along the row are not significantly different from each other.

Survival Performance among Hormone Types

When grouped according to hormone category, NAA recorded the highest overall survival (86.11%), followed by IBA (80.56%), whereas GA produced comparatively lower survival (69.44%) (Table 1b). The control treatment exhibited the lowest performance (66.67%).

Table 1b: Percentage survival of *Irvingia wombolu* cuttings among hormones

Hormone	Percentage survival (%)
NAA	86.11 ^a
IBA	80.56 ^b
GA	69.44 ^c
Control	66.67 ^d

NB: Means with same alphabets along the columns are not significantly different from each other.

Rooting, Callus Formation, and Mortality

Hormonal treatments exerted marked effects on rooting and callus formation (Table 2). IBA recorded the highest rooting percentage (50.11%), indicating superior capacity for adventitious root initiation. In contrast, NAA exhibited relatively low rooting (19.44%) but promoted the highest callus formation (50.00%), suggesting that tissue differentiation did not necessarily translate into root development.

GA exhibited moderate rooting performance (27.78%) but recorded relatively high mortality (30.56%), indicating poor suitability for rooting induction in *I. wombolu* juvenile stem cuttings. The control treatment showed the highest mortality (54.45%), emphasizing the importance of hormone application for successful propagation.

Table 2: Percentage rooted, callused, dead, and surviving cuttings of *Irvingia wombolu*

Hormone	% Rooted	% Callused	% Dead	% Alive (no root, no callus)
NAA	19.44 ^a	50.00 ^a	13.89 ^c	16.67 ^a
IBA	50.11 ^b	33.33 ^b	13.89 ^c	2.78 ^c
GA	27.78 ^c	33.33 ^b	30.56 ^b	8.33 ^b
Control	22.22 ^d	23.33 ^c	54.45 ^a	—

NB: Means with same alphabets along the columns are not significantly different from each other.

4. Discussion

The significant variation in survival, rooting, callus formation, and mortality observed among hormone treatments indicates differential physiological responses of *Irvingia wombolu* juvenile stem cuttings to exogenous growth regulators. The superior survival recorded in NAA-treated cuttings, particularly at 200 ppm and 250 ppm (91.67%), suggests that NAA enhanced tissue viability and reduced transplant stress under mist propagation conditions. Auxins such as NAA are known to stimulate cell dedifferentiation, vascular tissue regeneration, and wound healing, thereby enhancing post-excision survival in stem cuttings (Hartmann *et al.*, 2018). The present result agrees with findings by Tchoundjeu *et al.* (2002), who reported improved cutting survival in *Prunus africana* under moderate auxin concentrations, suggesting that exogenous auxin enhances physiological adaptation during the rooting process. Similarly, Ofori *et al.* (1996) observed improved establishment success in *Milicia excelsa* leafy stem cuttings following auxin treatment, emphasizing the importance of hormonal supplementation in difficult-to-root tropical woody species.

Although NAA promoted the highest survival percentage, it did not correspondingly induce superior rooting, as rooting under NAA remained comparatively low (19.44%) despite substantial callus formation (50.00%). This observation suggests that in *I. wombolu*, NAA may preferentially stimulate wound healing and callogenesis rather than direct root organogenesis. Similar findings were reported in

vegetative propagation studies of *Irvingia gabonensis*, where high auxin concentrations induced basal swelling and callus development without proportional increases in adventitious rooting (Anegebeh *et al.*, 2006). Excessive callus formation has been reported to interfere with vascular reconnection and root primordia emergence, particularly in woody perennial species where rooting competence is physiologically constrained (Leakey, 2012; Oyededeji and Oyededeji 2024).

Therefore, while callus formation may indicate tissue responsiveness, it does not necessarily predict successful root development.

In contrast, IBA-treated cuttings exhibited superior rooting performance (50.11%), confirming the greater effectiveness of IBA in stimulating adventitious root formation in juvenile stem cuttings of *I. wombolu*. This finding aligns with numerous studies on tropical tree species where IBA consistently outperformed other auxins in rooting induction. For instance, Tchoundjeu *et al.* (2002) reported enhanced rooting of *Prunus africana* cuttings treated with IBA, while Mesen *et al.* (1997) demonstrated increased rooting success in tropical hardwoods under moderate IBA concentrations. Similar results have been documented in *Dacryodes edulis*, *Garcinia kola*, and *Irvingia gabonensis*, where IBA significantly improved root initiation and cutting establishment (Leakey *et al.*, 1990; Anegebeh *et al.*, 2006). The superior performance of IBA may be attributed to its relatively greater chemical stability, slower degradation rate, and stronger ability to stimulate

cambial cell division and root primordial differentiation compared with NAA (Hartmann *et al.*, 2018).

Interestingly, the relatively high rooting percentage observed under IBA despite slightly lower survival than NAA demonstrates that survival alone is insufficient for evaluating propagation success. Successful vegetative propagation depends primarily on the capacity of cuttings to produce functional adventitious roots capable of supporting water and nutrient uptake after transplanting. The lower proportion of surviving but non-rooted cuttings under IBA (2.78%) compared with NAA (16.67%) further reinforces the greater rooting efficiency of IBA for *I. wombolu*. This observation corroborates previous assertions that IBA is particularly effective for woody species with rooting recalcitrance because it promotes direct root organogenesis rather than excessive callusing (Leakey, 2012).

The comparatively poor performance of GA-treated cuttings, characterized by lower survival (69.44%), moderate rooting (27.78%), and relatively high mortality (30.56%), suggests that gibberellic acid may not be suitable for rooting induction in juvenile stem cuttings of *I. wombolu*. Gibberellins are primarily associated with stem elongation, cell expansion, and shoot growth rather than adventitious root induction (Taiz *et al.*, 2015). Consequently, exogenous GA application may have altered endogenous hormonal balance in favor of shoot-related physiological processes at the expense of root development. Similar inhibitory effects of gibberellins on rooting have been reported in several woody species, where elevated GA concentrations reduced rooting competence through antagonistic interactions with auxin-mediated root initiation pathways (Hartmann *et al.*, 2018). The decline in survival observed at higher GA concentrations (250–300 ppm) further suggests possible phytotoxicity or hormonal imbalance under mist propagation conditions.

The concentration-dependent response observed among treatments highlights the importance of optimizing hormone dosage for rooting success. The superior performance of 200 ppm and 250 ppm NAA compared with 300 ppm suggests that moderate concentrations are more beneficial for tissue survival and physiological responsiveness than excessive hormone application. Similar concentration-dependent effects have been reported in tropical woody species where moderate auxin levels improved rooting, whereas excessive concentrations inhibited root initiation or induced tissue necrosis (Mesen *et al.*, 1997; Tchoundjeu *et al.*, 2002 and Amadi, *et al.*, 2022). The relatively consistent survival observed across IBA concentrations further indicates that *I. wombolu* juvenile stem cuttings respond favorably to moderate auxin-mediated stimulation.

The high mortality observed in untreated cuttings (54.45%) demonstrates the importance of exogenous growth regulator application in overcoming rooting recalcitrance in *I. wombolu*. Tropical woody species

often possess inadequate endogenous auxin levels to stimulate sufficient adventitious root formation after severance from the mother plant (Alaje, *et al.*, 2019 and Leakey *et al.*, 1990). The inability of the control treatment to sustain rooting and survival therefore supports the necessity for hormonal intervention in clonal propagation of elite genotypes.

Overall, the findings suggest that juvenile stem cuttings of *I. wombolu* are responsive to auxin treatment under mist propagation systems, with IBA demonstrating greater rooting potential and NAA enhancing survival and callus formation. The integration of high rooting efficiency and moderate survival makes IBA particularly suitable for large-scale vegetative propagation, domestication, and conservation of superior *Irvingia wombolu* genotypes.

5. Conclusion

This study demonstrated that growth regulators significantly influence the rooting ability and survival performance of juvenile stem cuttings of *Irvingia wombolu* under mist propagation conditions. Naphthalene Acetic Acid (NAA) enhanced cutting survival, particularly at 200 ppm and 250 ppm concentrations, indicating its effectiveness in maintaining tissue viability and promoting callus formation. However, Indole-3-Butyric Acid (IBA) proved superior for adventitious root induction, recording the highest rooting percentage and thus exhibiting greater potential for clonal propagation of the species. Gibberellic Acid (GA) showed comparatively poor rooting performance and elevated mortality, suggesting limited suitability for vegetative propagation of *I. wombolu*. The poor performance of untreated cuttings further underscores the necessity of exogenous hormone application for successful rooting and establishment.

The findings suggest that IBA, particularly at moderate concentrations, offers the greatest potential for rapid multiplication and domestication of elite *I. wombolu* genotypes. The study contributes valuable baseline information for the development of efficient propagation protocols aimed at supporting conservation, plantation establishment, and sustainable utilization of this economically important indigenous fruit tree species.

References

- Adebusuyi, G.A.*, Oyediji, O.F., Amadi, J.O., Alaje V.I., Nola M.O and Dunmade, Y. A. (2024): Sprouting and Rooting Potentials of *Irvingia wombolu* Vermoesen Cuttings in Plant Growth Regulators. *Journal of Sustainable Environmental Management*. Vol. 16, 104-112, 2024. ISSN: 2141-0267 www.awife.org.ng/publications/jsem.html
- Alaje, V. I., Amadi, J. O., Alaje, M. A. and Oyediji, O. F. (2019): Hormonal Concentration Influence

- on Vegetative Propagation of Sweet Wild Mango (*Irvingia gabonensis*). *Journal of Forestry, Environment and Sustainable Development* (JOFESD). Volume 5 (2), Pp 64 – 74. ISSN No:- 2449-1845. www.uniuyo.edu.ng
- Amadi, J. O., Alaje, V. I., Oyediji, O. F., Appah, O. R. and Ogunwande, O. A. (2022): Effect of Growth Hormones and Potting Media on Rooting Potentials of African Black Pepper (*Piper guineense*). *Journal of Forestry, Environment and Sustainable Development* (JOFESD), 8(1): 52 – 61. <https://www.eruditescholars.net> ISSN No:- 2449-1845. www.uniuyo.edu.ng
- Anegbeh, P. O., Tchoundjeu, Z., Fondoun, J. M., & Leakey, R. R. B. (2006). Vegetative propagation of *Irvingia gabonensis* and related indigenous fruit trees in West Africa. *Agroforestry Systems*, 67, 143–151.
- Anegbeh, P. O., Tchoundjeu, Z., Fondoun, J. M., Umoh, V., & Leakey, R. R. B. (2003). Domestication of *Irvingia gabonensis*: I. Phenotypic variation in fruits and kernels in Nigeria. *Agroforestry Systems*, 58, 213–218.
- Asaah, E. K., Tchoundjeu, Z., Jamnadass, R., & Leakey, R. R. B. (2023). Vegetative propagation and domestication of indigenous fruit trees in tropical Africa: Recent advances and future prospects. *Trees, Forests and People*, 13, 100420.
- Atangana, A. R., Tchoundjeu, Z., Asaah, E., Simons, A. J., & Khasa, D. P. (2015). *Tropical agroforestry tree domestication and biodiversity conservation*. Springer.
- Bellini, C., Druege, U., & Pacurar, D. I. (2024). Adventitious root formation in plants: New molecular insights and horticultural applications. *Plant Physiology*, 194(1), 25–43.
- CIFOR-ICRAF. (2023). *Transforming food systems through agroforestry*. CIFOR-ICRAF.
- Colebrook, E. H., Thomas, S. G., Phillips, A. L., & Hedden, P. (2014). The role of gibberellin signalling in plant responses to abiotic stress. *Journal of Experimental Botany*, 65(18), 5185–5200.
- Dawson, I. K., Powell, W., Hendre, P., et al. (2023). Diversifying food systems through indigenous and underutilized tree species. *New Phytologist*, 239, 1154–1172.
- Druege, U., Hilo, A., Pérez-Pérez, J. M., et al. (2019). Molecular and physiological control of adventitious rooting in cuttings. *Annals of Botany*, 123, 929–949.
- FAO. (2022). *The State of the World's Forests 2022*. Food and Agriculture Organization of the United Nations.
- FRIN. (2015). Forestry Research Institute of Nigeria, Annual Meteorological Report. <https://en.climate-data.org/location/529/>
- Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2018). *Hartmann and Kester's plant propagation: Principles and practices* (9th ed.). Pearson Education.
- Hartmann, H. T., Kester, D. E., Davies, F. T., Jr., Geneve, R. L., & Wilson, S. B. (2022). *Hartmann and Kester's Plant Propagation: Principles and Practices* (10th ed.). Pearson.
- Jamnadass, R., Dawson, I. K., Franzel, S., Leakey, R. R. B., Mithöfer, D., Akinnifesi, F. K., & Tchoundjeu, Z. (2022). Improving livelihoods and resilience through the domestication of indigenous fruit trees in sub-Saharan Africa. *Trees, Forests and People*, 8, 100258.
- Kettle, C. J. (2012). Seeding ecological restoration of tropical forests: Priority setting under REDD+. *Biotropica*, 44(5), 570–572.
- Leakey, R. R. B. (2012). *Living with the trees of life: Towards the transformation of tropical agriculture*. CABI.
- Leakey, R. R. B. (2022). *Living with the Trees of Life: Towards the Transformation of Tropical Agriculture*. CABI.
- Leakey, R. R. B., Asaah, E., Tchoundjeu, Z., & Jamnadass, R. (2022). Indigenous fruit trees and the future of tropical agroforestry. *Trees, Forests and People*, 7, 100194.
- Leakey, R. R. B., Mesén, F., Tchoundjeu, Z., Longman, K. A., Dick, J. M., Newton, A., Matin, A., Grace, J., Munro, R. C., & Muthoka, P. N. (1990). Low-technology techniques for the vegetative propagation of tropical trees. *Commonwealth Forestry Review*, 69(3), 247–257.
- Mesen, J. F., Leakey, R. R. B., & Newton, A. C. (1997). The effects of IBA concentration, leaf area and propagation medium on the rooting of tropical hardwood cuttings. *Forest Ecology and Management*, 92, 45–55.
- Oyediji, A.A. and Oyediji, O.F. (2024): Nodal Influence on *Nauclea diderrichii* (De Wildl and T. Durand) Merrill Juvenile Stem Cutting. *Scientia Africana*, Vol. 23 (No. 1), Pp 165-172. <https://dx.doi.org/10.4314/sa.v23i1.14> www.scientia-african.uniportjournal.info
- Pacurar, D. I., Perrone, I., & Bellini, C. (2014). Auxin is a central player in the hormone cross-talks that control adventitious rooting. *Physiologia Plantarum*, 151(1), 83–96.
- Sacandé, M., & Sanon, M. (2007). *Irvingia gabonensis* and *Irvingia wombolu*. Seed Leaflet No. 115. Forest & Landscape Denmark.
- Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant Physiology and Development* (6th ed.). Sinauer Associates.
- Tchoundjeu, Z., Avana, M. L., Leakey, R. R. B., Simons, A. J., Assah, E., Duguma, B., & Bell, J. M. (2002). Vegetative propagation of *Prunus africana*: Effects of rooting medium, auxin concentrations and leaf area. *Agroforestry Systems*, 54, 183–192.