FUDMA Journal of Agriculture and Agricultural Technology
ISSN: 2504-9496
Vol. 10 No. 2, June 2024: Pp.21-27

https://doi.org/10.33003/jaat.2024.1002.04

EFFECT OF LEAF EXTRACT POWDER FROM NITROGEN FIXING TREE SPECIES ON SEEDLING GROWTH OF *Tamarindus indica* Linnaeus

[1]Ogunbela, A. A., [1]Adesanmi, V. S., [1]Lawal, A. I., [1]Abdazeez. A. O., [1]Apenah, M.O., [1]Elumalero, G. O., [1]Agboola, J. O., [1]Ayanwusi, W. T. [2, 3, 5]*Salami, K. D., [2]Abdullahi, B. A. and Adeniyi, K. A [3, 4]
[1]Forestry Research Institute of Nigeria P.M.B. 5054, Jericho, Ibadan, Oyo State.
[2]Department of Forestry and Wildlife, Federal University Dutse, Jigawa state
[3]Center for Arid Zone and Wetland Ecology, Federal University Dutse, Jigawa state
[4]Department of Animal and Environmental Biology, Federal University Dutse, Jigawa state
[5]Center for Agricultural Research and Extension Services, Federal University Dutse, Jigawa state
***Corresponding author**: salami.d@fud.edu.ng or foristsalam@yahoo.com

ABSTRACT

Tamarind cultivation faces challenges due to marginal land use, soil erosion, nutrient depletion and suboptimal fertilization practices, impacting productivity and quality. A study assessed nitrogen-fixing tree leaf powder's effect on *Tamarindus indica* seedling growth, employing a Complete Randomized Design with four treatments (*Bauhinia racemosa*, *Tamarindus. indica*, *Siamese cassia* and control) and ten replications. Results showed no significant differences at 0.05 probability level, yet *Bauhinia racemosa* supported branch length, stem diameter and leaf production, outperforming other treatments. Siamese cassia exhibited highest shoot height, while control promoted leaf production. *Bauhinia racemosa* proved optimal for *T. indica* growth. Innovative strategies, such as examining leguminous leaves, breeding and bio-engineering, can enhance tamarind's slow growth, ensuring sustainable production and utilization.

Keywords: Growth Performances, Leaf Extract, Nitrogen Fixating Efficiency and *Tamarindus indica*

INTRODUCTION

Nitrogen is a crucial element in the formation of chlorophyll, the green pigment that enables plants to harness sunlight energy and convert water and carbon dioxide into sugars through photosynthesis. Additionally, nitrogen is a fundamental component of amino acids, which serve as the primary building blocks of proteins, essential for plant growth and development. Biological Nitrogen Fixation (BNF) is a vital process in plants, playing a crucial role in maintaining sustainable agricultural productivity and supporting the health of ecosystems. Through BNF, plants convert atmospheric nitrogen into a usable form, reducing the need for synthetic fertilizers and promoting a balanced and thriving environment. Legumes' Biological Nitrogen Fixation (BNF) capabilities, along with associative, endosymbiotic, and endophytic nitrogen fixation in non-legumes, are pivotal in minimizing the reliance on synthetic nitrogen fertilizers in agriculture. These processes not only enhance plant nutrient content but also contribute to soil health rejuvenation, ultimately leading to a more sustainable and environmentally friendly agricultural practice (Mahmud *et al.*, 2020). Temperton *et al.* (2007) conducted a study investigating the facilitative effects of four leguminous species - *Festuca pratensis*, *Plantago lanceolata*, *Knautia arvensis*, and *Trifolium pratensis* - on the growth of neighboring species. This research explored the potential benefits of legume companionship on plant community development and ecosystem functioning. The study revealed that the presence of legumes significantly enhanced nitrogen uptake in neighboring non-legume species, leading to a substantial increase in biomass production. Specifically, *Festuca pratensis* exhibited a pronounced increase in biomass across all levels of diversity, while *Plantago lanceolata* and *Knautia arvensis* showed a more modest gain in biomass. These findings highlight the facilitative role of legumes in promoting the growth and productivity of co-occurring species. Notably, the legume species *Trifolium pratense* exhibited a contrasting response, where its growth was inhibited by the presence of other legumes in its host community, across all levels of diversity. This finding suggests that, unlike the facilitative effects observed in non-legume species, legumes may engage in competitive interactions with each other, potentially limiting their own growth and productivity when co-occurring. A recent study by Adelani *et al.* (2022) demonstrated that the leaf litter of nitrogen-fixing Albizia trees, specifically *A. lebbeck*, significantly boosted the growth of G. albida seedlings. The results showed remarkable enhancements in various growth parameters, including: Height: 43.94 cm, Girth: 1.80 cm, Number of leaves: 15.00, Leaf area: 93.08 cm², Total fresh weight: 18.25 g and Total dry weight: 7.30 g. These findings suggest that incorporating leaf litter from *A. lebbeck* into the soil can substantially promote the growth and development of *G. albida*, highlighting the potential benefits of using nitrogen-fixing tree species as a soil amendment. In another study, Adelani *et al.* (2020) found that leaf litter from nitrogen-fixing Acacia tree species had a profoundly positive impact on the growth of *C. albidum* seedlings. The results demonstrated significant enhancements in seedling growth, underscoring the potential of using leaf litter from nitrogen-fixing tree species as a natural soil amendment to promote the growth and development of other plant species. This finding aligns with the previous study on Albizia leaf litter, highlighting the broader benefits of nitrogen-fixing tree species in enhancing soil fertility and supporting plant growth. In the context of nursery establishment, the application of nitrogenous and phosphorus fertilizers is a crucial practice. However, certain tree species have inherent properties that can enhance soil fertility. For instance, *Faidherbia albida* and *Leucaena leucocephala* have been observed to fix atmospheric nitrogen into the soil, enriching its nutrient content (Salami *et al.,* 2020a). Additionally, mycorrhizal associations have been found to be essential for the successful propagation of *Pinus caribaea* (Pines), highlighting the importance of symbiotic relationships in tree growth and development. These findings underscore the potential of integrating nitrogen-fixing and mycorrhizal tree species into nursery establishment practices to reduce reliance on synthetic fertilizers and promote sustainable soil management. Leaf litter plays a vital role in enhancing soil quality by incorporating organic matter and essential nutrients into the soil, as reported by *Triadiati et al*. (2011). However, the use of chemical fertilizers, such as NPK 15:15:15, has also been shown to significantly impact seedling growth, particularly in the nursery stage. Research by Salami et al. (2018) and Salami (2002) demonstrated that applying NPK 15:15:15 at a rate of 3g per pot resulted in optimal growth and performance of *Treculia africana* seedlings. This highlights the potential benefits of combining organic matter from leaf litter with targeted fertilizer applications to achieve enhanced soil fertility and seedling growth. In recent years, there has been a shift towards exploring natural and sustainable methods of sourcing nitrogen, driven by the high costs associated with inorganic fertilizers. As Chen (2006) noted, commercial nitrogen fertilizers are not only expensive but also inefficient, with only a small portion of the nutrient being absorbed by plants. Furthermore, the excessive use of chemical fertilizers can lead to water contamination. While chemical fertilizers do offer high levels of readily available nutrients for plant uptake, their drawbacks have prompted researchers and farmers to seek alternative, sustainable approaches to meeting nitrogen requirements, such as leveraging organic matter, nitrogen-fixing legumes, and other eco-friendly strategies. Chadzon (2003), highlighted the triple benefits of rapidly-growing tree species, especially nitrogen-fixing legumes, in Boosting soil organic matter through rapid growth and decomposition, Shielding against erosion by stabilizing soil and improving its structure and Super charging nutrient cycling by converting atmospheric nitrogen into a plant-available form. According to Adelani and Muhammed (2017), *T. indica,* a slow-growing tree species, requires fertilization to accelerate its growth and meet the increasing demand for its numerous benefits. In line with this, research has consistently shown that local plants can serve as effective, low-cost alternatives to chemical fertilizers, providing a sustainable solution for enhancing plant growth (Abebe *et al.,* 2015). This approach not only reduces reliance on synthetic fertilizers but also promotes eco-friendly practices, aligning with the growing need for sustainable agriculture and forestry management. Adekola and Usman (2009) pointed out that many agricultural practices aimed at restoring and enhancing soil fertility are confronting significant socioeconomic and ecological hurdles, limiting their ability to meet the current food demands of the growing population. Despite efforts to improve soil fertility, these challenges hinder the effectiveness of such initiatives, underscoring the need for innovative, sustainable approaches to address the complex interplay between soil health, agricultural productivity, and food security. Therefore the aim of this study is to determine the influence of the leaf litters of nitrogen fixating trees on the growth pattern of *Tamarindus indica* linn seedlings in view of recommending the nitrogenous leaf powder for agroforestry plots and plantation establishment

Plate 1: Showing the pod of *Tamarindus indica*

Plate 2: Tamarind tree showing pod

Source: Jibo *et al.*, 2021; Musa, 2021

MATERIALS AND METHOD

Description of the area

The study was carried out at the fishery Farm site, Federal University Dutse, Jigawa state. (11°04'04" N to 11°07'01" N latitude and 9°20'31" E to 9°30'41" E longitude). The study area experiences a mean annual rainfall of 734mm and an average temperature of 26.50°C, according to research findings (Ilu *et al*., 2020a; Ilu *et al*., 2020b; Salami *et al*., 2020b). The town receives an average of 10-11 hours of sunshine per day, with varying durations depending on the season (Jibo *et al*., 2021; Salami and Lawal, 2018; Jibo *et al*., 2018). The soil pattern in the study area is characterized by a fertile, sandy-loamy texture with a pH range of 6.07-6.72, and nutrient levels of 0.63-1.64 gkg^{-1} nitrogen, 6.25-12.04 mg/kg phosphorus, and 0.18-0.63 $cmolkg^{-1}$ potassium, as reported by Salami *et al*. (2019). Dutse, has an estimated population of 153,000 people (National Population Commission, 2006) and is largely agrarian, with farming being the main occupation, although other typical rural activities are also practiced by the inhabitants.

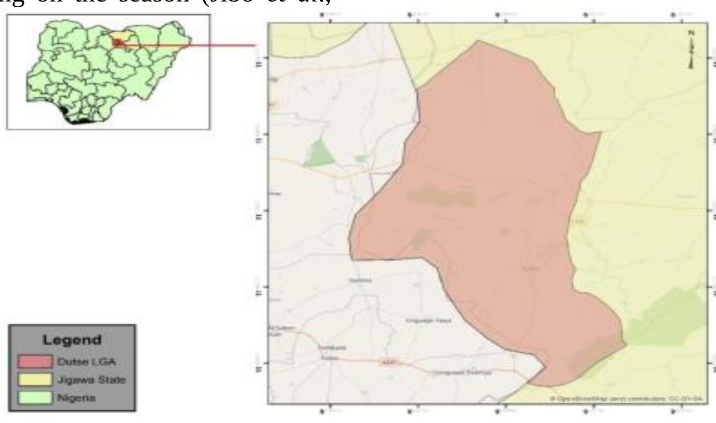

Fig. 1. Map of the study area

Adapted from Garba *et al.* 2021; Salami *et al.*, 2022

Seed and soil collection

Mature seeds of *T. indica* were obtained from Shawarim and Kiyawa markets in Jigawa State. The seeds were extracted from the fruits and subjected to a 24 hour soaking period in cold water, following the methods described by Jibo *et al*. (2021), and Musa (2021). River sand was collected from the floor of Warwade dam and processed to remove impurities, organic matter, and nutrient residues. The sand was first sieved through a 2mm mesh and then soaked in 10% hydrochloric acid for 24 hours, following the protocol recommended by Adelani *et al.* (2014). The soil sample was transported to the Soil Science Laboratory at the Department of Soil Science, Federal University Dutse, where particle size analysis was conducted using the Bouyoucos hydrometer method (Bouyoucos, 1951). This analysis aimed to determine the soil's actual textural class.

Method

Procedure

The biomass transfer method was employed, which entailed collecting wet leaves, due to the fact that some of the selected nitrogen-fixing tree species were not located at the same site. The collected leaves were then air-dried and pulverized to obtain uniform samples for further analysis. Each leaf sample was weighed (10g) according to Adelani (2019). The soil samples were then sterilized, thoroughly mixed with the powdered leaves of the selected nitrogen-fixing trees (10g), and subsequently packed into poly pots measuring 20 x 10 x 10cm, following the protocol outlined by Adelani, (2019). To serve as a control, pots containing only acid-washed sand, without leaf litter, were prepared. Seedlings of *T. indica*, one month old, were transplanted into pots filled with a mixture of sand and nutrients, and also into control pots. Using the method described by Olajuyigbe *et al*. (2013), all seedlings, including those in control pots, received a daily watering of 200ml of distilled water to maintain uniform moisture levels.

Plate 3: Display from the impact of control **Plate 4:** impact of *Tamarin* powder on *T. indica*
Plate 5: impact of *B. racemosa* powder **Plate 6:** impact of *S. cassia* powder

Experimental design

The experiment was conducted using a Complete Randomized Design (CRD). The treatments comprised leaf litter from selected nitrogen-fixing species: *Bauhinia racemosa*, *Tamarindus indica*, *Siamese cassia*, and a control treatment without leaf litter. The study consisted of four treatments, each with ten replicates, totaling forty (40) seedlings. This experimental design allowed for robust data collection and reliable results. Seedlings were established for two weeks after transplanting, Seedling growth was evaluated every two weeks for 12 weeks, with assessments including height, girth, leaf count, and leaf area measurements.

Data analysis

Data was collected and subjected to Analysis of Variance (ANOVA) using SAS (2003). A comparison of significant means was accomplished using Fishers' Least Difference LSD at 5% level of significance.

RESULTS

Table 1: the mean growth parameters of the *Tamarindus indica* at Twelve (12) weeks of planting

Treatment	Branch length (cm)	Leaf number	Shoot height (cm)	Stem diameter (mm)
Control (T1)	43	614	77	4.7
***T. indica* (T2)**	36	455	71	4.6
***B. racemosa* (T3)**	45	608	66	4.7
***S. cassia* (T4)**	40	590	80	4.5

Source: Field survey, 2023

Influence of leaf litter of nitrogen fixating tree on the growth pattern of *Tamarindus indica* seedling was established in this study. Analysis of Variance of the study indicated that stem diameter, shoot height, leaf number and branch length showed no significant different among the four treatments applied to seedlings at 0.05 probability level. *B. racemosa* leave powder (T3) had the highest number of branch length followed by control (T1) *S. cassia* (T4) and *T. indica* (T2) with the following value of branch length 45, 43, 40 and 36 respectively. This result showed that *B. racemosa* (T3) had the best in terms number of branch length performance. Little differences occurs among the treatments for the impacts of leaf power on the performance of the species in terms of branch length, leaf area, shoot height and stem diameter. *B. racemosa* had the best performance among the treatments for all the morphological attributes checked.

DISCUSSION

The significant growth of *T. indica* seedlings in terms of branch development, shoot height, leaf number, and stem diameter, when planted in soil amended with nitrogen-fixing leaf powder, demonstrates that the nitrogen fixers provided sufficient nitrogen to enhance these growth parameters. The exceptional performance can be attributed to its ability to retain and release nitrogen, supporting seedling growth. This finding aligns with reports by Silvia and Victor (2008), who noted that garlic growth was significantly enhanced by nitrogen released for fertilization. Similarly, the increased height and leaf number observed in carrots following *Tithonia diversiflora* manure application can be attributed to elevated levels of essential nutrients (NPK 15:15:15) in the tithonia manure, as evidenced by improved soil nutrient levels at the end of each growing season (Jeptoo *et al.*, 2013). Research by Warren and Adams (2002) on *Pinus pinaster* and Khamis *et al.* (2013) on *Populus euphratica* had demonstrated the effectiveness of various nitrogen sources in enhancing plant growth. Nitrogen is a crucial element for plant growth, playing a vital role in numerous physiological and biochemical processes (James and Michael, 2009). Its importance cannot be overstated, as it is essential for optimal plant development. Nitrogen is a fundamental component of chlorophyll, as well as essential compounds like proteins, fats, and nucleic acids (El-Mesiry and Azza, 2001; El-sallami, 2003). Furthermore, Camellia *et al.* (2009), highlighted that many enzymes, which are comprised of proteins, rely on nitrogen to facilitate various biochemical reactions, underscoring its critical role in these processes. The highest percentage value obtained in this study is consistent with the findings of Adelani *et al.* (2018), who reported a maximum potassium content of 2.08% in *C. equisetifolia.* Moreover, the highest leaf area index recorded in seedlings grown in soil amended with *C. equisetifolia* indicates its capacity to release potassium, leading to increased leaf area per unit land area of the seedlings. Adelani *et al*. (2014), made a similar observation, where *Gliricidia sepium* amendment increased maize seedling growth, likely due to its high potassium release. Leaf litter from nitrogen-fixing tree species serves as a valuable source of essential nutrients, including potassium, which plays a significant role in promoting plant growth. Potassium is a vital element that plays a crucial role in various plant physiological processes, including enzyme activation, photosynthate translocation, cellulose synthesis (a key component of plant cell walls), sugar transport from leaves to fruits, and oil production and accumulation (Marschner, 2012; Wang *et al.*, 2013; Romheld and Kirky, 2010). Nitrogen fertilization has been shown to increase water use efficiency, according to Ashraf *et al.* (2001). Adequate potassium supply is crucial for enhancing drought resistance by promoting root elongation and maintaining membrane stability (Wang *et al.*, 2013). The highest percentage values recorded for nitrogen in *J. mimosifolia*, *Vitex doniana*, and *Casuarina equisetifolia* indicate their superior ability to release nutrients compared to other investigated species. This finding is consistent with Adelani et al. (2014), who reported that *Gliricidia sepium* and *Parkia biglobosa* enhanced growth parameters in Zea mays seedlings due to their higher nutrient release capacity. Similarly, this study suggests that *J. mimosifolia, Vitex doniana,* and *Casuarina equisetifolia* released more nitrogen, phosphorus, and potassium than other species investigated, likely due to their higher nutrient content. The growth of seedlings in soil enhanced with nitrogen-fixing plant leaf litter was linked to nutrient uptake, consistent with findings by Odeyemi *et al.* (2015) and Atanda and Olaniyi (2015). The highest growth parameters in *J. mimosifolia, P. africana, and Casuarina equisetifolia* were attributed to increased nitrogen, phosphorus, and potassium uptake, respectively, highlighting the importance of nutrient absorption in soil. However, unamended soil showed significantly different results, with the highest growth parameters recorded.

CONCLUSION

This study conclusively demonstrates the significant impact of nitrogen-fixing tree leaf litter on *Tamarindus indica* seedling growth. *Bauhinia racemosa* leaf powder exhibited superior performance, with the highest branch length, surpassing control, *Senna cassia* and *Tamarindus indica* treatments. Minimal variations were observed in leaf area, shoot height and stem diameter among treatments. *Bauhinia racemosa* consistently outperformed other treatments across morphological attributes, underscoring its potential as a natural fertilizer. These findings promote sustainable agriculture practices, enhancing environmentally friendly cultivation and optimal seedling development. Integrating nitrogen-fixing leaf litter fosters eco-friendly fertilizer alternatives, contributing to food security and environmental stewardship. Future research directions include exploring economic viability, nutrient release dynamics and applications in other agricultural sectors.

RECOMMENDATIONS

i. More studies should be conducted on the impact of leaf litter of nitrogen fixation plant on slow growth tree
ii. Based on the primary investigation from study, more nitrogenous tree species should be examined aside the three species
iii. Future studies should also focus on the mechanism of action of the crude litters of nitrogen fixers for isolated compounds
iv. Improvement works should be done on this species

REFERENCES

Adekola, O. F. and Usman, A. (2009). The effect of pruning from trees on *Corchorus olitorius* and *Amaranthus caudatus. Journal of Sustainable Environmental Management* 2(2): 34-48.

Adelani, D.O, Suleiman, R.T., Oni, B.O., Ogunkalu, A.O., Ariyo, O. C., Mohammed, R., Ogunsanwo, J. A and Ariyo, M.O Effect Of Leaf Litters Of Selected Nitrogen-Fixing *Albizia species* On The Growth Of African Star Apple (*Gambeya albida* (G.Don) Aubrév. and Pellegr.) Seedlings Proceedings of the 8th Biennial Conference of the Forests & Forest Products Society, Held at the Forestry Research Institute of Nigeria, Ibadan, Nigeria. 14th - 20th pp 225-232

Adelani, D. O. (2015). Effects of Pre-germination treatments and sowing depths on early growth of Sesban (*Sesbania sesban)*. *Applied Tropical Agriculture* 20(1): 31-36. (Nigeria) https://www.futa.edu.ng/journal/home/paperd/363/12/11

Adelani, D. O., Aduradola, M.A. and Aiyelaagbe, I. O. (2017). Storability and pre-sowing treatments of African star apple (*Chrysophyllum albidum* G. Don) seeds. *Journal of Agricultural Science and Environment* 17(1): 91-102.

Adelani, D. O., Suleiman, R.A., Akesode, H.A. and Akande, M.T. (2014). Effect of sources and rates of organic fertilizer on the growth of *Chrysophyllum albidum* seedlings. Organic Agriculture Research: A Catalyst for Sustainable National Agricultural Transformation Agenda. In: Olabiyi, T. I and Bolarinwa, I.F (Eds). Proceedings of the 10th National Conference on Organic Agriculture held at Ladoke Akintola University of Technology, P.M.B 4000, Ogbomoso, Oyo State, Nigeria from 17th -20th November, 2014. Printed by A- Treasurer Digital Press LTD, Nigeria. Pp 65-73

Adelani, D.O., Aduradola, A.M., Suleiman, R.T. and Oyelowo, O.J. (2023) Effects Of Sources Of Nitrogen And Watering Regimes On The Growth Of African Star Apple (*Chrysophyllum albidum* G. Don) Seedlings *Ethiopian Journal of Environmental Studies & Management* 16(4): 454 – 473, 2023

Adelani, D.O., Ogunsanwo, J.A. and Awobona, T.A. (2018). Effect of seed weights on the germination and early seedling growth of African star apple (*Chrysophyllum albidum* G. Don). *Nigerian Journal of Forestry* 48 (1): 33-38

Adelani, D.O., Oni, B.O and Ariyo, O.C. (2020) Effect Of Leaflitters Of Nitrogen Fixing Acacia Trees On The Growth of African Star Apple (*Chrysophyllum albidum* G.Don): A Step Towards Enhancing The Growth Of An Endangered Species *Journal Of Research In Forestry, Wildlife & Environment* Vol. 12(2) June, 2020

Ashraf, M., Ahmad, A. and Neilly, T. M. (2001). Growth and photosynthetic characteristics in pearl millet under water stress and different potassium supply. Photosynthetica, 3: 389- 394.

Chazdon, R. (2003). Tropical forest recovery: legacies of human impact and natural disturbances. Perspectives in Plant Ecology, *Evolution and Systematics*, 6:51-71.

Chen, J. H. (2006) The combined use of chemical and organic fertilizer and /or biofertilizer for crop growth and soil fertility. Proceeding of International Workshop on sustained Management of the Soil Rhizosphere system for efficient crop production and fertilizer. Use 16-20 October Land Development, Bankok 10900 Thailand

Garba, A., Salami K. D. and Akanbi, W. B. (2021) Assessment of Endangered economic tree species and conservation Techniques in Jigawa state *FUDMA Journal of Agriculture and Agricultural Technology* V 7(2)116-123

Ilu, K. J., Salami, K.D. Muhammad. Y. K. (2020a) Influence of Tapping Dates on The Yield Of Acacia Senegal (L) Wild at Two Different Locations in Jigawa State, Nigeria. *FUDMA Journal of Sciences* (FJS) Vol. 4 No. 1, March, 2020, pp 246-249.

Ilu, K. J., Salami, K. D., Gidado, A. H., Muhammad, Y. K. and Bello Ahmed (2020b) Household's Responses to the Roles of Trees As Wind Breaker in Dutse Local Government Area of Jigawa State, Nigeria , *FUDMA Journal of Science* v4(3)162-169

Jibo, A. U. Salami K. D, Lawal A. A. and Muhammad Y. K, (2021): Influence of Soil Amendments on the Growth Performance of *Eucalyptus camaldulensis* (Dehnh) Seedlings *J. For. Sci. Env. Vol. 6 (2021): 8 – 13* ISSN 2635-3296

Jibo, A. U., Salami, K. D., Kareem Akeem, A. Muhammad, Y. K. and Musa, F. Y: (2021) Impact of Provenances on Seed Germination, Early Growth Performance and Survival Rate of *Tamarindus indica* (L) in North Western Nigeria. *Nigerian Journal of Horticultural Science (NJHS) Volume 26 Issue 1 and 2 pp 87-104*

Jibo, A. U., Salami, K. D. and Inuha, I.M (2018). Effects of Organic manure on growth Performance of *Azadirachta indica* (A.Juss) seedlings during early growth in the Nursery. *FUDMA Journal of Sciences (FJS)*. Vol 2 (4):99-104

Mahmud, K.; Makaju, S.; Ibrahim, R. and Missaoui, A. (2020). Current Progress in Nitrogen Fixing Plants and Microbiome Research. *Plants, 9* (97).

Marschner, P. (2012). Marschner's Mineral Nutrition of Higher plants, 3rd edition, Academic Press: London, UK, PP 178-189.

Musa, F. (2021) Provenances on Seed Germination, Early Growth Performance and Survival Rate of *Tamarindus indica* (L) in North Western Nigeria. A project submitted to the Department of Forestry and Wildlife Management, Federal University Dutse, Jigawa State

National Population Commission, (2006) National population census conducted

Olajuyigbe, S.O., Jimoh, S.O., Adegeye, A.O. and Mukhtar, R. B. (2013). Drought stress on early growth of Diospyros mespiliformis. Hochst ex A.Rich in Jega, Northern Nigeria. *Nigeria Journal of Ecology,* 12: 71- 76.

Salami, K. D. Shuaibu, R. B. and Kareem, A. A. (2022) Ecological survey of medicinal tree species in Sudano sahelian region of Nigeria. *Ethiopian Journal of Environmental studies and Management.* 15(5): 588-607 *Ethiopian*

Salami, K. D. and Lawal, A. A. (2018). Seed Germination and early growth of *Spondia purpurea* (Linn) as affected by different growth. A proceeding of the 6th Biennial National Conference of the Forests and Forest Products Society. April 23th-27th, 2016, Pp290-295.

Salami, K. D., Lawal A. A., Oyebamiji, N And Yisau, J. A. (2020a) Effect Of Nitrogen, Phosphorus Fertilizers And Mycorrhizal Nodulation On The Growth And Yield Of Tree Seedlings, *FUW Trends In Science & Technology Journal,* Www. Ftstjournal.Com E-ISSN: 24085162; P-ISSN: 20485170; April, 2020: Vol. 5 No. 1 Pp Katsina

Salami, K. D., Odewale, M. A., Gidado, A. H and Adam, Z. A (2019): Pre-germination Treatments on Seeds of *Balanites aegyptiaca* (L) Delile and Influence of Potting Mixtures on the Early Growth. *Journal of Forestry Research and Management.* V 16(1).107-117., ISSN 0189-8418. www.Jfrm.org.ng IBADAN

Salami, K.D. (2002) Effects of Organic and Inorganic Fertilizer on the Early Growth and Development of *Treculia africana*. *African Journal of Agricultural science* 15: 46-51

Salami, K. D., Jibo A. U. and Lawal A. A. (2018) Effects of Organic and Inorganic Fertilizer on the Early Growth Performance of *Treculia africana*. LINN (AFRICAN BREAD FRUIT). *Dutse Journal of Agriculture and Food Security* (DUJAFS). Vol 5: (2) 28-36.

Salami, K. D., Akinyele, A.O. and. Folorunso, W.O. (2020b). Effect of Pre-Treatments, Inorganic Fertilizer and Varying Soil Volumes on the Early Growth Performance of *Adansonia digitata* (Linn) Baobab. Nigeria *Journal of Horticultural Science, Horticultural Society of Nigeria*. Vol 25 (1):1-10

Silvia, G. and Victor, M. L. (2008). Effect of nitrogen fertilization on yield and colour of red garlic (Allium sativum L) cultivars. Instituto Nacioonal de Technologra. Experimental Agropecuaria. Meridoza, Argentian Cicencia Investigation Agraria 35 (1): 57-64.

Temperton, V. M., Mwangi, P. N., Scherer-Lorenzen, M., Schmid, B., and Buchmann, N. (2007). Positive interactions between nitrogen-fixing legumes and four different neighbouring species in a biodiversity experiment. *Oecologia*, *151*, 190-205.

Triadiati, S., Tjitrosemito, E., Sundarsono, G., Qayim, I and Leuschner, C. (2011). "Litter fall production and leaf-litter decomposition at natural forest and Cacao agroforestry in Central Sulawesi, Indonesia," *Asian Journal of Biological Sciences*, (4): 221–234.

Wang, M., Zheng, Q., Shen, Q and Guo, S. (2013). The critical role of potassium in plant stress response. *International Journal of Molecular Science*, 14:7370-7390.

Warren, C. R. and Adams, M. A. (2002). Phosphorus effects, growth and partitioning of nitrogen to Rubisco in Pinus pinaster. Tree Physiology 22:11-19.