Improving Growth of *Chrysophyllum albidum* G. Don Seedlings Using Leaf Litters of Selected Nitrogen-Fixing Albizia Trees

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Abstract

There is paucity of quantified information on the influence of plant-based manure on the growth of *Chrysophyllum albidum*. In an attempt to improve the slow growth of *C. albidum* seedlings, investigation was conducted to assess growth of *Chrysophyllum albidum* using the leaf litters of some nitrogen-fixing albizia trees. The experiment adopted a Completely Randomized Design (CRD) with six treatments duplicated five times. The treatments included leaf litters from selected nitrogen-fixing albizia trees (*Albizia zygia, Albizia coriaria, Albizia ferruginea, Albizia lebbeck*, *Albizia saman*) and a check on the growth of *C. albidum*. The experiment involved a total of thirty seedlings. One-way Analysis of Variance (ANOVA) was performed on the result of *C. albidum* seedlings carefully transplanted into pots with and without 400g of leaf litters of nitrogen-fixing albizia trees. The growth of *C. albidum* was significantly ($P<0.05$) influenced by the leaf litters of specific nitrogen-fixing albizia trees. Tallest plant (29.84cm)., widest girth (1.71cm)., widest leaf area (53.86cm^2)., highest total fresh weight (15.42g) and dry weight (8.89g) were recorded from seedlings planted in the soil supplemented with leaf litters of *A. ferruginea*., while least growth metrics were recorded from unamended treatment (control). Seedlings cultivated in the soil supplemented with leaf litters of *Albizia lebbeck* gave highest number of leaves (12.20). The leaf litter of *A. ferruginea* improves the growth of *C. albidum* seedlings.

Key words: Leaf litters, Plant based manure, Nitrogen-fixing trees, Slow growth, Indigenous tree species.

Resumé

Il y a peu d'informations quantifiées sur l'influence du fumier végétal sur la croissance de Chrysophyllum albidum. Dans une tentative d'améliorer la croissance lente des semis de C. albidum, une enquête a été menée pour évaluer la croissance de Chrysophyllum albidum en utilisant les litières de feuilles de certains arbres ;albizia fixateurs d'azote. L'expérience a adopté une conception complètement randomisée (CRD) avec six traitements dupliqués cinq fois. Les traitements comprenaient des litières de feuilles d'albizias sélectionnés fixateurs d'azote (Albizia zygia, Albizia coriaria, Albizia ferruginea, Albizia lebbeck, Albizia saman) et un contrôle de la croissance de C. albidum. L'expérience a impliqué un total de trente semis. Une analyse de variance à une voie (ANOVA) a été réalisée sur le résultat de semis de C. albidum soigneusement transplantés dans des pots avec et sans 400 g de litière de feuilles d'arbres albizia fixateurs d'azote. La croissance de C. albidum a été significativement

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($P<0,05$) influencée par les litières de feuilles d'arbres albizia fixateurs d'azote spécifiques. Plante la plus haute (29,84 cm)., circonférence la plus large (1,71 cm)., surface foliaire la plus large (53,86 cm2)., poids frais total (15,42 g) et poids sec (8,89 g) les plus élevés ont été enregistrés à partir de semis plantés dans le sol complété avec des litières de feuilles d'A. ferruginea., tandis que les mesures de croissance minimale ont été enregistrées à partir d'un traitement non amendé (témoin). Les semis cultivés dans le sol additionné de litière de feuilles d'Albizia lebbeck ont donné le plus grand nombre de feuilles (12,20). La litière de feuilles d'A. ferruginea améliore la croissance des semis de C. albidum.
Mots clés : Feuilles mortes, Fumier à base de plantes, Arbres fixateurs d'azote, Croissance lente, Espèces d'arbres indigènes. (Abstract was translated by Google Translator and edited by the Editorin-Chief)

Introduction

Trees increase soil fertility by nitrogen fixation and the addition and decomposition of nutrient-rich litter (Ebisa and Abdela, 2017; Latamo and Wondmagegn, 2020). Trees equally provide necessities of life as food, fuel wood, fodder and income for household (Negash *et al.*, 2012; Girmay *et al.,* 2015; Negese and Motuma, 2021; Habte *et al.,* 2021). They also have an important role in carbon sequestration, biodiversity conservation and micro-climate amelioration (Gebrewahid *et al.,* 2018 ; Yikuno amlak and Selemawi, 2019; Latamo and Wondmagegn, 2020; Habte *et al.,* 2021).

The genetic erosion of our indigenous tree species through human activities is affecting species necessary for survival of present generation as *Chrysophyllum albidum*. *Chrysophyllum albidum* is a species of climax tree, found in tropical rainforest and family of Sapotaceae (Olaoluwa *et al.,* 2012; Wole, 2013) that make nearly half of the order with 800 species (Ehiagbonare *et al.,* 2008). It is called "Osan Agbalumo," "Udara" or "Udala" and "Agwaluma or Agwaluba" in Yoruba, Igbo and Hausa languages respectively (Rahaman, 2012; Wole, 2013; Adelani *et al.,* 2018). The immense economical (Onyekwelu *et al.,* 2011); nutritional and medicinal (Onyekwelu and Stimm, 2011), industrial (Olaoluwa *et al.,* 2012) and ecological (Aduradola *et al.,* 2005) values of *C. albidum* have been reported.

The deforestation of natural forest resources has subjected the soil to wind and water erosion as well as other factors that cause reduction in soil nutrient or fertility. Dania *et al.* (2014) mentioned that the major limiting factor of crop production in the tropics is the deficiency of soil nutrient resulting from land degradation which affects the growth, nutrient content, and uptake of the plant. Razaq *et al.* (2017) stated that soil nutrient management is essential for sustainable biomass production and for maintaining soil quality. Soil nutrient management leads to improvement in soil fertility. One way to improve soil fertility is the application of fertilizer which obviously is a means required for optimum crop yield (Dania *et al.,* 2004).

Fertilizer application is mostly adopted in nurseries to increase plant healthy growth and yield (Shen *et al.,* 2010), however, fertilization can enhance plant growth by either increasing soil water, nutrients and oxygen or by improving the ability of seedlings to gather resources (Lincoln *et al.,* 2007) by modifying soil pH (Jose *et al.,* 2003). The importance of fertilizers in the growth of tree seedlings cannot be overstated (Hu and Schmid halter, 2005; Berger and Glatzel, 2001; Gbadamosi, 2006; Oskarsson *et al.,* 2006; Oskarsson and Brynleyfsdottir, 2009; Dianda *et al.,* 2009). Reza (2015) stated that the use of chemicals to correct nutrient deficiency has caused a lot of environmental challenges. The regular practice of using chemical fertilizers has led to extensive ecological damages. The challenges as ground water contamination, eutrophication, acid rain and Ozone depletion have been widely recognized as the effects of the extensive use of harmful chemicals in agricultural practices (Reza, 2015) as well as forestry practices.

Reza (2015) reported that the health challenges such as birth malformations, hypertensions, respiratory ailments, cardiac diseases and multiple cancers have been associated with environmental degradation caused by unsafe chemical fertilizers used in soil amendments and enhancing plant growth. Reza (2015) opined that nature offers healthy alternatives to artificial treatments of soil that contaminate the environment. Natural solutions are proving efficacious in resolving environmental issues, allowing communities to rely less on toxic remedies. Nitrates, nitrogen dioxide and ammonia are transformed into accessible components by plants through biological nitrogen fixation (Reza, 2015). WAC (2018) reported that the fixation of nitrogen has been proven and found to be a significant factor in soil fertility. Nitrogen-fixing tree species have the ability to fix nitrogen to increase soil nutrients by the process of nitrogen fixation.

The most popular N_2–fixing trees adopted in tropical agro-forestry systems involved the legumes as *Acacia spp, Erythrina spp*, *Gliricidia spp*., *Inga spp* and *Leucaena spp* which form symbiotic cooperative unions with a wide variety of N_2-fixing bacterial species (Bala *et al.,* 2003). Winrock International (2022) and WAC (2009) gave documentation of full lists of nitrogen-fixing albizia trees. The nitrogen-fixers and soil-enhancers are common among albizias. Nitrogen-fixing trees help to enhance soil fertility for high plant productivity through its litters and fixation processes. The organic matter and nutrients from litter increase the quality of the soil (Ngoran, *et al.,* 2006; Mahmood and Hoque, 2008; Triadiati *et al.,* 2011). Hossain *et al.* (2011) and Park and Kang-Hyun (2003) reported that relative to other litter types, leaf litter is the main and fastest source of soil fertility. Leaf litters help to restore and maintain appropriate soil fertility.

Hoque *et al.* (2004) reported that maintaining adequate fertility of forest nursery soils guarantees production of excellent planting stock. High-quality establishing stocks will cope with environmental stress and perform better in the field for long time (Davis and Jacobs, 2005). To produce high-quality planting stock of tropical trees from soil fertility, there is need to investigate on their propagation and nutritional requirements. Buochuama and Akhabue (2020) opined that there is scarcity of investigation on the propagation and nutrient needs of most tropical tree species. Owing to advantages of plant-based manure over others, its nutritional sources for tropical forest trees worth investigating. There is dearth of trials on the growth response of *C. albidum* to the leaf litters of nitrogen-fixing albizia trees. In this light, investigation was conducted into growth response of *C. albidum* to leaf litters of specific nitrogen-fixing albizia trees.

Materials and Method

The investigation was carried out in the screen house of Federal College of Forestry Mechanization, Afaka, Kaduna State during wet season of 2015. The College is located in the Northern Guinea Savannah ecological zones of Nigeria. It is situated in Igabi Local Government Area of Kaduna State, Nigeria. It lies between Latitude 10 ° 35' and 10 ° 34' and Longitude 7 ° 21' and 7 ° 20' (Adelani, 2015). The mean annual rainfall is approximately 1000 mm. The vegetation is open woodland with tall broad leave trees (Otegbeye *et al.,* 2001).

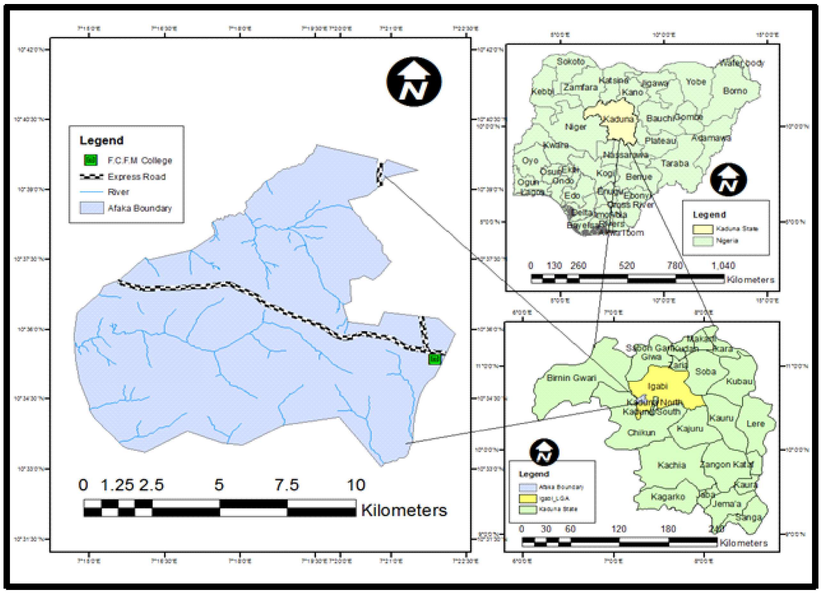

Fig 1: The location of Federal College of Forestry Mechanization, Afaka, Kaduna State, Nigeria

Experimental Procedure

The fruits were sourced from Osiele village in Odeda Local Government, Ogun State and transported to Kaduna State. The seeds were extracted from fruits and air dried for thirty minutes. Three hundred seeds were extracted from fruits. The viability of the randomly selected seed samples were assessed using cutting method (Schmidt, 2000). The sowing media (river sand), which was collected from the floor of College dam was made to pass through 2mm sieve and then sterilized at 160^{o}C for 24hours. The polythene pots used was 20x10x10 cm^{3} in dimension and filled with the sterilized river sand and arranged in the screen house. After a year of germination of seeds, uniform seedlings were available for growth experiment.

The experimental design adopted for investigation on the improving growth of *Chrysophyllum albidum* seedlings using leaf litters of specific nitrogen-fixing albizia trees (*Albizia zygia, Albizia coriaria, Albizia ferruginea, Albizia lebbeck* and *Albizia saman*) was a Completely Randomized Design (CRD) with five replicates. The preference for specific albizias used for this *Chrysophyllum albidum* experiment was traced to their earlier recommendation for highest production of *Zingiber officinale* by Adelani *et al.* (2020). One-year old seedlings were painstakingly transplanted into a potting mixture filled in larger poly pots of 25x20x15cm^{3} dimensions. The potting mixture contained samples of sterilized sand carefully mixed with each leaves of nitrogen-fixing albizia trees (400g).

Each sample of milled leaves of nitrogen-fixing trees was analyzed chemically for nitrogen, phosphorus and potassium (NPK). The sand without the supplementation of leaf litters was analyzed for nutrient content under untreated soil (control). The 200ml of distilled water per seedling was used to water the seedlings twice daily. Growth variables were taken monthly for 6 months. Growth variables studied include; Seedling height with the use of meter rule; girth with the use of venier caliper; the number of leaves were counted manually and Leaf area was obtained by linear measurement of leaf length and leaf width as described by Clifton-Brown and Lewandowski (2000).

$$LA=0.74xLxW \quad (1)$$

Where, LA =Leaf area=Product of linear dimension of the length and width at the broadest part of the leaf.

The fresh and dry weight were determined by the use of Mettler Top Loading Weighing Balance, but dry weight was taken after oven dried the seedlings at 70°C for 72hours (Umar and Gwaram, 2006).

Chemical analysis of leaf litters applied

The samples of leaf litters air dried for two weeks were analyzed chemically for nitrogen, phosphorus and potassium (NPK) content at Federal University of Agriculture Abeokuta, Ogun State, Nigeria laboratory. Determination of total nitrogen was done by Macro Kjeldahi method. Available phosphorus (P) was extracted by Bray-1 method and determined colourimetrically. Extracts from the digestion of leaf litters were used to determine potassium by flame photometry.

Data analysis

The data on the growth of *Chrysophyllum albidum* seedlings using leaf litters of selected nitrogen-fixing albizia trees were subjected to one way analysis of variance (ANOVA) using SAS (2003). Comparison of significant means was accomplished using Fisher's Least Significant Difference (LSD) at 5% level of significance.

Results

Tallest plant of 29.84cm was recorded from seedlings planted in the soil amended with leaf litters of *A. ferruginea.,* while the shortest plant of 15.08cm was recorded from seedlings planted in an unamended soil (control). The height of seedlings planted in the leaf litters of *A. ferruginea* was significantly (P<0.05) different from that of control. (Table1).

Table 1: Improving growth of *C. albidum* seedling height (cm) using leaf litters of selected nitrogen-fixing albizia trees

NFAT	WAT					
	4	8	12	16	20	24
A.lebbeck	20.64[a]	20.72[a]	22.00[a]	23.36[a]	27.72[a]	28.74[a]
A.zygia	18.90[ab]	20.00[a]	24.30[a]	24.90[a]	27.46[a]	28.48[a]
A.coriaria	18.12[ab]	20.30[a]	22.52[a]	24.90[a]	26.00[a]	27.62[a]
A.ferruginea	17.12[ab]	20.73[a]	24.40[a]	25.00[a]	28.32[a]	**29.84[a]**
A.saman	18.44[ab]	20.73[a]	21.98[a]	22.92[ab]	23.92[a]	25.44[a]
Control	**15.08[b]**	15.38[b]	16.32[b]	19.14[b]	19.70[b]	20.38[b]
SE±	1.69	1.63	1.66	1.71	1.70	1.45

*Means on the same column having different superscripts are significantly different (P<0.05)

Key: WAT= Weeks After Transplanting

Key: NFAT=Nitrogen Fixing Albizia Trees,

Widest girth of 1.71cm was recorded from seedlings planted in the soil influenced with leaf litter of *A. ferruginea.* The narrowest girth of 0.72cm was recorded from seedlings planted in the soil without the amendment of leaf litters of nitrogen-fixing albizia trees. The girth of seedlings planted in the soil enhanced with leaf litters of *A. ferruginea and A. zygia* was significantly (P<0.05) different from that of others (Table 2).

Table 2: Improving growth of *C. albidum* seedling girth (cm) using leaf litters of selected nitrogen - fixing albizia trees

NFAT	WAT					
	4	8	12	16	20	24
A.lebbeck	0.98[a]	1.02[a]	1.04[b]	1.08[a]	1.10[a]	1.48[b]
A.zygia	0.96[a]	1.02[a]	1.04[b]	1.06[a]	1.50[a]	1.70[a]
A.coriaria	0.96[a]	1.02[a]	1.10[b]	1.18[a]	1.20[a]	1.48[b]
A.ferruginea	0.74[a]	0.96[a]	1.03[b]	1.25[a]	1.58[a]	**1.71[a]**
A.saman	0.98[a]	1.02[a]	1.20[a]	1.30[a]	1.50[a]	1.54[b]
Control	**0.72[a]**	0.94[a]	1.03[b]	1.12[a]	1.45[a]	1.47[b]
SE±	0.13	0.11	0.04	0.70	0.07	0.05

*Means on the same column having different superscripts are significantly different (P<0.05)

Key: WAT= Weeks After Transplanting

Key: NFAT=Nitrogen Fixing Albizia Trees

Highest number of leaves of 12.20 was recorded from seedlings planted in the soil influenced with leaf litters of *A. lebbeck.,* while the least number of leaves of 5.80 was recorded from seedlings planted in an unamended soil (control). At the end of experimental period, there was no significant (P>0.05) difference between number of leaves of seedlings subjected to treatment and no treatment (Table 3).

Table 3: Improving growth of *C. albidum* seedling number of leaves using leaf litters of selected nitrogen-fixing albizia trees

NFAT	WAT					
	4	8	12	16	20	24
A.lebbeck	7.20^{a}	7.80^{a}	9.20^{a}	10.00^{a}	10.20^{a}	**12.20^{a}**
A.zygia	7.40^{a}	7.80^{a}	8.00^{a}	9.20^{a}	9.40^{a}	11.60^{a}
A.coriaria	6.60^{a}	8.00^{a}	8.60^{a}	8.65^{a}	11.00^{a}	11.60^{a}
A.ferruginea	6.40^{a}	8.20^{a}	9.60^{a}	9.80^{a}	10.00^{a}	11.60^{a}
A.saman	6.20^{a}	8.00^{a}	9.20^{a}	9.80^{a}	9.80^{a}	11.40^{a}
Control	**5.80^{a}**	6.20^{a}	7.40^{a}	8.80^{a}	9.00^{a}	10.00^{a}
SE±	1.31	1.29	1.31	1.33	1.72	1.71

*Means on the same column having different superscripts are significantly different (P<0.05)

Key: WAT= Weeks After Transplanting

Key: NFAT=Nitrogen Fixing Albizia Trees

Widest leaf area of 53.86 cm^2 was recorded from seedlings planted in the soil improved with leaf litters of *A. ferruginea.* The narrowest leaf area of 9.60cm^2 was recorded from seedlings planted in the soil without the influence of leaf litters of nitrogen-fixing albizia trees (control). The leaf area of seedlings planted in soil enhanced with the leaf litters of *A. lebbeck, A. zygia* and *A. saman* were not significantly (P>0.05) different from one and other. The leaf area of seedlings planted in the soil with leaf litters of *A. ferruginea* was significantly (P<0.05) different from that of control.

Table 4: Improving growth of *C. albidum* seedling leaf area (cm^2) using leaf litters of selected nitrogen-fixing albizia trees

NFAT	WAT					
	4	8	12	16	20	24
A.lebbeck	19.76^{a}	19.82^{a}	19.93^{a}	34.47^{a}	48.85^{a}	53.08^{a}
A.zygia	12.90^{b}	24.13^{a}	27.77^{a}	31.83^{a}	48.16^{a}	48.95^{a}
A.coriaria	9.68^{b}	9.88^{b}	10.67^{ab}	26.47^{ab}	27.75^{bc}	31.19^{b}
A.ferruginea	19.20^{a}	19.82^{a}	27.64^{a}	33.50^{a}	48.81^{a}	**53.86^{a}**
A.saman	13.86^{b}	23.35^{a}	29.18^{a}	35.05^{a}	35.13^{b}	48.40^{a}
Control	**9.60^{b}**	9.68^{b}	9.86^{b}	10.67^{b}	20.47^{c}	26.47^{b}
SE±	2.35	3.03	4.11	4.73	5.62	6.54

*Means on the same column having different superscripts are significantly different (P<0.05)

Key: WAT= Weeks After Transplanting

Key: NFAT=Nitrogen Fixing Albizia Trees

Highest total fresh weight (15.42g) and total dry weight (8.89g) were recorded from seedlings planted in the soil enhanced with leaf litters of *A. ferruginea*. The least values of total fresh weight (4.79g) and total dry weight (2.35g) were recorded from seedlings planted in the soil not amended with leaf litters of nitrogen-fixing albizia trees (Table 5).

Table 5: Improving growth of *C. albidum* seedling fresh and dry weight (g) using leaf litters of selected nitrogen-fixing albizia trees

NFAT	FW			TFW	DW			TFW
	L	R	S		L	R	S	
A.lebbeck	3.40^{ab}	3.95^{a}	3.85^{a}	11.20^{ab}	1.45^{b}	1.75^{a}	1.65^{ab}	4.85^{ab}
A.zygia	3.00^{ab}	0.85^{b}	3.45^{a}	7.30^{b}	1.35^{b}	0.35^{b}	1.55^{ab}	3.25^{ab}
A.coriaria	6.30^{a}	3.75^{a}	3.30^{a}	13.35^{ab}	4.35^{a}	1.50^{a}	1.35^{ab}	7.20^{a}
A.ferruginea	7.00^{a}	4.40^{a}	4.02^{a}	**15.42^{a}**	5.15^{a}	1.99^{a}	1.75^{a}	**8.89^{a}**
A.saman	4.75^{ab}	1.00^{b}	1.60^{b}	7.35^{b}	2.50^{ab}	0.55^{b}	0.40^{ab}	3.45^{ab}
Control	2.03^{b}	1.98^{b}	0.78^{b}	**4.79^{b}**	1.15^{b}	1.03^{ab}	0.17^{b}	**2.35^{b}**
SE±	1.68	0.70	0.68	2.95	1.14	0.36	0.63	1.12

*Means on the same column having different superscripts are significantly different (P<0.05)

Key: NFAT=Nitrogen Fixing Albizia Trees, FW= Fresh Weight, TFW-Total Fresh Weight, DW=Dry Weight, TDW=Total Dry Weight, Rs=Rates, L=Leaf, S=Shoot, R=Root

Nutrient composition of leaf litters of selected nitrogen-fixing albizia trees

Highest nitrogen (7.05%), phosphorus (0.213%) and potassium (0.573%) were recorded from leaf litters of *A. ferruginea, A. coriaria and A. lebbeck* respectively. The least values of nitrogen (0.05%), phosphorus (0.02%) and potassium (0.07%) were recorded from control treatment (Table 6).

Table 6: Nutrient composition of leaf litters of selected nitrogen-fixing albizia trees

NFAT	N%	P%	K%
A.ferruginea	**7.05**	0.200	0.510
A.zygia	6.85	0.161	0.473
A.coriaria	5.24	**0.213**	0.524
A.lebbeck	5.89	0.184	**0.573**
A.saman	6.60	0.170	0.451
Control	**0.05**	**0.02**	**0.07**

Key: NFAT=Nitrogen Fixing Albizia Trees

Discussion

Seedlings planted in the soil influenced with leaf litters of *A. ferruginea* gave highest growth parameters. Contrary to this result, Kolapo *et al.* (2014) reported that application of 2.5 t/ha *Albizia saman* leaves enhanced the growth parameters of maize and improved the soil chemical properties. Highest leaf area and leaf dry weight recorded from seedlings planted in the soil influenced with leaf litters of *A. ferruginea* showed that it enhanced growth as well as yield of the plant. This result is in consonance with the report of Rafiq *et al.* (2010) who stated that the maximum leaf area (LA) and total leaf biomass of plants are a determinant of higher crop yield.

Highest growth parameters recorded from seedlings planted in the soil influenced with leaf litters *A. ferruginea* was adduced to its highest nitrogen content. Nitrogen is essential in the growth of plants (Zhang *et al.,* 2011). Nitrogen promotes plant growth and improves fruit and seed production, resulting in a greater yield (Smil, 2001; Mas, 2013; Shah *et al.,* 2016, Caines, 2018). It is also essential for photosynthesis, which is the process in which plants convert light energy into chemical energy (Ahmad *et al.,* 2009; Mas, 2013; Caines, 2018; Rodriguez, 2018; Li *et al.,* 2019).

Nitrogen incorporation enhances the formation of active photosynthetic pigments, by improving the amounts of stromal and thylakoid proteins in leaves (Cooke *et al.,* 2005; Filho *et al.,* 2011), in addition to increasing the formation of chloroplasts during leaf growth (Li *et al.,* 2012). Chlorophyll and carotenoid synthesis are dependent upon mineral nutrition (Daughtry *et al.,* 2000). The accurate nitrogen accessibility is important in cell division and development of active photosynthetic pigments, including chlorophyll (Razaq *et al.,* 2017). Nitrogen is an essential nutrient for the production of amino acids, proteins, nucleic acids (Hu and Schmidhalter, 2005; Desmond, 2006; Aref and Shetta, 2013).

Various investigators as Inkham *et al.* (2021) (green oak lettuce)., Montenegro *et al.* (2019) (*Jatropha curcas*)., Li *et al.* (2019) (Moso bamboo) have reported that nitrogen enhanced plant growth. Sanzperez *et al.* (2007) and Oliet *et al.* (2009) stated that N addition can greatly affect the shoot morphology and nutritional status of nursery seedlings. The ideal growth-promoting effect of N improves cytokinin production, which eventually influence cell wall elasticity (Bloom *et al.,* 2006), number of meristem matic cells, and cell growth (Lawlor, 2002). Furthermore, N fertilization also increases seedling height and root collar diameter (Cuesta *et al.,* 2010; Andivia *et al.,* 2011).

Previous findings reported that N availability has significant effects on plant root biomass, production, and mortality (Kern *et al.,* 2004), root elongation (Lopez-Bucio *et al.,* 2003) and higher root-order development and branching (Woolfolk and Friend, 2003). In addition, N fertilization significantly increases the diameter of *Larix gmelinii* root tips (Sun *et al.,* 2010) and the growth, root length, and root diameter of *Pongamia pinnata* seedlings (Chaukiyal *et al.,* 2013). Correlation analysis showed that the total nitrogen content was significantly correlated with root growth, which also fully explained the sensitivity of roots to nitrogen utilization (Valladares *et al.,* 2000; Boucher *et al.,* 2007).

The preliminary investigation revealed that N addition can improve plant growth variables to a point but has a detrimental effect at higher levels (Mas, 2013; Shah *et al.,* 2016; Razaq *et al.,* 2017). For example, excess N has been shown to shorten the life span of plant leaves, increase their susceptibility to disease (Bojovic and Stojanovic, 2005; Rodriguez, 2018). Plants exposed to high nutrient deficiencies exhibited a progressive reduction in total root length (TRL) (Gruber *et al.,* 2013; Rodriguez, 2018) whereas higher and lower N levels have been shown to reduce plant root growth and biomass (Salih *et al.,* 2005; Fageria and Moreira, 2011; De Giorgio and Fornaro, 2012). Therefore, nutrient management practices should be technical and most advantageous (Shah *et al.,* 2016).

Highest number of leaves recorded from seedlings planted in the soil improved with leaf litters of *Albizia lebbeck* could be adduced to the highest potassium content. Potassium (K) is required by all plant and animal life (Ross, 2022). Potassium is a macronutrient that is essential for many physiological and biochemical processes pertaining to plant growth, development, and nutrient uptake (Santiago *et al.,* 2012; Ben and Marchand, 2013; Hafsi *et al.,* 2014; Fontana *et al.,* 2020) water regulation, photosynthesis, and stand in as an enzyme activator (Pettigrew, 2008; Hu *et al.*, 2016). El-Mogy *et al.* (2019) established that potassium is a chemical compound in diverse enzymatic reactions in carbohydrate biosynthesis, photosynthesis, and stress regulation of plants. It is essential for a plant's mechanical stability, nutrition, development, reproduction, and resistance to pathogens (Jaiswal *et al.,* 2016). Ross (2022) stated that the appropriate potassium application increases photosynthetic efficiency, disease resistance and greater water use efficiency, which eventually produces good quality plant.

Jaiswal *et al.* (2016) stated that administering potassium lessens plant abiotic stress by improving photosynthate translocation and promoting gas exchange, protein synthesis, enzyme activity, and stomatal conductance (Jha *et al.,* 2017; Zahoor *et al.,* 2017). Potassium helps maintaining a normal balance between plant carbohydrates and proteins (Ross, 2022). Ray *et al.,* (2015) established that the increased potassium application improves some plant molecular and physiological mechanisms to response to environmental stress and maximizes watering and fertilizer utilization to improve water retention, stomatal conductance and light absorption that lead to increased crop improvement and yield (Kruashvili *et al.,* 2016).

The potassium application had signiûcant effect on *Eucalyptus grandis* **(**Gotore *et al.,* 2014) and olive tree and its oil yield (Elloumi *et al.,* 2009). Ali *et al.* (2018) reported that potassium minimizes plant water damage and energizes anti-stress enzyme systems at the same time enlarging plant root system. This additional translocation, increases water absorption, lessens respiration, and rises photosynthetic activity (Prado, 2008), which improves crop development and reduces lodging. The participation of potassium in the regulation of the opening and shutting of the stomata reduces the excessive loss of water by the plant under hydric stress (Lima *et al.,* 2003; Taiz and Zeiger, 2013). This favorable effect of potassium was observed in *Eucalyptus grandis* W. Hill plantlets under moderate hydric stress promoting reduction of water loss by the plant (Silva *et al.,* 2004).

The application of potassium also mitigates water stress in many other crop plants such as *Nicotiana rustica*, *Zea mays*, and *Oryza sativa* (Zain and Ismail, 2016; Martineau *et al.,* 2017; Farooq *et al.,* 2020); vegetable (Wang *et al.*, 2016) and *Brassica juncea* cultivars (Rani *et al.,* 2021). However, Rani *et al.,* (2021) stated that if the low availability of water persists for a long period, photosynthesis rate decreases and, as a consequence, plant growth is reduced. Potassium plays a main act in cellular growth, leaf response, tropisms, metabolic homeostasis, osmoregulation, stomatal movement, and wood formation in trees (Fromm 2010). Begum *et al.* (2019) established that the potassium further lessens plant salt stress owing to its direct and indirect involvement in antioxidant activation, an adaptive salt-stress response.

Excess or insufficiency in potassium affects complete plant growth (Hasanuzzaman *et al.,* 2018) because it is necessary for different biochemical and physiological processes as protein synthesis, carbohydrate metabolism, and enzyme activation (Wang *et al.,* 2013). Fontana *et al*. (2020) stated that potassium inadequacy considerably damaged *Gossypium hirsutum* L, cotton seedling growth and development, with proof of reduction in their growth variables. Potassium deficiency also significantly inhibited plant root and leaf respiration and leaf photosynthesis (Fontana *et al.,* 2020). Fontana *et al.* (2020) opined that potassium deficiency significantly inhibited root elongation and total root surface areas that further inhibited cotton seedlings to uptake nutrients from the medium. Potassium deficiency induced aberrant expression of both microRNAs (miRNAs) and their protein-coding targets. These miRNAs regulate plant root development as well as response to abiotic stresses (Fontana *et al.,* 2020).

Conclusion

With the rapid disappearance of our indigenous forest trees as *C. albidum* as well as associated land degradation, there is need to embrace affordable, accessible, adoptable and environmentally friendly organic manure as leaf litters of nitrogen-fixing albizia trees to restore soil fertility for enhancing its growth to meet its population demand. The investigation conducted into growth response of *C. albidum* to leaf litters of selected nitrogen-fixing albizia revealed that leaf litters of *A*. ferruginea enhances the growth of *C. albidum* seedlings. Appropriate plant nutrition with the use of leaf litters help to produce high quality planting stock of tropical forest trees.

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Key: WAT= Weeks After Transplanting
Key: NFAT=Nitrogen Fixing Albizia Trees, FW= Fresh Weight, TFW-Total Fresh Weight, DW=Dry Weight, TDW=Total Dry Weight, Rs=Rates, L=Leaf, S=Shoot, R=Root