ISSN: 3068-9538

Research Article

Journal of Environmental Sciences and Plant Research

Effect of Selected Leguminous Leaf Litters on Growth and Yield of Maize Under Agroforestry System

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ABSTRACT

Declining soil fertility are increasingly viewed as critical problems affecting agricultural productivity. The quality of litter inputs under agroforestry system from trees and shrubs is essential for improving soil fertility. The study was carried out in Jos metropolis (Jos North and Jos South Local Governments). This research work was divided into two parts (survey and field studies). The survey study was conducted by purposive sampling of100 farmers in two Local Governments in Jos metropolis using structure questionnaire. The identified tree species were grouped into indigenous and exotic and then prioritized under the field experiment. Height and number of leaves were measured at two-week intervals for a period of 14 weeks. At maturity, the cob was harvested. Cob weight, cob length, cob diameter and grain weight were determined. The study revealed that P. biglobosa having the highest frequency (19), Results on growth showed that all the maize with litter application had significantly ($p<0.05$) higher height values than the maize in the control with L. leucocephala having the highest value (152.7cm). The results on yield showed that the maize plant with the application of L. leucocephala leaf litter had significantly ($p<0.05$) the best yield for all the parameters assessed compared to maize in other treatments. The study revealed that T. indica and L. leucocephala litter were high-quality litter that decomposed very rapidly to release a considerable amount of nutrients within a short period of time. Hence, L. leucocephala is recommended for crops of short growth cycles like maize.

Keywords: Agroforestry, Maize (Zea mays L.), Leaf Litter, Leguminous Trees, Soil Fertility, Albizia lebbeck.

Received: May 30, 2026;
Accepted: June 06, 2026;
Published: July 06, 2026

Introduction

Fertilizer application is one of the methods commonly used to correct nutrient depletion and increase crop yield. However, most farmers cannot afford the cost or have limited access to it. In addition, fertilizer application alone cannot guarantee sustainable long-term productivity on many soils. High population pressure dictates that efficient, high-input systems must be developed. Hence, inputs of organic materials are needed to maintain soil organic matter levels [1]. Therefore, the role of agroforestry-based alternatives in improving soil quality and fertility call for urgent attention. In the context of soil fertility, an understanding of the soil's biological processes and the quality of organic inputs from on-farm materials such as litter from trees, shrubs, and crop residues are essential. This understanding usually assists in the manipulation of organic materials to improve the synchrony between nutrient release from plant residues and crop demand for nutrients [2]. The use of locally available plant materials from tree legume tree species as farm inputs has many benefits. Organic materials can be more advantageous in that it helps in controlling many biochemical processes and nutrient cycling in the soil than costly fertilizers. It can also help to increased microbial biomass and soil organic matter

Citation: Dahunsi OM, Majolagbe MO, Erhabor TA, Salau LO, and Olujobi OJ (2026) Effect of Selected Leguminous Leaf Litters on Growth and Yield of Maize Under Agroforestry System. J Envir Sci Plant Res 2: 1-5.

build-up, improve soil physical properties and supply of macro/micro nutrients especially those not present in commonly used fertilizers [3]. The main objectives of this study is to identify and prioritize tree species planted or retained for soil fertility improvement in the study area; and to investigate the effect of selected leguminous tree species leaf litter on the growth and yield of maize. Organic inputs play a role in reducing Phosphorous adsorption and soil acidification. However organic inputs, even if applied at reasonable rates, could sustain crop yields [4]. Insufficiency of nutrients (especially Phosphorous) could limit nitrogen availability, also nutrient mineralization of input litter must synchronize with crop demands to increase crop yield.

Materials and Methods

Study Area

The study was carried out in Jos metropolis (comprising Jos North and Jos South Local Governments. Jos lies between latitude 9o 54'N and 10o 10'N and longitude 8o 48'E and 9o 30'E in the southern limit of the Guinea Savannah ecological zone of Nigeria. The soil is sandy, light to dark in colour. The soil is well-drained and well aerated. Annual rainfall is about 1460 – 4800 mm. The temperature ranges from 10 oC – 32 oC with an altitude of 1220m above sea level (University of Jos Metrological Station Directory, 2009). Jos has a population of about 900,000, with over 70% of its population engaging in agriculture. The soil and climatic conditions of the state favour the production of exotic crops like Irish potatoes, apples, grapes, wheat, barley and vegetables. These crops are grown throughout the year: rain-fed during the wet season and irrigated during the dry season. Jos is blessed with commercial quantities of minerals such as barite, kaolin, and phosphate, among others.

Research Method

Tree Species Planted/retained by Farmers

Purposive sampling through the use of a structured questionnaire and group discussions were used to determine the tree species planted/retained by 100 farmers in the study area.

Data on the socio-economic characteristics of the farmers, farming practices and tree species used in fallows, among others, were collected with the use of a structured questionnaire. The tree species were grouped into indigenous and exotic and then prioritized.

Effects of Leaf Litter on the Growth and Yield of Maize

Litters of the preferred tree species: Parkia biglobosa, Tamarindus indica and Albizia lebbeck, Leucaena leucocephala (two indigenous and two exotic) retained/planted by farmers in the study area were collected, air-dried and ground in a steel grinding mill. Two hundred grams (200g) of the grounded leaves litter samples were added to 15kg of degraded soils in used cement bags and arranged in a Completely Randomized Design (CRD). The experiment comprises five treatments, including control (T0= Control (no leaf litter i.e. degraded soil only).

Results and Discussion

Results

Agroforestry Practice by the Farmers in the Study Area

Table 1 shows the type of agroforestry practiced by the respondents in the study areas. The result showed that alley cropping has the highest value (40%), followed by Woodlots (24.16%), Shifting cultivation (17.50%), while home garden and Boundary Planting are 12.50% and 5.83% respectively.

Table 1: Types of agroforestry practice

Variables	Frequency	%
Alley cropping	48	40.00
Woodlots	29	24.16
Shifting cultivation	21	17.50
Home garden	15	12.50
Boundary planting	7	5.83
Total	120*	100

* Multiple responses Source: Field Survey, 2024.

Species Preferences

The study revealed that eleven (11) tree species were either retained or planted in the study area, with Parkia biglobosa ranked 1st with the highest mention (19), followed by Leucaena leucocephala (18), Tamarindus indica (15), and Albizia lebbeck (14) in the 2nd, 3rd and 4th positions, respectively (Table 2).

Table 2: Tree species planted or retained by the respondents on their farmlands

	Names of Species	Frequency	Rank
1	Parkia biglobosa	19	1st
2	Leucaena leucocephala	18	2nd
3	Tamarindus indica	15	3rd
4	Albizia lebbeck	14	4th
5	Magnifera indica	11	5th
6	Adansonia digitata	11	5th
7	Vitex doniana	9	6th
8	Psidium guajava	6	7th
9	Citrus	6	7th
10	Milithia thonnigi	6	7th
11	Azadirachta indica	5	8th
	Total	**120***	

* Multiple responses Source: Field Survey, 2024

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Effect of Leguminous Tree Leaf Litter on Maize Growth

The effect of leguminous tree species leaf litter on the growth of maize is presented in Figure 3. The results showsed that the maize plant with the application of Leucaena leaf litter had significantly ($p<0.05$) the highest height (10.6cm) at the early growth stage (4 WAP). The maize plant with Albizia litter application has the highest height of 32.1cm and 71.2cm at 6 and 8, respectively. At maturity (10-14 WAP), the maize plant with

Leucaena leaf litter application has significantly ($p<0.05$) the highest height values. The results showed that all the maize with litter application had significantly ($p<0.05$) higher height values than the maize in the control treatment throughout the growth period. Figure 1 showed that the maize plant with Leucaena litter application has a significantly ($P<0.05$) greater number of leaves throughout the growth period. This was followed by maize with Albizia litter treatment. The result also shows that maize in the control treatment has the lowest leaf number throughout the growth period.

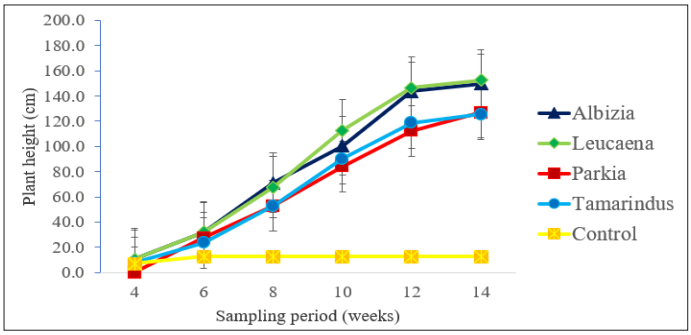

Figure 1: Maize plant height as affected by leguminous tree leaf litter

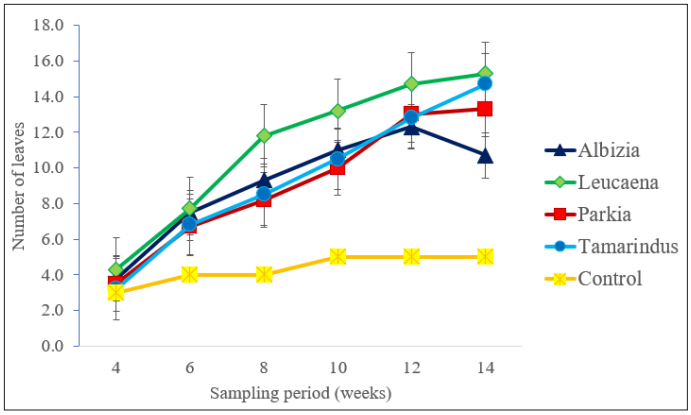

Figure 2: Number of leaves of maize plants as affected by leguminous tree leaf litter

Effect of Leguminous Tree Species Leaf Litter on Maize Yield Parameters

The effect of leguminous tree species leaf litter on maize yield parameters is presented in Table 2. The results showed that the maize plant with the application of Leucaena leaf litter had significantly ($p<0.05$) the highest yield values (8.30cm, 15.20cm, 42.83g, and 27.20g) for cob diameter, cob length, cob weight and grain weight, respectively, when compared to maize in other treatments. This was followed by maize with litter applications of Albizia, Tamarindus and Parkia, respectively, while the maize plant without litter application (control) had the lowest values for all yield parameters (Table 3).

Table 2: Effect of leguminous tree species leaf litter on maize yield parameters

Treatment	Cob diameter (cm)	Cob length (cm)	Cob weight (g)	100 Grain weight (g)
Albizia lebbeck	8.27^{a}	12.80^{b}	30.53^{b}	25.50^{ab}
Leucaena leucocephala	8.30^{a}	15.20^{a}	42.83^{a}	27.20^{a}
Parkia biglobosa	7.52^{a}	9.83^{c}	19.93^{d}	23.69^{b}
Tamarindus indica	7.98^{a}	10.50^{c}	26.60^{c}	24.39^{b}
Control	4.81^{b}	5.61^{d}	12.24^{e}	15.87^{c}
SE+	0.2595	0.3898	0.9824	0.8195

Means followed by the same letter(s) within the same column are not significantly different at $p\leq0.05$ level of probability using DMRT

Discussion

Agroforestry Practice by the Farmers in the Study Area

Farmers in the study area engage in various agroforestry practices to enhance agricultural productivity, improve soil fertility, and ensure environmental sustainability. The system also helps farmers seeking to diversify income, especially those vulnerable to crop failure. Income from timber, fruits, nuts, or medicinal plants serves as a buffer during off-seasons or market downturns. Shifting cultivation, Alley cropping, Woodlot, Home Garden and Boundary planting are the most common agroforestry practices in the area. The choice of these agroforestry systems depends on land availability, cultural practices and economic goals as it relates to individual farmers. This is also in consonance with the findings of Okonya-Chukwu and Nwanwu, who reported that some of these factors affect agroforestry practices in Ebonyin state, Nigeria [5]. All these practices contribute significantly to food security, income diversification, and ecological resilience of the study area.

Species Preferences

The study revealed that eleven (11) different tree species were either retained or planted in the study area, with Parkia biglobosa having the highest percentage, followed by Tamarindus indica, in the ingenious category, while Leucaena leucocephala and Albizia lebbeck are most preferred in the exotic species group. The observed preference for these species could be attributed to the benefits derived from them: such as soil fertility reclamation through the addition of Nitrogen, the provision of tangible products (fuel wood, fruits, herbs and fodder) and environmental services (wind break, erosion control and shade). This assertion confirms the submission by Adewusi that trees, both exotic and indigenous, are usually planted or retained on farmland by farmers to provide essential products crucial to their survival [6]. Besides the production of timber and provision of food for man and feed for animals, observations from the study revealed that these species also serve as a major source of income for farmers in the study area.

Effect of Leguminous Tree Species Leaf Litter on Maize Plant Height in the Screen House

The statistical analysis reveals that Leucaena leucocephala-treated maize plants consistently exhibited higher plant heights across all growth periods. The superior performance of Leucaena

leucocephala aligns with its high nitrogen content, as observed, which is crucial for vegetative growth. Albizia lebbeck also promoted significant growth, which may be attributed to its moderate organic carbon content and nitrogen availability. On the other hand, Parkia biglobosa and Tamarindus indica showed relatively lower impact, possibly due to lower nutrient release rates from their leaf litter.

The findings corroborate those of Sanchez et al. (2001), who highlighted that leguminous tree species enhance soil fertility, promoting better crop growth through nitrogen fixation and organic matter decomposition. Similarly, Akinnifesi et al. in Nigeria reported that Leucaena leucocephala and Albizia lebbeck significantly improve soil structure and nutrient availability, leading to better maize growth [7].

Effect of Leguminous Tree Species Leaf Litter on the Number of Leaves of the Maize Plant in the Screen House

Leucaena leucocephala treatment resulted in the highest leaf count (15.3 leaves), followed by Tamarindus indica and Parkia biglobosa. Albizia lebbeck-treated plants had relatively lower leaf production, though still higher than the control. The observed differences can be linked to the nutrient composition of the leaf litter. The high nitrogen content in Leucaena leucocephala and Tamarindus indica likely stimulated vegetative growth and leaf expansion, as nitrogen is essential for chlorophyll synthesis and photosynthesis (Mafongoya et al., 2006). The control treatment, which lacked additional organic inputs, resulted in significantly fewer leaves, reinforcing the role of organic amendments in maize productivity [8].

Giller reported that nitrogen-fixing trees such as Leucaena leucocephala improve maize growth by enhancing soil organic matter and nitrogen availability, leading to increased biomass accumulation [9]. This may enhance plant height and leaf production due to improved soil fertility. Owoeye and found that Leucaena leucocephala-based organic amendments significantly improved maize growth parameters compared to inorganic fertilizers, emphasizing its role in sustainable agriculture [10]. Similarly, Bamire et al. demonstrated that agroforestry systems incorporating Albizia lebbeck and Parkia biglobosa leaves litter enhanced maize productivity by improving soil physical properties and nutrient cycling [11].

Effect of Leguminous Tree Species Leaf Litter on Maize Yield Parameters in the Screen House

Leucaena leucocephala and Tamarindus indica leaves litter resulted in higher root weight, which was different from root weight from Albizia lebbeck, Parkia biglobosa and untreated control that produced similar root weight. However, for the cob diameter from the leaf litter, they were similar, but significantly different from the cob from the control, which recorded a narrower diameter. Furthermore, Leucaena leucocephala leaf litter recorded a higher cob weight compared to other treatments and the control. The response of 1000-grain weight to the application of different tree species leaf litter from the experiment showed a significant ($P \leq 0.05$) variation in 1000-grain weight with the application of leaf litter, with Leucaena leaf litter having the highest weight. However, seed grain from Albizia, Parkia and Tamarindus has no significant difference, but they are different from the control.

It was observed that the influence of leaf litter on maize dry matter yield and subsequent crop growth was highly significant. Dry matter is an expression of the crop's biological yield and a measure of plant relative growth rate and is a reflection of the net assimilation rate (Khan et al. 2008). The increase in the biological yield of maize could reflect the better growth and development of the plants due to the availability of nutrients throughout the growing period. This result was in agreement with the findings of Laekemariam and Gidago [12].

The statistically significant effect observed could be due to the fact that more photosynthetic activities of the plant are on account of an adequate supply of nitrogen. Nitrogen is an essential requirement for cob growth. Therefore, the bigger the cob size, the better the crop development and the higher the economic yield of the maize crop as reported previously This finding is in agreement with that of Laekemariam & Gidago who reported a significant increase in cob size and length with increasing rates of nitrogen fertilizer application [12]. This study clearly demonstrates that the application of leaf litter had an influence on growth parameters such as plant height, leaf nitrogen content and dry matter weight. The significant effect on maize growth with respect to an increase in plant height and dry matter may be linked to the ability of leguminous leaf litter to supply plant nutrients on a continuous basis, as reported by Farhad et al. 2009 [13].

Conclusion and Recommendation

On the growth parameter; the results from the study indicates that Leucaena leaf litter had the most significant impact on maize height at 14 weeks, followed closely by Albizia. Parkia and Tamarindus showed moderate effects, while the control (without leaf litter) exhibited the least growth throughout the study. Leucaena and Tamarindus leaf litter resulted in higher root weight, which was different from root weight from Albizia, Parkia and untreated control that produced similar root weight. However, for the cob diameter from the leaf litter, they were similar, but significantly different from the cob from the control, which recorded a narrower diameter. This study clearly demonstrates that the application of leaf litter had an influence on growth parameters such as plant height, leaf nitrogen content and dry matter weight. Tamarindus indica and Leucaena leucocephala is good for the growth of short-period crops since it decomposes very rapidly and releases a considerable amount of nutrients within the early growing season. However, the rapid decomposition and nutrient release pattern of foliage biomass may limit its potential for long-term build-up of soil fertility. Alternatively, Albizia lebeck and Parkia biglobosa can be considered for long-term buildup of soil organic matter [14-17].

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