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Management of *Khaya senegalensis* (Desr.) A. Juss Intercropped with Maize and Groundnut under Agroforestry Scheme.

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Abstract

A field experiment was carried out to examine the growth performance of three years old *Khaya senegalensis* plantation intercropped with agronomic (maize and groundnut) crops under Agro forestry scheme. As silvicultural activities continued, data collection begun after three (3) weeks of plating agronomic crops. The plant variables measured are plant height, basal girth and leaves count. Data was analysed using Mean and Analysis of variance in a Randomized Completely Block Design (RCBD) and significant mean differences were separated at p>0.05. The result of the mean value of growth parameters measured showed that the saplings of Mahogany intercropped with Groundnut recorded the highest mean value in the plant height (98.50±17.14) basal girth (98.63±17.06) and number of leaves, 89±64. The result of the correlation analysis revealed that there was a significant correlation between the plot and weeks of data collection (0.00**), plot and basal girth (0.13*) plot and number of leaves (0.30*), plot and tree height (-0.10*). It was recommended that management of *Khaya senegalensis* under agroforestry scheme with nitrogen fixing plant should be encouraged as it improves growth performance.

Keyword: Agroforestry, *Khaya senegalensis*, Agronomic crops, Intercropped

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Introduction

Khaya senegalensis A. Juss. (Melaceae), (mahogany) occurs from Mauritania and Senegal east to northern Uganda. It is commonly planted within its natural area of distribution, mainly as ornamental and roadside tree, and also outside this area, e.g. in Cape Verde, Tanzania, Malawi, Madagascar, Reunion, Egypt, South Africa, India, Indonesia, Vietnam, Australia and tropical America. In drier zones in Sri Lanka it has become a priority species for timber plantation establishment since mid-1990s, with more than 500 ha of plantation established by 2004 and 200 ha/year of new plantations planned for the future. Mahogany is the most suitable indigenous species for timber production in the world, growing up to 35m in high and 1.5m in a diameter on fertile soil, with a 10-16m clean bole, its wood is hard, dense, reddish in colour and highly resistant to biodegradation. The wood has attractive colour, mostly straight grain orientation and a high luster. It is used for cabinetwork, ship building and in the production of decorative veneers Its natural regeneration is poor, especially with the problem of mahogany shoot borer (Moore) attack that usually prevents the success of plantations within the native area in West Africa (Nikiema and Pasternak,2008, Egbewole et al,2018). Agroforestry is the incorporation of trees for forest products into agricultural systems. The incorporation of trees into productive agricultural systems is one of the ways deep-rooted vegetation can be returned to the landscape while maintaining a level of agricultural productivity. Agroforestry has the potential to provide multiple benefits simultaneously. It improves agricultural productivity, diversify and increase farm income, conserve land, maintain biodiversity and contribute to the national timber supply.

Poor management culture of Nigeria forest has led to poor yield and multiplication of timber product in view of the potentials of *Khaya senegalense*, the rate at which the tree species is being felled for forage, commercial and other purposes is high whereas the regeneration and afforestation of the species is virtually nothing to write home about as there is an annual decline in the rate of plantation establishment and effective management Yet, there is increase demand by a greater majority of users for timber and structural works. In order to increase production, this study therefore was carried out to examine growth performance of *K. senegalense* in a plantation under Afro forestry scheme with the aim to assess and compare the growth of *K. senegalense* grown with different agronomy crops and suggest suitable solution to this problem of scarcity and proper management of this tree species.

Materials and Methods

This study was carried out at the *Khaya senegalense* Agroforestry plot of the Department of Forestry and Wildlife management, Nasarawa State University Keffi, Shabu- Lafia Campus. Lafia is located in the Guinea savannah zone of North Central Nigeria and found on latitude 08° 35'N, longitude 080 32 'E, altitude 181.53m above sea level with a mean temperature of 34°C, relative humidity of 40-86% and average day light of 9-12h (Jayeoba et al 2012). The materials used for the experiment include; *Khaya senegalensis* saplings, field book and pencil, thread, and veneer Calliper for Measuring girth, Tags, marking pen, Tap, Meter rule, hoe, cutlass, maize seed, Groundnut seed, Rope for fence, Sign board. The *Khaya senegalensis* plantation was established in March 2016. At the onset of the 2019 raining season the experiment was carried out. The portion of the agroforestry plot planted with *K. senegalensis* was further divided into 4 as shown in Table 1. Ridges were made before planting of agronomic crops manual weeding was employed to reduce competition. Each plot of land was divided into 3 Section for rising of agricultural crop in the same pieces of land with *K. senegalensis.* The crops that were sown are Groundnut and Maize. regular maintenance such as weeding, and watering were carrying out to increase performance of *Khaya* in the plantation. Data collection begun after three (3) weeks of plating the agronomic (maize and groundnut) crops the parameter assed include; Plant height measurement, Basal Girth Measurement, Number of leaves.

This study was laid out in a Randomized completely block design (RCBD), having four treatments with an unequal replicate (Table 1). Analysis of variance was performed on the data to show the comparative performance of each treatment with another. Correlation and regression analysis were used to identify magnitude and the degree of relationship between the selected variable.

Results and Discussion

The mean values of growth parameter assessed on *Khaya* Agroforestry plots reveals that Plot 1 (*Khaya* and groundnut) recorded the highest mean plant height of 98.50±17.14 cm followed by plot 4 (control) with mean value of 95.71±17.87cm, while Plot 2 (Maize and Groundnut Agro-forestry plot) recorded the least mean plant height value with 95.63±12.41cm (Table 2). The result of mean Basal girth showed that, Plot 1 again recorded the highest mean basal girth of 38.63±7.06mm, followed by the control plot with mean value of 36.72±5.87mm, while plot 3 recorded the least collar girth value of 34.19±5.48mm. The mean values for Numbers of leaves showed that, plot 1 again had the highest Numbers of leaves with 89±64, followed by plot 2 with mean value of 76±51, While plot 4 recorded the least mean value of 42±19. (Table 2). The mean values of growth parameters measured on the basis of month shows that the higher the period the increase in growth. Month 20 recorded the highest mean plant height value of 98.58±13.50 cm. Followed by month 19 with mean value of 96.58±7.51inche, while month 18 recorded the least mean plant height value of 95.67±7.51 inches. The mean values of Basal girth showed that, month 20 has the highest mean Basal girth 19.12±6.78mm followed month 19 with mean Basal girth value of 15.58±5.62mm, while month 18 again recorded the least mean value of 14.24±5.50mm. The mean values for Numbers of leaves showed that, month 20 again has the highest Numbers of Leaves with 94.59±62.22, followed by month 19 with mean value of 73.31±50.90, while month 18 recorded the least mean value of 51.79±3.47.

The results of analysis of variance is indicates that plot (0.01**), and month (0.01**), significantly influence plant height at $p<0.05$ (Table 3). The result of interaction between plot and month (0.99^{ns}) was not significant. On the basis of basal girth, the results of analysis of variance indicate that plot and month (0.00**) are significant at $p<0.05$, meanwhile the result of two ways interaction between plot and month (0.24^{ns}) was not significant at $p<0.05$. plots and month (0.00**) were

highly significant at $p<0.05$, and the result of two ways interaction between plot and month (0.19^{ns}) was not significant at $p<0.05$. The result of the correlation analysis in Table 4 revealed that there was a significant correlation between the plot and month (0.00), there was no significant correlation between plot and basal girth (0.13**) plot and number of leaves (0.30**), plot and tree height (-0.10**). The correlation analysis also revealed that there was a significant correlation between the month and basal girth (0.31**) month and number of leaves (0.32**) month and tree height (0.14**). It's also revealed that there was a significant correlation between the basal girth and number of leaves (0.56**), basal girth and tree height (0.40**) Likewise there was a significant correlation between the number of leaves and tree height (0.32**). The result of the regression analysis (Table 5) on the effects of growth variables on tree plant height had coefficient of ($R^2 = 0.19$) meaning that the assessed growth variables had about 19.2% effects on plant height of *Khaya senegalense* intercropped with maize and groundnut in Nasarawa State.

It can be deduced from the result that Plant growth is directly related to the availability of nutrient in the soil. The planting of agronomic crops also had a positive effect on the growth of the assessed variable. The result showed that the sampling of *K. senegalensis* where groundnut was planted with mahogany recorded the highest mean values of growth parameters with 98.50±17.14cm in plant height 38.63±7.06mm in basal girth and 89±64 was recorded under the number of leaves. This could be attributed to the fact that groundnut is a nitrogen fixing plant and makes this study agrees with Feldhake, *et. al.*, (2008) who noted that forages under trees experienced essentially shaded conditions when the flush of spring growth occurred and with Egbewole *et al.,* (2015) on the assessment of germination and early growth trial of *Gmelina arborea*. The plot where maize was planted also shows an additional growth effect on mahogany with 95.63±12.41cm in plant height, 76.0 ±51.0 in leave produced and 35.51±5.68 in collar girth. This was contrary to the study carried out by Egbewole *et. al.*, (2017) on *Gmelina* in an agro-forestry practice where he reported Maize agro-forestry plot to be the least performed to okra but to groundnut. But in accordance with the research of Bargali and Tewari (2004), who reported that planting *Khaya s.* with crops like maize has been found beneficial in increasing the simultaneous production of wood and food. This output could be attributed to the fact that maize utilized more nutrients within the upper layer of the soil.

On a general note, all the treatment influences the growth of mahogany positively as the parameters value of treated supersedes the control. They could be that the presence of this agronomic crops helps reduce the impact of sunlight on Mahogany. A similar situation was reported by Feldhake (2001) who found that surface soil temperatures during dry periods could affect growth and yield of forest tree; he further observed that soil moisture was slightly lower under trees than in the alley centres. However, for most of the study period soil moisture levels were sufficient that this difference was not critical. A decrease in shade-site evapotranspiration demand may help compensate for lower soil moisture and facilitate forages maintaining. The continuous growth noticed as at the period of data collection could be attributed to the fact the *Khaya* stands is still at the sapling stage hence, growing at rapid rate. This is in accordance with the report of Rotowa *et. al.,* (2007) on *Moringa olifera*, Rotowa and Adeagbo (2019) in a Provenance trial of *Gmelina aborea* in middle-Belt Zone of Nigeria and Baligari (2008) who reported that the uptake of all the macronutrients was significantly influenced by species with time. In another study carried out on Beltsvile, variations observed in nutrients uptake were related to differences in dry matter accumulation between species. Nine cover crop species tested in this experiment expressed significantly different in growth parameter and nutrient uptake, influx, transport, and utilization efficiency at different time on different tree crop (Baligar *et. al.*, l997)

Conclusions and Recommendations

There is no doubt that *Khaya senegalensis* is predominately strives well in savanna wood land of guinea zone including transition types of the forest zone as it is the most suitable indigenous species for timber production in many African countries including Nigeria. Base on the result of the study therefore, it was discovered from the analysis result that the plants grows as the week increases. It is recommended that proper management should be given to the *Khaya senegalensis* plantation, and also intercropped with agronomic crop so has to meet the ever-increasing demand. Also, the management of *Khaya senegalensis* under agroforestry scehme should be encouraged as it improves growth performance.

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Tables

Table 1: Experimental lay-out.

Plots	Treatment	Sample population
Plot 1	*K. senegalensis* intercropped with Maize	250
Plot 2	*K. senegalensis* intercropped with Maize and G/nut	250
Plot 3	*K. senegalensis* intercropped with Groundnut	250
Plot 4	Control	250

Table 2: Mean value and Duncan mean separation value for growth variable of Khaya senegalensis on the basis of Agro-plant and duration.

Source of variation	Sample size	Plant height (cm)	No. of leaves	Basal girth (mm)
Plot 1 (G. nut)	250	98.50±17.14^{b}	89±64^{c}	38.63±7.06^{c}
Plot 2 (Maize)	250	95.63±12.41^{b}	76.±51^{b}	35.51±5.68^{ab}
Plot 3 (G. nut + Maize)	250	95.65±12.01^{a}	53.±37^{a}	34.19±5.48^{a}
Plot 4 (control)	250	95.71±17.87^{a}	42±19^{a}	36.72±5.87^{bc}
Grand mean	**1000**	**96.61±9.95**	**72±54.**	**16.29±6.32**
Duration				
18-month		95.67±7.51^{a}	51±31^{a}	14.24±5.50^{a}
19-month		96.58±7.51^{a}	73±50^{b}	15.58±5.62^{b}
20-month		98.58±13.50^{b}	94.±62 ^{b}	19.12±6.78^{c}
General mean		96.29±9.95	72±54.	16.29±6.32

Note: Figures with the same alphabet in the same column are not significantly different at p<0.05

Table 3: Analysis of variance of the parameters assessed

Source of variation	Df	Sum of squares	Mean square	F	Sig	R^2
Tree Height						
Plot	3	1158.88	386.29	3.99	0.01**	
Months	2	950.90	475.45	4.92	0.01**	
plot* Month	6	92.90	15.48	0.16	0.99^{ns}	
Error	988	59235.18	96.63			
Total	999	61817.52				0.25
Basal Girth						
Plot	3	1288.92	429.64	12.69	0.00**	
Months	2	1528.57	764.29	22.58	0.00**	
plot* Month	6	270.37	45.06	1.33	0.24^{ns}	
Error	988	20815.87	33.85			
Total	999	24994.68				0.15
No. of leaves						
Plot	3	168111.60	56037.2	23.53	0.00**	
Months	2	112367.40	56183.7	23.59	0.00**	
plot* Month	6	20749.11	3458.18	1.45	0.19^{ns}	
Error	988	1445376.34	2381.18			
Total	999	1820864.91				0.19

Note: * = significant, ** = highly significant, ns = not significant at p = 0.0

Table 4: Correlation analysis for parameters assessed

	Plot	**Months**	**Basal Girth**	**Num of Leaves**	**Tree Height**
Plot	1				
Months	0.00	1			
Basal Girth	-0.13**	0.31**	1		
Num of Leaves	-0.30**	0.32**	0.60**	1	
Tree Height	-0.10**	0.14**	0.40**	0.32**	1

** = Correlation is significant at 1% level p<0.01, * = correlation is significant at 5% level p<0.05

Table 5: Regression analysis for parameters

Model	**Un-standardized coefficients**		**Standard coefficient**	**t**	**Sig**	**R^2**
	B	**Std. Error**		**B**		
(Constant)	18.45	8.90		2.07	0.04	
Plot	-0.17	0.39	-0.02	-0.43	0.67	
Months	-0.08	0.48	-0.01	-0.17	0.87	
Basal Girth	0.49	0.07	0.31	6.97	0.00	
No of Leaves	0.03	0.01	0.14	3.07	0.00	**0.19**

Note: ** = highly significant at 1% probability level, * = significant at p<0.05, ns = not significant dependent variable: height.