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COPPICING ABILITY AND GROWTH OF *Albizia lebbeck* L. BENTH SUBJECTED TO PLANTING ESPACEMENT AND CUTTING HEIGHTS IN WOODLOT

Ogunwande, O. A., Adegoke, F. F., Majolagbe, M. O., Ajani, B. A., Ogunsiji, A.O., Williams, O. A and Kareem, A. A

Forestry Research Institute of Nigeria, Ibadan
PMB 5054 Jericho Hills, Ibadan Nigeria
solaogunwande@gmail.com/2348054393060

ABSTRACT

Over-dependence on fuelwood by Nigeria rural populace has led to diminished forest reserves which woodlots establishment is essential to salvage the situation but considering land scarcity and dearth of information on ability of fuelwood species to coppice at any cutting point, it is necessary to study effects of planting espacement and cutting heights on ability of *Albizia lebbeck* saplings to coppice as fuelwood species in woodlot. The study was carried out on field at Forestry Research Institute of Nigeria, Ibadan. Relatively uniform seedlings (45) were selected and subjected to different spacing (PE) (1m x 1m, 1.5m x 1.5m and 2m x 2m) and after 6 months of planting, pollarding at different heights (CH) (60cm, 90cm and 120cm above the ground level) was done. The experimental design used was 3 x 3 factorial with 5 single plant replicate laid in CRD. Number of coppice, height of dominant coppice, diameter of dominant coppice and number of leaves were parameters assessed. *S*aplings subjected to 2m x 2m PE and 60cm CH had the highest mean number of coppice (5.4 sprouts) while the least mean number of coppice was recorded in 1m x1m PE and 120cm CH with 2.6 sprouts. Saplings subjected to 120cm CH and 2m x2m PE recorded the longest dominant sprout length with 93 mm. Albizia can be established for fuelwood using 2m x 2m espacement in areas where 3m x 3m conventional spacing is not possible, while 120cm cutting height is suggested for production of vigorous sprout.

Keywords: *Albizia lebbeck*, Saplings, Cutting Heights, Espacement, Coppicing

Introduction

Albizia lebbeck is one of the most useful and promising fast growing trees which grows at elevations from sea level to 1500m in different climatic zones. It is widely cultivated and naturalized in subtropical regions and other tropical region though a native to tropical Asia (Bhat and Chauhan 2002; Faisal *et al*., 2012). More often it is 15-20 m tall with a diameter of 50cm (DFSC, 2000); bark grey-violet with rusty brown breathing pores, rough and fissured. *A. lebbeck* coppices well, responds to pollarding, pruning and lopping, and will produce root suckers if the roots are exposed (Troup, 1921; World Agroforestry Centre, undated). It grows well in areas with 600-2500 mm rain/year. It performs well on fertile, well-drained loamy soils and can tolerate acidity, alkalinity, heavy and eroded soils, and waterlogged soils (Salim *et al*., 2002). The shallow root system makes it a good soil binder which makes it recommendable for soil conservation and erosion control. It is nitrogen-fixing, tolerant to drought and older trees can survive grass fires and intense night frost (Dorthe, 2000).

A. lebbeck wood can be suitable for construction, furniture and veneer (Orwa *et al*., 2009). Aside its value as timber species, ornamental and shade plant, fodder to mention few, it is also an excellently useful fuelwood and charcoal species with a calorific value of 5200kcal/g (Salim *et al.,* 2002).

Forest and forest products play a very important role in the development of any nation. The uses of forest resources vary but provision of fuelwood for domestic consumption cannot be overemphasized. There are many sources of domestic fuel but of all these, fuel wood remains the commonest in Nigeria partly due to its accessibility, affordability, convenience, tradition and vegetation distribution (Akut, 2008). The over-dependence on fuel wood for energy is chiefly because of its relatively low prices and easy accessibility while population increase was also associated with increasing demand for fuel wood (Audu 2013; Makinde 2017). Daily consumption of firewood by the rural communities in Nigeria was estimated at 27.5 million kg/day (Ogunsanwo and Ajala, 2002) while Maduka (2011) put fuel wood consumption of Nigeria to about 80 million cubic meters. This observation was buttressed by another data published by The Solar Cooking Archive (2011) which put the estimate of Nigeria's fuel wood consumption as percentage of energy at about 87%. Therefore, majority of the Nigerian rural people have been using and will continue to use the dried biomass fuels as energy source for many years to come.

Meeting rural household wood fuel energy needs in the country has become a herculean task due to the enormous quantity of wood required and use of wood as fuel for domestic and local industry use in developing countries has diminished forest reserves and increased desertification, leading to wood fuel crisis in some areas (Cooke *et al*,2008). The immediate logical response to this crisis, that will have many ecological and economic benefits in order to curb the problem of indiscriminate felling of trees for fuelwood, is to establish woodlots in many of the communities especially in rural areas. Woodots for use as fuel wood may have positive environmental outcomes and might be as part of a farm, buffer or industrial forests. Before a tree species could be used for a particular purpose, adequate knowledge about the mode of planting, suitable soil type, nutrient requirement, nursery techniques, early growth behavior and its response to other silvicultural treatments should be gathered. For fuelwood, relatively fast growing, multi-purpose indigenous tree species that can be culled for firewood in less than ten (10) years and can regenerate through coppicing after cutting have to be considered in combination with others economic benefits for instance, fruit trees and vegetables, pole and timber.

Typical spacing of *Albizia* is 3 x 3 m for fuelwood while the fuelwood plantations spaced at 3 x 3 m clear felled on a 10-year rotation produce about 50 cubic m/ha of stacked fuelwood (Orwa *et al.*, 2009). Considering availability of land for woodlot at the face of population increase, industrialization and infrastructural development, it is necessary to study the performance of this species at reduced espacement. More so, cutting height during pollarding may be necessary information to look into as various tree species responds to pollarding differently. Though the species has great coppicing potential, it is essential to establish the fact, as the coppicing ability of this species subjected to different cutting height during pollarding were studied with the view of providing the information for its establishment in community woodlots.

Materials and Method

The study was carried out on the field at Silviculture sectional nursery of the department of Sustainable Forest Management, Forestry Research Institute of Nigeria, Ibadan located on the latitude 07°23'18" N to 07°23'43" N and longitude 03°51'20" E to 03°53'43" E. The location lies on 199 m above sea level, having total rainfall of 1420.06mm with peaks in June and September. It has average annual temperature of 26.46°C and relative humidity of 74.55% (Afolabi *et al.*2021).

Two hundred seeds of the *Albizia* were sown on germination beds and germinated seeds were transplanted in to polythene pots of 2kg capacity. Forty five relatively uniform seedlings were selected and arranged in nursery for proper management. The seedlings were then moved to the field at 6 weeks after pricking. The seedlings were subjected to different spacing (1m x 1m, 1.5m x 1.5m and 2m x 2m) and after 6 months of planting, cutting off of the stem at different heights (60cm, 90cm and 120cm above the ground level) was carried out. The experiment was 3x3 factorial laid out in completely randomized design with 5 replicates. The cutting was done with hand saw. The following parameters were assessed: number of shoot/coppice, height of dominant coppice, diameter of dominant coppice and number of leaves per seedling. Data generated was subjected to Analysis of Variance and Duncan Multiple test used for mean separation.

Results

Effects of planting enspacement and cutting height on coppice/sprouts production of *Albizia lebbeck* saplings

Initial heights of *Albizia* sapling subjected to 1m x 1m, 1.5m x 1.5m and 2m x 2m espacements before application of cutting treatments were 3.91m, 3.96m and 4.24m respectively. From the study, it was observed that all the plants subjected to different plant espacement and cutting heights produce coppices ranging from 2.6 to 5.4. From Figure 1, it could be observed that plants subjected to interactions of 2m x 2m espacement and 60cm cutting height had the highest mean number of coppice (5.4 sprouts) followed by those exposed to the same espacement with 90cm cutting height (4.8 sprouts).

The least mean number of coppice was recorded in 1m x1m espacement and 120cm cutting height with 2.6 sprouts. Considering espacement, it was observed that planting espacement significantly affects number of coppice produced at p = 0.05 (Table 1) as 1.5m x 1.5m spacing had the highest mean number of coppice with 11.44. This was followed by 2m x2m which was not significantly different from 1.5m x1.5m. The least mean number of coppice was observed in 1m x1m with 7.46 (Table 2). There was no significant effect of cutting height on number of sprouted shoots of *A. lebbeck* though it was observed that the highest number of coppice shoot was recorded in the cutting height 90cm with 11.23 while 60cm produced the least mean number of coppice shoot (8.80).

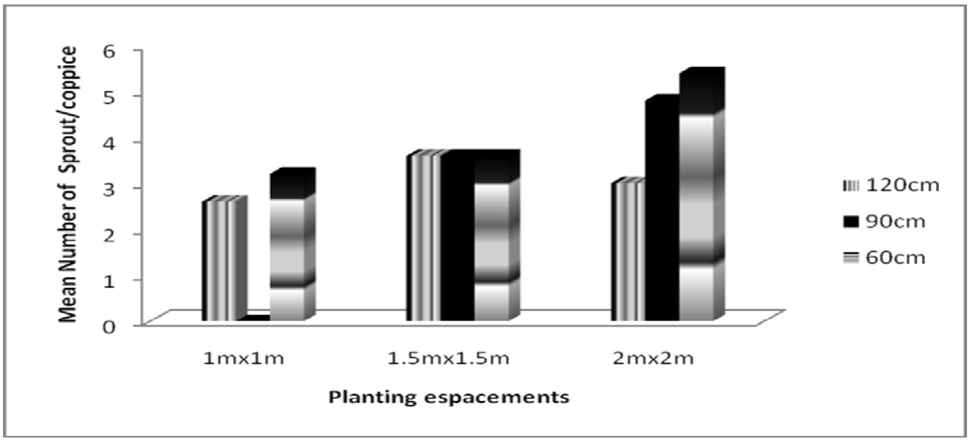

Figure 1: Mean number of sprouts/ coppice of *Albizia lebbeck* as influenced by different planting enspacements and cutting heights

Table 1: Results of analysis of variance on coppicing ability of *Albizia lebbeck* subjected to different planting enspacement and cutting heights (p = 0.05)

Parameters	Treatments	df	Sum of squares	Mean square	F	Sig.
Number of coppice	Planting Espacement (PE)	2	13.511	6.756	3.086	0.058
	Cutting height (CH)	2	8.844	4.422	2.020	0.147
	PE X CH	4	8.489	2.122	0.970	0.436
	Error	36	78.800	2.189		
	Total	44	109.644			
Coppice Length	Espacement	2	973.00	486.50	0.898	0.416
	Cutting height	2	6602.82	3301.41	6.09	0.005
	PE X CH	4	3220.95	805.24	1.49	0.227
	Error	36	19503.77	541.77		
	Total	44	30300.54			
Coppice diameter	Espacement	2	20.767	10.384	3.407	0.044
	Cutting height	2	30.327	15.163	4.975	0.012
	PE X CH	4	26.575	6.644	2.180	0.091
	Error	36	109.716	3.048		
	Total	44	187.385			
Number of leaves	Espacement	2	699.91	349.96	0.37	0.69
	Cutting height	2	3619.24	1809.62	1.92	0.16
	PE X CH	4	6140.62	1535.16	1.63	0.19
	Error	36	33876.80	941.02		
	Total	44	44336.58			
Source	Dependent Variable	df	Sum of Squares	Mean Square	F	Sig.
Planting Espacement	Number of coppice	2	13.511	6.756	3.086	.058
	Coppice Length	2	973.000	486.500	.898	.416
	Coppice diameter	2	20.767	10.384	3.407	.044

	Number of Leaves	2	699.911	349.956	.372	.692
Cutting Heights	Number of coppice	2	8.844	4.422	2.020	.147
	Coppice Length	2	6602.814	3301.407	6.094	.005
	Coppice diameter	2	30.327	15.163	4.975	.012
	Number of Leaves	2	3619.244	1809.622	1.923	.161
PE xCH	Number of coppice	4	8.489	2.122	.970	.436
	Coppice Length	4	3220.954	805.239	1.486	.227
	Coppice diameter	4	26.575	6.644	2.180	.091
	Number of Leaves	4	6140.622	1535.156	1.631	.188
Error	Number of coppice	36	78.800	2.189		
	Coppice Length	36	19503.768	541.771		
	Coppice diameter	36	109.716	3.048		
	Number of Leaves	36	33876.800	941.022		
Corrected Total	Number of coppice	44	109.644			
	Coppice Length	44	30300.536			
	Coppice diameter	44	187.385			
	Number of Leaves	44	44336.578			

Table 2: Table showing means of parameters assessed on *Albizia lebbeck* saplings subjected to different planting espacement and cutting heights

Treatments		Number of Coppice	Coppice length (cm)	Coppice diameter (mm)	Number of leaves	Mean Dry weight of harvested coppice (g)
Planting spacing	1x1	7.46^{a}	65.33^{ns}	6.87^{a}	29.0^{ns}	1.5
	1.5x1.5	11.44^{b}	75.27^{ns}	8.31^{b}	34.2^{ns}	1.8
	2x2	10.72^{b}	75.13^{ns}	8.32^{b}	32.5^{ns}	2.2
Cutting height	120cm	9.60^{ns}	82.1^{b}	8.74^{b}	31.99^{ns}	2.1
	90cm	11.23^{ns}	78.7^{b}	8.02^{ab}	34.32^{ns}	1.8
	60cm	8.80^{ns}	54.9^{a}	6.79^{a}	29.4^{ns}	1.7

Means with same alphabet are not significantly different from one another along the columns. ns = Not significant

Effects of Planting Espacement and Cutting Height on Dominant Coppice/Sprouts Length of *Albizia lebbeck* Saplings

Albizia saplings subjected to 120cm cutting height and 2m x2m enspacement recorded the longest dominant sprout length with 93.6cm followed by the same cutting height at 1.5m x1.5m espacement with mean sprout length 92.6cm. The shortest dominant sprout length was recorded in saplings subjected to 60cm cutting height and 1m x1m espacement (51.4cm) as shown in Fig. 2.

Coppice length was not significantly influenced by planting espacement but 1.5m x1.5m recorded the sapling with highest mean of dominant coppice length of 75.27cm.

Dominant coppice length was significantly influenced by cutting heights as 120cm recorded the highest mean value of 82.1cm which was not significantly different from 90cm (78.7cm). Cutting height 60cm had the least mean value of 54.9cm.

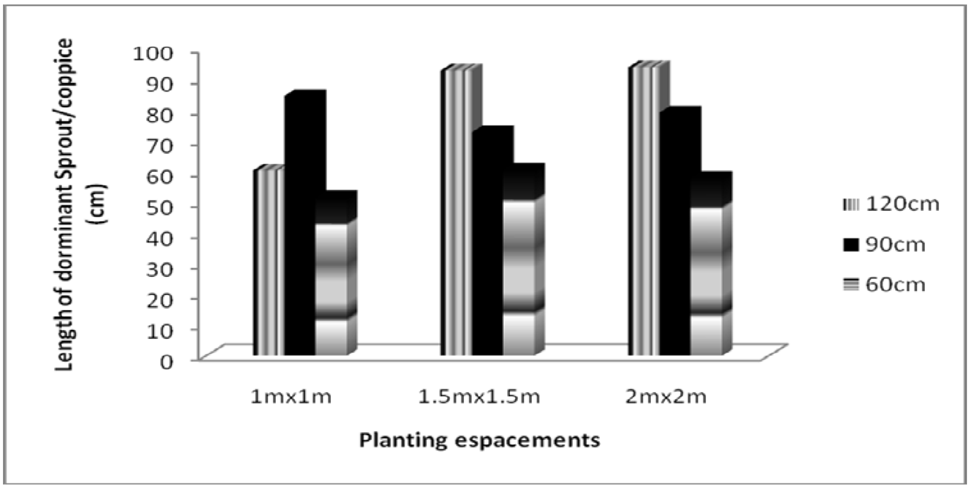

Fig. 2: Dominant sprout/ coppice length of *Albizia lebbeck* sapling subjected to different planting espacement and cutting heights

Effects of Planting Espacement and Cutting Height on Dominant Coppice/Sprouts Diameter of *Albizia lebbeck* saplings

Considering Fig. 3, saplings subjected to 120cm cutting height and 2m x 2m recorded the highest mean diameter with 10.0mm which was closely followed by saplings subjected to same cutting height with 1.5m x 1.5m (9.95mm) while plants treated with same cutting height at 1m x1m espacement recorded the least mean diameter (6.25mm).

From Table 1, it was also observed that planting espacement had significant influence on dominant coppice diameter at p = 0.05.

Considering planting espacement, 2m x2m recorded the highest mean coppice diameter (8.32mm) which was not significantly different from 1.5m x1.5m (8.31mm) while 1m x1m recorded the least with 6.87mm. Also cutting height has significant influence on coppice diameter. As 120cm recorded the highest mean value of 8.74mm while 60cm had the least means value of 6.79mm.

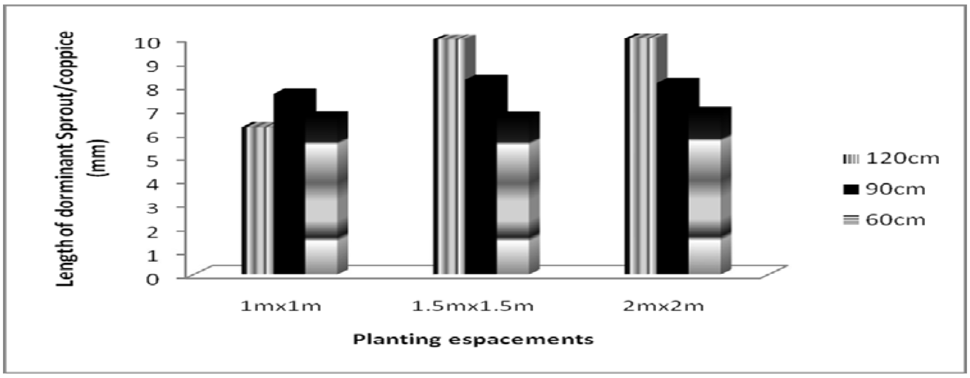

Fig. 3: Mean diameter of dominant sprout/ coppice of *Albizia lebbeck* subjected to different planting espacement and cutting height

Effects of Planting Espacement and Cutting Height on Leaf Production of Coppice and Dry Weight of Harvested Coppice of *Albizia lebbeck* Saplings

Albizia plants subjected to 90cm cutting height and 2m x2m espacement produced highest mean number of leaves (38.6 leaves) followed closely by those treated with 120cm cutting height and 1.5m x 1.5m espacement (38.2 leaves) while least number of leaves was observed in plants subjected to 60cm cutting height and 1m x 1m espacement (25.2 leaves)(Fig. 4).

Number of leaves on the sprouts was not affected by planting espacement at p = 0.05 (Table 1) but it was observed that 1.5m x1.5m recorded the highest mean value of 34.2 while the lm x1m spacing recorded the least mean value with 29.0 leaves (Table 2). There was no noticeable effect of cutting height on the number of leaves of the sapling but it was observed that 60cm recorded the least mean value (29.4 leaves).

The mean dry weight of the harvested coppice in Table 2 showed that 2 x 2 espacement (2.2 g) and 120cm cutting height (2.1g) recorded highest weight and the weights decreased with reduced espacement and cutting height.

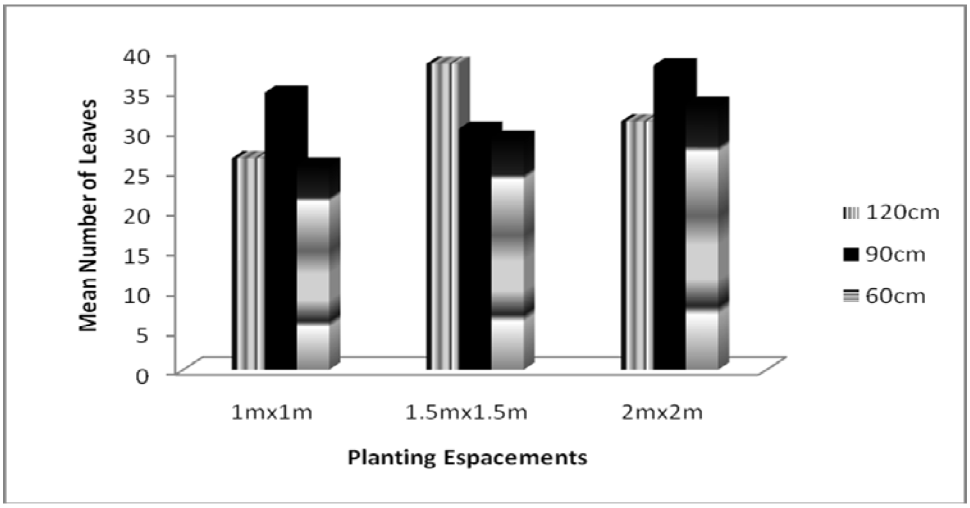

Fig. 4: Mean number of leaves as affected by planting espacements and cutting heights on *Albizia lebbeck* saplings

Discussion

Espacement is an important factor which influences growth rate, yields and quality as it dictates the amount of light, water and nutrients plants are exposed to (Borka, 1971; Negash and Mulualem, 2015). From this study, it was observed that saplings of *Albizia* performed well in 2m x2m and 1.5m x 1.5m espacement as they recorded excellent results for coppice production, dominant coppice height, diameter and leaf production when compared with 1m x 1m.

This buttressed the selection of 3m x 3m espacement for its plantation establishment as stated by Orwa et *al.* (2009) and it implies that espacement has great influence on coppice production and growth of *Albizia*. Amaglo *et al.* (2006) studied effect of spacing and harvest frequency on growth of Moringa and observed that the wider spacing produced more leaves per plant and was significantly different when compared to plants of the medium and closer spacing throughout the study period. For stem diameter, Amaglo *et al.* (2006) observed that individual plants with wider spacing had a larger girth followed by the medium spacing, than that of the closer spacing. This is in line with the result of the study as 2m x 2m spacing recorded the highest mean coppice diameter which is significantly different in relative to 1x1m spacing.

Cutting *Albizia* stems low to the ground level may not be a good practice as the lowest cutting height did not give good results when compared with other treatments. Shackleton (2000) observed that the number of coppice shoot produced by savannah trees and shrubs is influenced by species, stump dimension, and particularly the cutting height; it is therefore recommended that a greater cutting height should be considered to have large number of coppice shoots. Misra *et al*. (2000) reported that number of coppice shoots per stump increased with stump height in *Vitex negungo* and *Leucaena leucocephala* while average diameter of coppice shoots decreased with increasing coppicing height of the stumps. Also Tipu *et al*. (2006) observed that 150 cm pruning height resulted in highest number of branches and leaves of *Leuceana* per plant while biomass production also increased with increasing pruning height which may be possible due to more reserve materials in taller stocks or stumps.

Similar result was observed in this study as cuttings heights 90cm and 120cm from the ground were observed to produce more coppices while dry weight of the harvested coppice from 120cm cutting height recorded highest weight and the weights decreased with reduced cutting height. Canadell *et al.* (1991) also observed that the number of shoots per stump of selected savanna tree species studied increased in relation to cutting heights and increased cutting height had a positive effect on the number of coppice shoots. He related this observation to increased stump surface area with increasing cutting height. More so, positive correlation was recorded between cutting height and the number of shoots that sprouted on *Julbernadia globiflora* as observed by Chibinga *et al*. (2017). This implies that the higher the cutting height the more the coppices on the tree stool.

Conclusion

Albizia lebbeck saplings subjected to different espacements and cutting heights showed various responses to the treatments. Highest number of coppice was recorded in saplings planted in 2m x2m espacement and cut at 120cm. For coppice to produce dominant shoots with biggest girth, the saplings could be planted at 1.5m x1.5m or 2m x 2m and the cut be applied at 120cm from the ground level. Application of these treatments depends on management plan of the plantation and availability of land which was the purpose of the experiment in which smaller espacements was considered.

The coppicing potential was studied and information made available for future use in prediction of fuelwood yield through number and growth assessment of the coppice. Albizia can be established for fuelwood using 2m x 2m espacement in areas where 3m x 3m conventional spacing is not possible, while 120cm cutting height is suggested for production of vigorous sprout.

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