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COPPICING POTENTIALS AND MANAGEMENT OF *Tectona grandis* Linn. F PLANTATION IN INVESTIGATION 309 EXPERIMENTAL PLOT OF RAINFOREST RESEARCH STATION, ORE, ONDO STATE, NIGERIA

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ABSTRACT

Coppicing is described as a vital mechanism of regeneration in harvested plantation, but there is dearth of information on the management practice of certain species. The study therefore investigated the growth and sprouting potentials of different stump diameters in relation to number of sprouts retained on the stumps of Tectona grandis Linn with a view to determining the best coppice management. Systematic cluster sampling technique was used for plot location in four (4) randomly selected cardinal points of the site while the fifth plot was located at the center. In each plot, stump diameters of≥ 25 -< 35cm, ≥ 35 < 45cm and ≥ 45 cm were identified and sprouts/coppices were reduced to the desired number; that is one, two, three and more than three. The experimental design was a 3 x 4 factorial replicated 5 times. Number of sprouts/emergent, Coppice diameter and coppice height were assessed once in a month for 6 months. Data collected were subjected to analysis of variance (ANOVA). Results revealed that there were no significant differences (P>0.05) in the effects of stump diameter (SD) and number of coppices (NC)on of coppice heights and coppice diameter but significantly different (P<0.05) on number of sprouts. The relationship among numbers of coppices left on the stumps and different diameters on coppice heights (CH), coppice diameter and number of sprouted coppices (NS) showed that the coppice diameter was highest (18.32 cm) in diameter of >45cm with a single coppice. At more than three coppices left on different stump diameters, the stump diameter of >45cm had highest CH of 375.1cm, coppice diameter of 11.02 cm and NS of 18.4. Number of sprouts/coppices retained on the stumps and various diameters of stumps had influence on the growth and sprouting of T. grandis.

Keywords: Regeneration, Systematic cluster sampling, Silvicultural management, Coppicing.

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INTRODUCTION

Coppicing is one of the oldest silvicultural management practices in many countries of the world (Fujimori, 2001). Historically, coppice managements were usually carried out to enhance fuel wood production until the second half of the 19th century when management strategy changed (Buckley, 1992). The objective of the practice changed thereafter, due to increase in demand for high quality timber and the conversion of coppices to high forests became the main hub especially in several parts of globe. (Hédl *et al.*, 2010). Coppice is generally defined as emergent shoots or growth from living stumps or suckers (Fujimori, 2001). It is an aged long method of forest management where many felled trees producenew growth from stumps or roots (Ureigho, 2020). In the process, stems are continuously felled at interval to ground level and so many new shoots emerge. After some years, the coppiced trees are ready to be harvested and the cycle begins again (Ureigho, 2020). Till date, coppicing remains a common forest management system to provide myriads of products such as fuel wood, poles, timber and Non-Timber Forest Products (NTFPs). The significance of coppices increases in the field of nature protection and management where there is an increased population growth and competition for limited land area (Mason and Macdonald, 2002). Coppice management plays significant role in forest habitat maintenance and their characteristics improvement. It has been found that coppicing practice minimized soil damage during harvest, reduce weed invasion and enhance physical protection of coupe. The practice also reduces the risk of wind throw and the activity facilitates income where markets for the harvested products exists (Corcuera, 2006). Despite the fact that the interest in coppicing is increasing, there is still a dearth of information on the effect of coppice management on the growth rate of certain tree species.

Teak seed was brought to Nigeria in the year 1889 from India and became naturalized in the country (Ball *et al*., 1999). It has since then considered a prime timber species in Nigeria due to its high timber value (Pandey and Brown, 2000). The first750 ha of teak plantation was established in1890 at Olokemeji forest reserve in the then Western Nigeria, now part of Ogun State (Formecu, 1991). As at the year 2000, there were about 132,500ha of Teak plantation in tropical Africa (Pandey and Brown, 2000). Common local uses of teak timber include furniture making, joinery and general carpentry works, floor parquet production, flush, poles for electricity transmission and so on. In order to meet up with the current demand for teak products due to it numerous uses and considering the time required for the species to attain rotation age from seedling, coppicing may be a more effective means of regeneration than the slow-growing seedlings (Hamilton, 2006).Rapid production of coppices can get benefits from the established root system and may enable the species to regenerate in the gap (Ureigho, 2020).The study therefore investigated the growth and sprouting potentials of different stump diameters in relation to number of sprouts retained on the stumps with a view to determining the best coppice management practice.

MATERIALS AND METHODS

Study Area

The study was carried out at the Teak Plantation in Investigation 309 Experimental Plot of Rainforest Research Station, Ore Ondo State. The study area lies between latitude 6.74^o N and 6.75^o N and longitude 4.86^o E and 4.87^o E. The plots are artificial regeneration trials that comprised of both indigenous and exotic species. The plot borders with the Ondo State *Gmelina arborea* plantation and stretch towards Benin-Lagos express road. It covers 250 hectares of land where selective thinning was carried in the year 2021. The climate of the area is Lowland Tropical Rain Forest type with distinct wet and dry seasons (Esu *et al.,* 2014).

The vegetation is dominated by broadleaved hardwood trees that form dense, layered stands. Some of the prevalent species include *Terminalia ivorensis, Terminalia superba, Entadorpragma spp, Cleistopholis patens, Hura crepitans, Triplochiton scleroxylon* among others The mean annual temperature is about 26^{o}Cand the rainy season lasts for9 months annually, between March and November (about 2500 mm with bimodal rainfall pattern) while the dry seasons usually last for 3 months, between December and February (Adekunle *et al*, 2013). The soil of the study area is classified as basement complex rocks composed mainly of granite-gneiss, mica-schist and feldspathic rocks. The soils belong to Omotosho soil series (Esu *et al.,* 2014).

Sampling Procedure and Experimental Design

Systematic cluster sampling technique was used for stratification of location into clusters at four (4) cardinal points and centre of the site. Five clusters were thereby randomly selected for laying of the plots. The dimension of each plot which was 100 x 100 m. Three (3) categories of stump diameters were randomly identified in each plot. The categorization was based on the range of stumps in the study area. The three categories of stump diameters (the first experimental factor) were ≥ 25 -< 35cm, ≥ 35 < 45cm and ≥ 45 cm while the second factor which was number of sprouts comprised of one sprout, two sprouts, three sprouts and more than three sprouts (sprouts/coppices were reduced to the desired number; that is one, two, three and more than three). The experimental design was a 3 x 4 factorial replicated 5 times. The assessment was carried out once in a month for 6months. The following parameters were assessed: Number of sprouts/emergent, Coppice diameter and coppice height. Data collected were subjected to analysis of variance (ANOVA) and where there were significant differences; post-hoc analysis was carried out with Duncan Multiple Range Test (DMRT) in order to separate the means.

RESULTS and Discussion

There were no significant differences (P>0.05) in the effects of stump diameter (SD) number of coppices (NC) on the height of coppices (Table 1). Also, there was no significant difference (P>0.05) in interaction between effects of SD and NC on the growth variables. Regeneration or sprouting of disturbed living plants have been described as age longed adaptation strategy of degraded forested areas to destructive agents (Keyser and Zarnoch, 2014). The Insignificant difference in coppice heights from different stump diameters and numbers of sprout could be ascribed to the fact that physiological processes of disturbed plants do not stop completely but make meristems inactive during unfavourable environmental conditions. Selected stumps for the study are exposed to similar environmental and climatic conditions, and their adjustment to the shock from felling which are relatively similar could make the shoot heights not significantly different irrespective of stump diameter and number of sprouts (Dietze and Clark, 2008). According to (Del Tredici, 2001), all angiosperm trees have potential to produce new shoots from dormant buds despite the disturbances, but ability to callus may differ among species.

Table 1: Analysis of Variance (ANOVA) for Coppice height (cm) of coppices as affected by Stump diameter and Number of Coppices within 6 months of study

SV	df	SS	MS	F-cal	P-value
Stump Diameter (SD)	2	1026.900	513.450	0.154	0.858^{ns}
Number of Coppices (NC)	3	11258.183	3752.728	1.123	0.349^{ns}
SD*NC	6	20599.367	3433.228	1.027	0.419^{ns}
Error	48	160422.400	3342.133		
Total	59	193306.850			

^{ns} *=not significant at P>0.05*

Diameter of coppices as affected by stump diameters and number of coppices within six months of study were not significantly different (P>0.05) (Table 2). The increase in dimension of apical stems and roots of living plant amount to growth and development of the plant. This is made possible by the active metabolism processes of the plant under favourable climatic and edaphic factors (Ojo and Asinwa, 2022). The similarity in the diameter growth of the coppices under different treatments could be ascribed to favourable environmental conditions of the stumps in the study area. This corroborates the findings of Spinelli *et al*. (2017) that reported regular re-sprouting and vigour physiology of coppice stumps. This implies that coppicing of harvested plantation can be enhanced by ensuring healthy forest community.

Table 2: Analysis of Variance (ANOVA) for Diameter (cm) of coppices as affected by Stump diameter and Number of Coppices within 6 months of study

SV	df	SS	MS	F-cal	P-value
Stump Diameter (SD)	2	14.522	7.261	1.694	0.195[ns]
Number of Coppices (NC)	3	15.173	5.058	1.180	0.327 [ns]
SD*NC	6	46.599	7.767	1.812	0.117 [ns]
Error	48	160422.400	4.287		
Total	59	282.070			

[ns] =not significant at P>0.05

There were significant differences (P<0.05) in the effects of stump diameters (SD) and number of coppices (NC) on the emerged number of coppices but there was no significant difference in the interaction or combine effects od between SD and NC (Table 3). The stump diameter with ≥ 25 -< 35cm had the highest mean coppices of 9.100±0.17 cm while >35-<45 had the least (6.650±0.11cm) (Table 4). This implies number of sprouted coppices is independent of stump diameter. This finding is at variance with assertion of Jyrki (2019) that older birches prouted better than small and young trees due to increasing number of buds with increasing stump diameter. The mean separation for number of sprouted coppices as affected by number of Coppices retained on the stump within 6 months of presented in table 5. Stumps left with more than 3 coppices had highest mean number of sprouted coppices (15.600±0.17) while the stumps left with 3 coppices had the least mean number of sprouted coppices 5.600±0.12. Though stumps left with 1 and 2 coppices produced new shoots/coppices monthly but not as much as that of treatment with 3 coppices and more. Schweier *et al.* (2015) found that stump diameter influenced and sustained multiple coppicing which was ascribed to the ability of tap root to translocate nutrients from the soil and store them as carbohydrates for new shoots growth. Multiples shoots are reported by Han and Renzie (2005), from studies on the effect of slope, stump diameter and species on coppicing potentials. Spinelli *et al.* (2017) reported re-sprouting vigour and physiology of coppice stumps after mechanized cutting from different stump diameters.

Table 3: Analysis of Variance (ANOVA) for emerged Number of sprouted coppices as affected by Stump diameter and Number of Coppices within 6 months of study

SV	df	SS	MS	F-cal	P-value
Stump Diameter (SD)	2	61.033	30.517	3.426	0.041*
Number of Coppices (NC)	3	1226.850	408.950	45.906	0.000*
SD*NC	6	102.700	17.117	1.921	0.096 [ns]
Error	48	427.600	8.908		
Total	59	1818.183			

=significant at P<0.05****;*** *ns =not significant at P>0.05*

Table 4: Post- hoc Testfor Analysis of Variance (ANOVA) for Number of sprouted coppices as affected by Stump diameter within 6 months of study

Treatments	Mean
>25-<35	9.100±0.17[a]
>35-<45	6.650±0.11[b]
>45	7.600±0.10[ab]

Means with the same superscript are not significantly different (p> 0.05)

Table 5: Post- hoc Testfor Analysis of Variance (ANOVA) for Number of sprouted coppices as affected by Number of Coppices left on the stump within 6 months of study

Treatments	Mean
1 Coppice	4.800±0.06[a]
2 Coppices	5.133±0.13[a]
3 Coppices	5.600±0.12[a]
More than 3 Coppices	15.600±0.17[b]

Means with the same superscript are not significantly different (p> 0.05)

The relationship among numbers of coppices retained on the stumps, and different diameters on coppice heights (CH), coppice diameter and number of sprouted coppices (NS) are presented in figure 1 to 4. The stump diameter of >35-<45cm had the highest CH (288.8 cm), the coppice diameter was highest in diameter >45cm (18.32 cm) while the mean highest NS (6.8) was recorded for >25-<35cm with a single coppice (Fig.1). At two coppices left on different stump diameter, CH (329cm) and coppice diameter (16.22) in stump diameter >45 were the highest while diameter >25-<35cm had highest NS of 6.6 (Fig. 2). In the same vein, at three coppices left on different stump diameter, diameter >25-<35cm had highest CH and NS of 330.2cm and 6.8 respectively while diameter >45cm had the highest coppice diameter of 15. 48cm (Fig. 3). At more than three coppices left on different stump diameter, the stump diameter of >45cm had highest CH of 375.1cm, coppice diameter of 11.02 cm and NS of 18.4 (Fig.4). The highest CH (375.1cm) recorded for the treatment more than three coppices left on >45cmstump diameters could be ascribed to competition for light among multitude of coppices. Knowing fully well that light play significant roles on the growth and survival of plant. It contributes immensely to plants food manufacturing, stem growth, flowering and fruiting (Ojo and Asinwa, 2021; Batista *et al*., 2014). Teak being a light demander which can strive to grow tall in order to capture more of the available light could be reason for the highest CH. The highest coppice diameter with single coppice left on the stump diameter of >45cm is an indication that the single coppice maximized available space and nutrients for its growth and development. This is in line with assertion of Rotowa *et al.* (2020) that healthy plant growth is directly dependent on the availability of nutrient in the soil under the auspices of other environmental factors, most especially the spacing that enhances plant aeration and exposure to light.

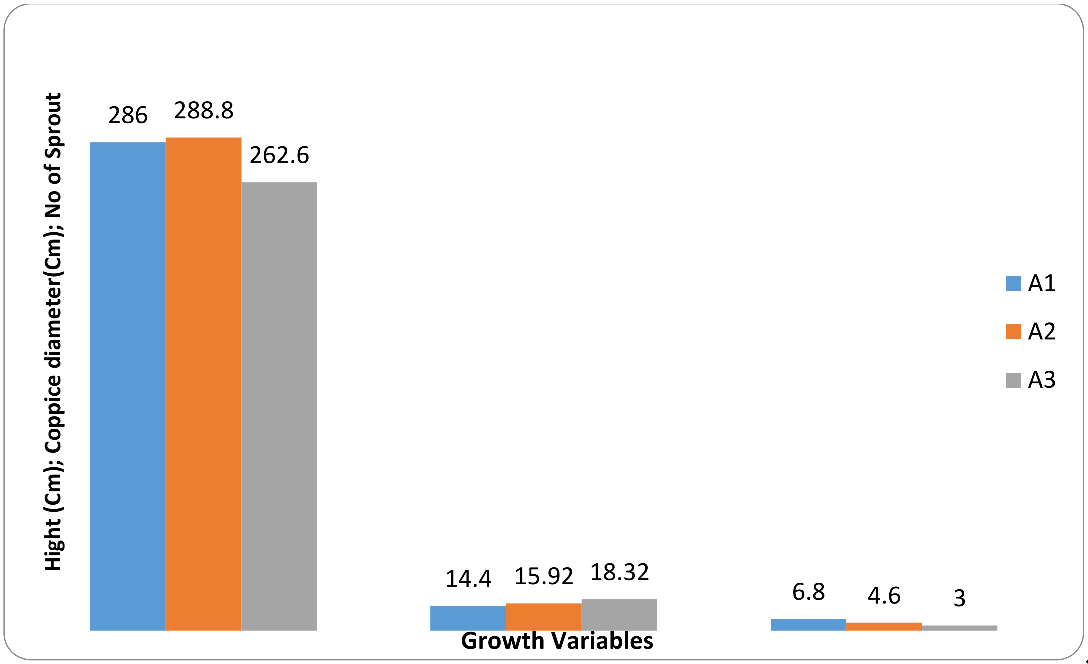

Figure 1: Relationship between single coppice at different Stump diameters on Coppice heights (CH), Coppice diameter and Number of sprouts (NS)
A1 = >25-<35, A2 = >35-<45, A3 = >45

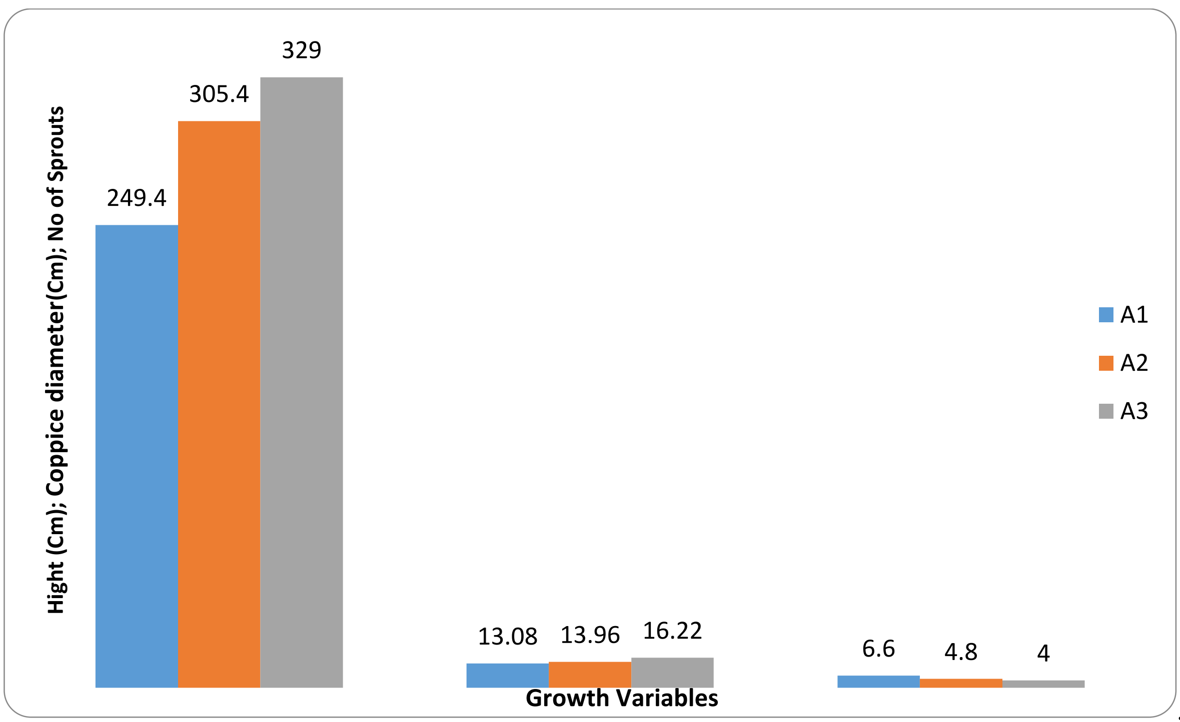

Figure 2: Relationship between two coppices at different Stump diameters on Coppice heights (CH),Coppice diameter and Number of sprouts (NS)
A1 = >25-<35, A2 = >35-<45, A3 = >45

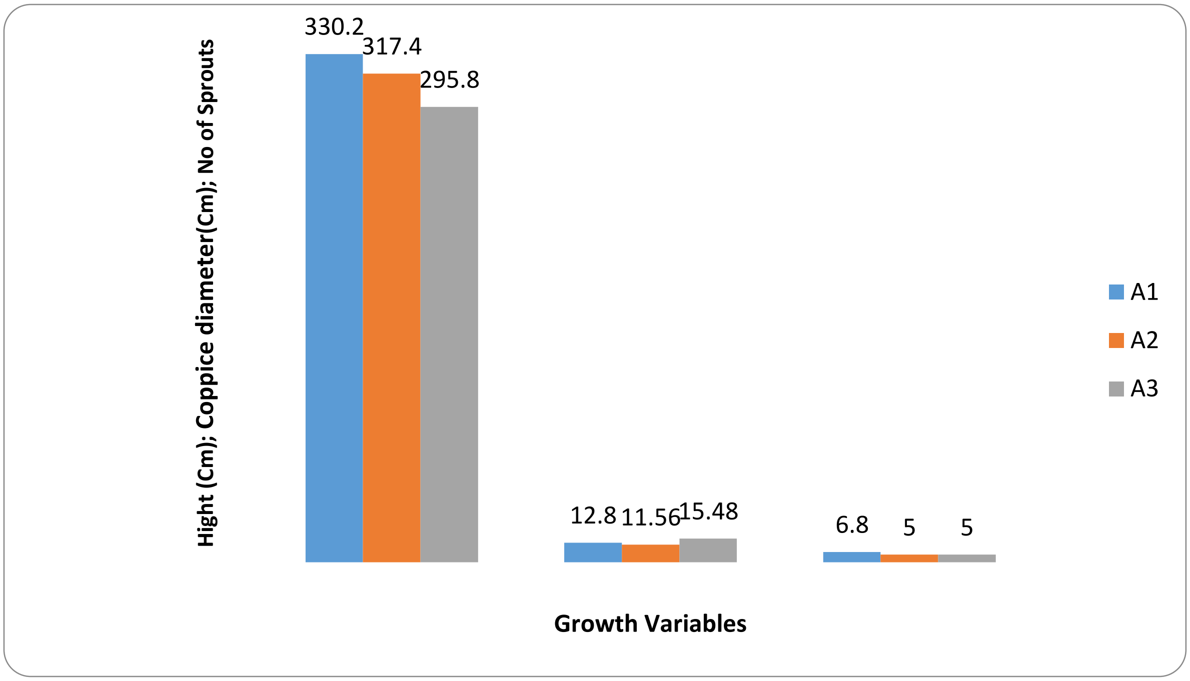

Figure 3: Relationship between three coppices at different Stump diameters on Coppice heights (CH), Coppice diameter and Number of sprouts (NS)
A1 = >25-<35, A2 = >35-<45, A3 = >45

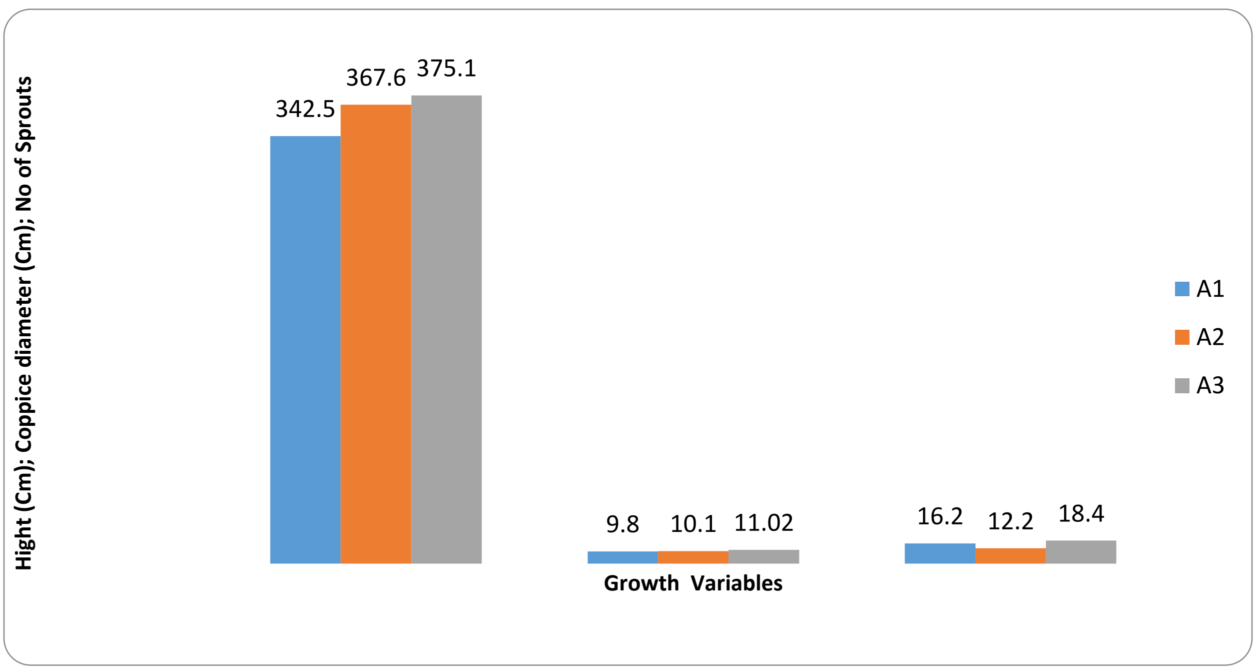

Figure 4: Relationship between more than 3 coppices at different Stump diameters on Coppice heights (CH), Coppice diameter r and Number of sprouts (NS)
A1 = >25-<35, A2 = >35-<45, A3 = >45

CONCLUSION

The study investigated the *T. grandis* growth and sprouting potentials of different stump diameters in relation to number of sprouts retained on the stumps with a view to determining the best coppice management practice. The study revealed that number of sprouts/coppices retained on the stumps and various diameters of stumps had influence on the growth and sprouting of *T. grandis*. Stumps with diameters > 45cm and multiple sprouts/coppices had highest coppice heights while the one with single sprouts had the highest coppice diameter. It is therefore recommended that for better coppice management and optimum regeneration enhancement of *T. grandis* plantation, the coppices/sprouts to be retained on the stumps must not exceed 3 sprouts with stump diameter of > 45cm.

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