THINNING EFFECTS ON TEAK (*Tectona grandis*) GROWTH PERFORMANCE IN TAIN II FOREST RESERVE, GHANA

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ABSTRACT

Plantation establishment has been promoted in the tropics in the last 4-5 decades in a bid to mitigate climate change, timber deficit, and biodiversity loss, as well as restore degraded forests and provide employment incentives to fringe communities. Practitioners require technical information about appropriate cost-effective silvicultural techniques that can achieve higher productivity. In Ghana, government incentives have promoted the commercial establishment of teak and other species plantations, yet information on tree response to silvicultural management is still scarce. The present study evaluates the effects of thinning intensity on the growth response and pruning requirements of teak plantations, two years after thinning. The thinning trial was conducted on a four-year-old stand with initial stocking of 1111 trees per hectare in the Tain II forest reserve of Ghana. Four thinning intensities: 50%, 30%, 0% thinning intensities and 50% de-crowning were the treatments arranged in a completely randomized design. Two years after thinning, the treatments were significantly different in DBH ($p < 0.00029$), total height ($p = 0.017$) and stem density ($p<0.0002$). The 50% thinning intensity had the highest mean tree DBH, volume, height and BA of 15.57 cm, 0.13 m^3, 11.94 m and 0.02 m^2, respectively while the lowest was found in the control except height which was least in de-crowned plots. Maximum mean annual increment of DBH, total height, and volume were respectively 2.00 cm, 1.34 m and 9.9 m^3ha^{-1} for the heavily thinned stand. The number of epicormic shoots per tree increased with the thinning intensity/regime, hence increasing the pruning requirement. It is concluded that 50% thinning intensity promotes positive growth of residual stand and the economic value of the trees but increases the pruning requirements and possibly the costs. Long-term evaluation of this trial is essential to validate the recommendations from this study.

INTRODUCTION

- In the last 4-5 decades, plantation establishment has been promoted in the tropics in a bid to mitigate climate change, timber deficit, and biodiversity loss, as well as restore degraded forests and provide employment incentives to fringe communities.
- In Ghana, though forestation rates (1000 $hayr^{-1}$) still lack behind deforestation rates (135,000 $hayr^{-1}$), more than 325,000 ha of plantation forest have been established since the 1990s, primarily using exotic species (FAO 2015).
- *Tectona grandis* (teak), an exotic species, constitutes about 50-70% of the total plantation forest in Ghana (Foli *et* al, 2009).
- Majority of these plantations are largely unmanaged. The few intensively managed plantations are currently in a pilot phase within the jurisdiction of international agencies/partners such as Miro, Form-Ghana etc.
- Consequently, there is paucity of information on the silvicultural interventions that can be adopted to boost productivity and shorten the rotation cycle in plantations at relatively lower cost.

OBJECTIVES

- The study examines the effects of thinning intensity on the growth response and pruning requirements of teak plantations, two years after thinning.

MATERIALS AND METHODS

Study area & Experimental set up

- The study was carried out in Tain II Forest Reserve, near Berekum in Bono Region of Ghana (Figure 1).
- A completely randomized design with thinning regime as treatment and 4 replications was adopted (Figures 2&3).
- The four thinning regimes administered included; A – control or no thinning, B – 50% thinning intensity, C – 50% de-crowning (rest cut), D – 30% thinning intensity (Figure 2).
- The initial stand density was 1111 trees ha^{-1} with an experimental unit or plot size of 50 x 50 m (16 trees).
- Trees were planted in 2015 and first thinned in 2019.
- Heights, diameter at breast height (DBH), survival were measured before and two years after thinning.
- Number of live and dead epicormics shoots two years after thinning were also determined for each treatment

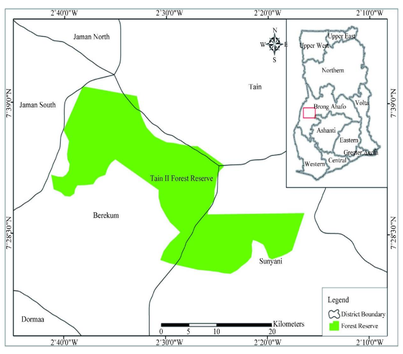

Figure 1. Map of Tain II Forest Reserve, Ghana

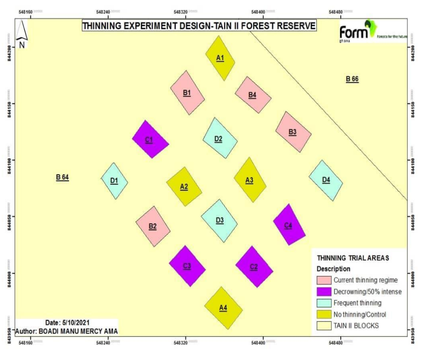

Figure 2. Experimental lay out of the study. A – control or no thinning, B – 50% thinning intensity, C – 50% de-crowning, and D - 30% thinning intensity

Figure 3 – Data collection on plot C1, Tain II Forest Reserve, Ghana

RESULTS

Table 1. Mean stand variables among thinning treatments in a six year old teak stand at Tain II Forest Reserve, Berekum, Ghana, two years after thinning. Means in the same column followed by the same letter are not significantly different among treatments at $p<0.05$.

Treatment	Height (m)	DBH (cm)	BA (m^2ha^{-1})	Stem density (sph)	Volume (m^3ha^{-1})
0% Control (A)	11.62±0. 28ab	12.99±0.46b	13.4±0.46	959.2±50.8a	93.7±4.37
50%Intensity (B)	11.94 ±0. 19a	**15.15± 0.39a**	10.0±0.85	**533.9±24.9b**	69.0±5.7
50%De-crowning (C)	10.10±0.42b	13.64±0.55b	12.1±1.5	889.8±78.7a	75.6±12.6
30% Intensity (D)	11.67±0.52a	12.97±0.25b	11.9±0.53	859.4±51.8a	82.6±7.4
Sig. diff (p-value)	**0.0171**	**0.0029**	0.136	**0.00067**	0.224

Table 2. Change in mean tree growth parameters (height, diameter at breast height (DBH), stem density, basal area and volume) two years after thinning. Means in the same column followed by the same letter are not significantly different. A – control; B – 50% thinning intensity; C – 50% decrowning; D – 30% thinning intensity

Treatment	Height (m)	DBH (cm)	Stem density (stems ha^{-1})	Basal area (m^2ha^{-1})	Volume (m^3ha^{-1})
A	2.14±0.03bc	1.96±0.13b	13.0±4.34b	3.64±0.2a	37.9±9.0a
B	2.61±0.14ab	**3.94±0.33a**	**352.6±83.7a**	1.27±0.2b	**19.8±4.0b**
C	1.62±0.21c	1.98±0.34b	4.34±4.34b	3.39±0.2a	30.7±2.72a
D	2.96±0.17a	2.27±0.12b	56.4±34.3b	3.16±0.4a	36.5±1.4a
p-value	**0.0003**	0.**00033**	0.**00041**	0.**00525**	0.**0013**

RESULTS

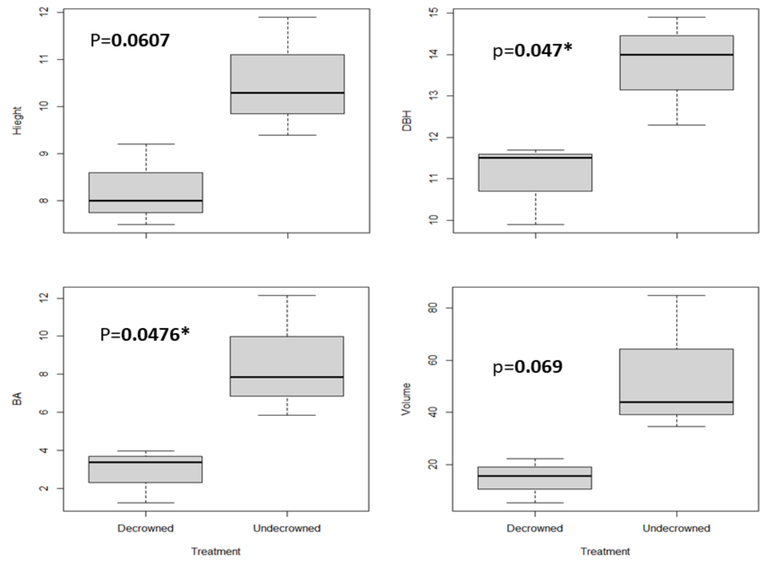

Figure 4. Stand growth parameters (height (m), DBH – diameter at breast height (cm), BA - basal area (m^2ha^{-1}), and volume (m^3ha^{-1}) in six year old decrowned and undecrowned teak stands, two years after thinning.

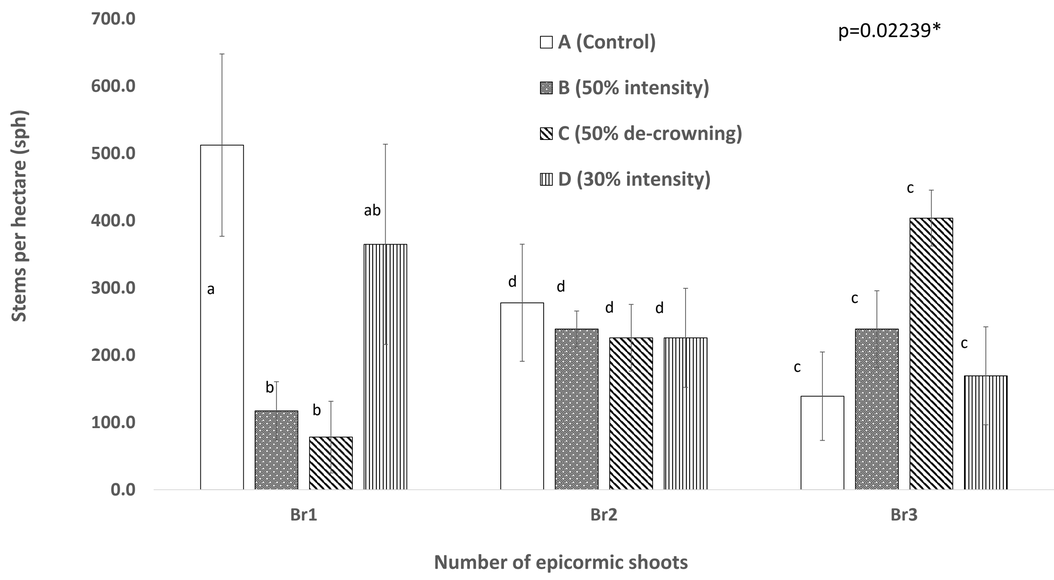

Figure 5. Mean number of trees without or with epicormics shoots (or branches) among different thinning regimes, two years after thinning. Br1 – trees without; Br2 – trees with 1 – 2 branches; and Br3 trees with at least 3 branches or epicormics shoots. Bars followed by the same letter are not significantly different within the given branching category.

DISCUSSION AND CONCLUSION

- Pre-thinning height, DBH, and volume were not significantly different among treatments ($p>0.05$) (Radio and Delgado 2014).
- B (50% thinning intensity) had the highest mean increase in DBH, height and volume per tree while De-crowning (C)) had the least growth after thinning (Tables 1 & 2).
- Growth parameters (i.e. DBH) two years after thinning were significantly different among treatments ($p<0.05$) (Tables 1 & 2).
- Increased in diameter growth of teak stands with increased spacing after thinning agrees with several previous studies (Zhang et al, 2007; Kanninen *et* al, 2004).
- Diameter (DBH) and basal areas of undecrowned trees were significantly greater than the decrowned trees (Figure 4) due to reduced competition for light through decrowning.
- On average, there were 3 live and 6 dead epicormics shoots per tree in these teak stands. More than 80% of the trees in treatments B and C carried epicormics shoots (1 – 6 live branches) while in the control (A) and 30% thinning intensity (D), proportion of trees without epicormics shoots was about equal to proportion with epicormics shoots (Figure 5).
- This study concludes that 50% thinning intensity best favors the growth of residual trees 2 years after thinning but it increases the pruning requirements and potentially the pruning costs. Further monitoring of these stands are required throughout the entire 20-year rotation cycle.

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