

The Growth Performance of *Triplochiton scleroxylon*, *Terminalia superba* and *Ceiba pentandra* in Pure and Mixed Stands.

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Abstract

Plantation developers mostly prefer exotic to indigenous tree species in restoration of degraded forests due, perhaps to, inadequate information on indigenous tree plantations to enable them change in that direction. The study was conducted at the Jimira Forest Reserve in the Nkawie Forest District to compare the growth performance of *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* in their pure and mixed stands. Four plots, each divided into four subplots measuring 50m x 50m, of one hectare demarcated represented three pure stands of *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* and one mixed stand of the three species. Simple random sampling was used to a subplot from each plot and diameter and height measurements were taken. The mean growth rates in diameter of *Ceiba pentandra*, *Terminalia superba*, and *Triplochiton scleroxylon* in the pure stands and the mixed stand were 1.73 and 1.61cm/year; 1.77 and 2.02 cm/year; and 2.70 and 2.57 cm/year respectively and those in height were 1.06 and 0.80 m/year; 1.16 and 1.25 m/year; and 1.98 and 1.59 m/year respectively. The statistical analysis carried out to determine the variations in tree diameter and height in the pure and mixed stands indicated no significant differences.

Keywords: Growth Performance, *Triplochiton scleroxylon*, *Terminalia superba*, *Ceiba pentandra*, Pure and Mixed Stands.

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1. Introduction

Over the past decade the world's forest cover has been rapidly decreasing, with average annual decline rates of 0.22% between 1990 and 2000 and 0.13% between 2000 and 2010 (FAO, 2011). Ghana, originally well-endowed with natural forests, is no exception to this general trend. Ghana's extent of forested land declined from 2000 to 2010 with a staggering annual rate of 2.1%, leaving a total forest area of 4,940,000 ha in 2010, accounting for about 21.7% of all land in Ghana (FAO, 2011). The reduction and degradation of the tropical forest affect not only the production of timber but also the global environment as a whole. The loss of biological diversity, both plants and animals through forest degradation threatens the sustainable and harmonious development of the global ecosystem (Lamb and Gilmour, 2003). With this current rate of deforestation and degradation, it is anticipated that about 3 to 8 million biological species, including a large number of less used species, will be wiped off from the surface of the earth by the end of the 21st century if measures are not put in place (Kobayashi, 2004). Plantation forestry is one way of reducing forest degradation and alleviating the pressure on the natural forests, FAO, (2011), and also meeting future wood needs and demand. The Forestry Department established about 50,000 ha of plantations in the 1970's to offset the wood deficit (Agyeman, Veenedall, Amankwa and Swaine, 1996). However, most of these plantations were limited to exotic tree species. For several reasons there has been a preference for exotic tree species because there is enough information on them, they are fast growing and easy to manage. Foli, Agyeman and Ofori-Attah (1997) had reported that some indigenous tree species are faster growing in plantations than in natural forest conditions and may well be faster growing than some of the commonly grown exotic species and therefore encouraged their cultivation in plantations.

Lack of adequate information in plantation establishment with indigenous species deters many prospective forest plantation developers. It is therefore necessary for the Forest Services Division to provide such information, particularly, the gestation period of the species, for its clients. One way of achieving this is by determining the growth rates of the indigenous species that have been used in plantations.

Though monoculture plantations of exotic species have been productive, Cossalter and Pye-Smith, (2003); Odom, (2002); Sedjo, (1999) and provides wood and fibre for some industrial purposes Bowyer, (2001), they usually fail to provide a wide variety of non-timber products and other ecological services that are essential to sustain rural communities McNamara, Tinh, Erskine, Lamb, Yates and Brown, (2006); Lamb, Erskine and Parrotta, (2005); Hartley, (2002); Lamb, (1998). Indigenous species on the other hand have been identified to have the potential to

perform well and even do better than most commonly used exotic species (Wagner et al., 2008; Lamb, 1998; Butterfield, 1995). The study was meant to determine the growth rates of *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* in their pure and mixed stands.

2. Materials and Methods

2.1 Study Area

The study was conducted in a plantation established in 2010 at the Jimira Forest Reserve by the Resource Management and Support Centre (RMSC) of the Forestry Commission of Ghana. The reserve lies in a humid climatic zone with a two-peak rainy season (June and October). The average rainfall is between 1,400 and 1,525 mm. The mean maximum temperature is 30⁰ C whilst the mean minimum is 21.7⁰ C. The maximum monthly average of 32.8⁰ C occurs in March and the minimum of 19.9⁰ C occurs in January (Addey and Barker, 1995).

It lies between latitudes 6⁰ 17' and 6⁰ 40' North and longitudes 1⁰ 50' and 2⁰ 16' West. The total area of the reserve is 6,216 ha. Ownership of the reserve is vested in the Golden stool with the stools of Toase, Manso-Nkwanta, and Nkawie as caretakers.

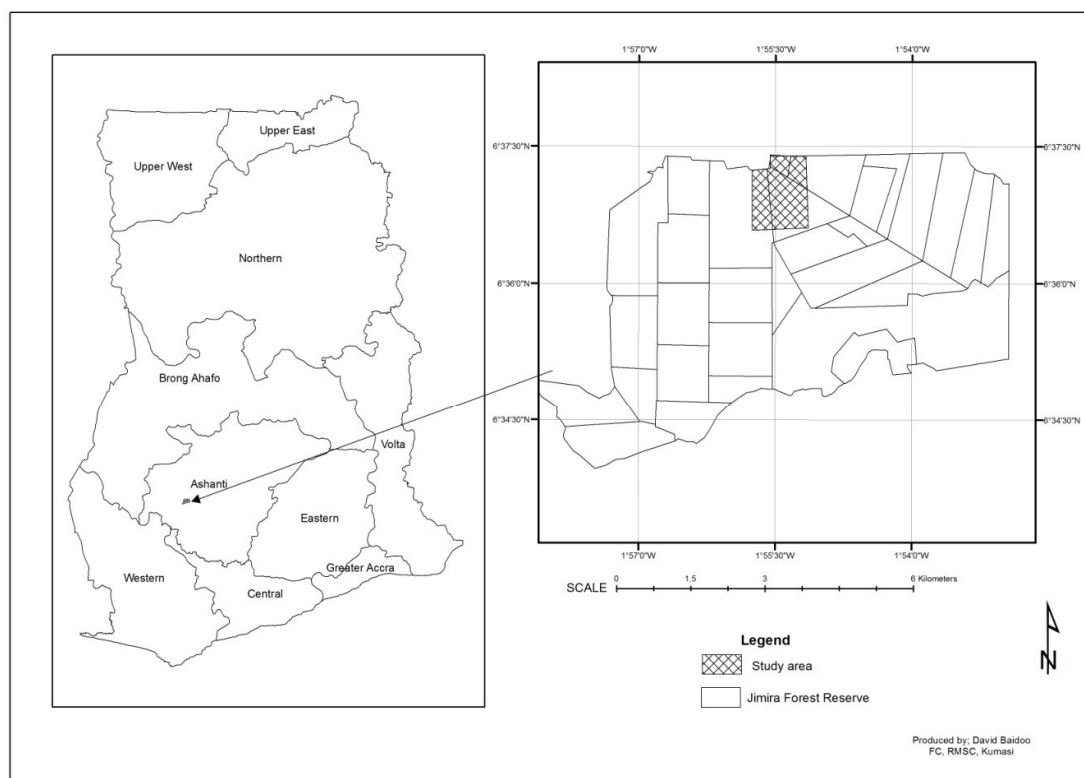


Figure 1 Map of Jimira Forest Reserve showing the study area

The established plantation consist of four plots of one hectare each made up of *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon*in pure stands and a mixed stand of the three mentioned species. The pure and the mixed stands were planted at a planting distance of 5m × 5m.

Each plot was divided into four subplots measuring 50m x 50m each. A subplot was randomly selected from each plot and the diameters and heights of all the trees within the subplot measured using a Diameter tape and a Suunto Clinometer respectively. Growth rates in diameter and height were determined.

3. Results

3.1 Diameter growth rates for *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* in pure and mixed stands

The mean growth rates in diameter of *Ceiba pentandra* in the pure and the mixed stands were 1.73 cm/year and 1.61cm/year respectively. A statistical analysis of variance showed no significant difference in growth rate of the tree diameter at 5% significant level. The mean growth diameter for *Terminalia superba* was 1.77 cm/year and 2.02 cm/year in the pure and mixed stands respectively. At 5% level of significance, there was no significant difference in tree diameter for the pure and mixed stands. The results showed 2.70 cm/year and 2.57 cm/year mean growth diameter for *Triplochiton scleroxylon* in the pure and mixed stands respectively. A statistical analysis of variance (ANOVA) at 5% level of significance indicated no significant difference in tree diameter measurement.

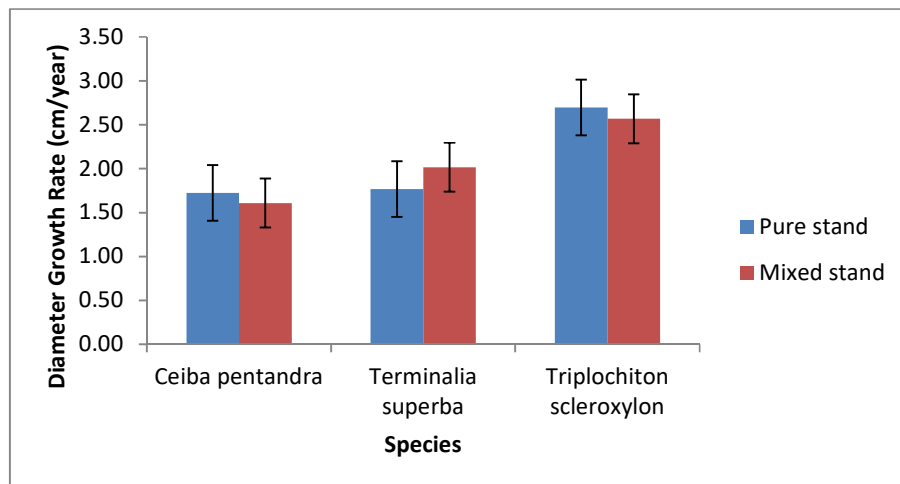


Figure 2 Growth rates in diameter for *Ceiba pentandra*, *Terminalia superba* and *Triplochiton Scleroxylon*

3.2 Height growth rates for *Ceibapentandra*, *Terminalia superba* and *Triplochiton scleroxylon* in pure and mixed stands

The mean height growth of *Ceiba pentandra* in the pure and the mixed stands were 1.06 m/year and 0.80 m/year respectively. The mean growth rate in height growth for *Terminalia superba* in the pure and the mixed stands were 1.16 m/year and 1.25 m/year respectively. The height growth of *Triplochiton scleroxylon* in the pure stand was 1.98 m/year and that of the mixed stand was 1.59 m/year. A statistical analysis of variance (ANOVA) at 5% level of significance indicated a significant difference in the mean of tree diameter measurements. Comparing of means using the Least Significant Difference (LSD) method showed a significant difference between the mean heights of *Triplochiton scleroxylon* in pure and mixed stand. There was however, no significant difference between the mean heights of *Ceiba pentandra* and *Terminalia superba* in their pure and mixed stands.

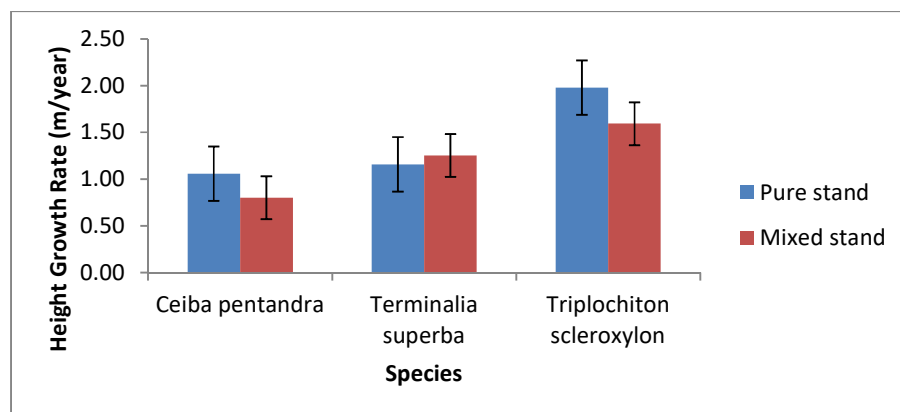


Figure 3 Growth rates in diameter for *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* in pure and mixed forest stand

4. Discussion

4.1 Diameter growth rates of *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* in pure and mixed stands

The mean growth in diameter of *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* were higher in the pure stands than in the mixed stands. However, there was no significant difference between the mean growth rate in diameter of the species in their pure and mixed stands at 5% significant level. *Ceiba Pentandra* recorded the least growth in diameter in both pure and mixed stand. This was due a disease that attacked *Ceiba* in its early stages. The disease might be due to failure to treat *Ceiba* seedlings with fungicides before transporting and subsequent planting.

The higher *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* growth, in diameter observed in mixed stands suggest better performance in mixed stands compared to that in pure stand stands. The higher growth in diameter for *Triplochiton scleroxylon* than the other species in both the pure and mixed stand could be due to the *Celtis-Triplochiton* tree association in the ecological zone. The results correspond with several other studies which reported better growth in mixtures than monoculture stands (Potvin and Dutilleul, 2009); (Binkley, Dunkin, DeBell and Ryan, 1992). However, it seems to differ from other studies which suggested greater growth and productivity in some tree species planted in monocultures compared to mixtures. Results from, Petit and Montagnini, (2006) indicated that *Calophyllum brasiliense*, *Virola koschnyi* and *Hyeronima alchorneoides* significantly grew better in monocultures than in mixed plantations. Piotto, Viquez, Montagnini and Kanninen, (2004) also emphasized that in the dry tropics of Costa Rica, *Tectona grandis* planted in monoculture was the most productive compared to planting in mixture with other species. *Araucana cunninghamii* planted in the humid tropics of Australia reported by Erskine, Lamb and Bristow, (2006) performed poorly in mixtures with average basal area and stand basal area 16% and 10% lower respectively, than in monoculture stands. Thus the concept of productivity of tree species in mixed stand or pure stand may be species specific.

4.2 Height growth rates of *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* in pure and mixed stands

The mean growth rate in height of *Terminalia superba* was higher in the mixed stand than in the pure mixed stand. The mean growth in height for *Ceiba pentandra* and *Triplochiton scleroxylon* in pure stands were higher than that of the mixed stands. *Ceiba pentandra* recorded the least growth in height in both pure and mixed stand. This was due a disease that attacked *Ceiba pentandra* in its early stages. The disease might be due to failure to treat *Ceiba pentandra* seedlings with fungicides before transporting and subsequent planting.

The differences in growth rates in height between pure stands and mixed stand could be to competition. Competition is mostly for any one or more factors of light, water and nutrients and the closer any two plants are in their responses to limitations in these variables, the more intense the competition between them (Hunt, Battaglia, Davidson, and Unwin, 2006).

Competition is one of the most important interactions which can influence productivity and growth in mixed stands of trees. This phenomenon is crucial because in any natural community one species may influence another species directly or indirectly (Hunt et al., 2006); (Cannell, Rothery and Ford, 1984). Therefore, competition is a very important factor which influences growth and survival of individual plants (Firbank and Watkinson, 1985). Several studies have however shown that mixtures can be highly productive compared to monoculture plantations (Nadrowski, Wirth and Scherer-Lorenzen, 2010); (Potvin and Dutilleul, 2009); (Potvin, C. and Gotelli, 2008); (Bristow, Vanclay, Brooks and Hunt, 2006); (Erskine, Lamb and Bristow, 2006); (Forrester, Bauhus, and Cowie, 2005); (DeBell, Cole and Whitesell, 1997); (Binkley, Dunkin, DeBell and Ryan, 1992). The slight differences in growth between pure stands and mixed stand could also be attributed to the genetic composition of the trees and competition among tree species. This assertion is supported by Nwoboshi, (1982) who explained that the pattern of height growth of an individual tree primarily depended upon differences in the genetic composition of the trees. Light is a principal limiting factor for growth in all forest trees as observed by Swaine, Agyeman, Kyere, Orgle, Thompson and Veeneendal, (1997) and hence influences the average height of the trees as they are all light demanding species. The results, however, contrast several other studies which recorded better growth in mixed stands than monoculture stands (Potvin and Gotelli, 2008); (Forrester, Bauhus and Cowie, 2005); (Binkley et al., 1992).

5. Conclusion

The research significantly provided the required information for a successful restoration of the degraded forest using indigenous plant species in pure and mixed stands. The *Ceiba pentandra*, *Terminalia superba* and *Triplochiton scleroxylon* planted in mixed stand performed better than the pure stands in diameter and height growth rates.

Triplochiton scleroxylon had the best growth performance in monoculture and mixed stands, followed by *Terminalia superba* with *Ceiba pentandra* having the least growth performance.

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