



Experimental demonstration of seven industrial tree species at Aman in southwestern Ethiopia

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Report summary

In Ethiopia annual plantation expansion is as low as 3700 ha nationally (Million, 2011) that could not even satisfy the domestic demand for forest product. Although Ethiopia own high potential to make best out of plantation, the establishment large scale forest plantation for generation of foreign currency is hardly attained, and the country is continuing to import forest products from abroad. Therefore, this study was conducted (i) to enhance forest cover of the country and (ii) to increase the quality of industrial tree species. This experiment was established in south west Ethiopia at Aman site at the altitude of 1280 m .a.s.l since July 2017.

The seedlings of the species were raised at Aman site and planted in RCBD, 100 seedlings per plot at 2 m spacing in three replications. The data on growth parameters were collected. Important management practices including watering, weeding, fencing and pruning were adopted for the success of the participatory trial. DBH, SV% and Height data were subjected for analysis using one-way ANOVA ($P < 0.05$). Almost all species, in the first-year data collection season, were less than 1.3m height. The mean survival rate (%), diameter at breast height (cm) and height (m) differed significantly between the species. The results show that *Eucalyptus grandis* (10.2 m) grew significantly better in height than others, while *Cedrela odorata* (3.39 m) grew significantly lower in height than others. *Eucalyptus grandis* was revealed the biggest in DBH, while *Cordia alliodora* was the smallest in DBH at the age of 28 months. Based on the results, the selected exotic species demonstrated promising capacities for commercial purpose.

1. Introduction

The Ethiopian characteristic timberlands are vanishing at an alarming rate, and a consider recommended that the normal deforestation rate of Ethiopia lies some place between 1-1.5% every year (Lemenih and Woldemariam, 2010). The unabated deforestation and their destitute substitution on the one hand and the ever-increasing demand for wood items (Hunde et al., 2003; Sandewall et al.,

2015) on the other can have financially ominous results. For instance, on the year 2015 alone, the nation imported over 3 million m³ Roundwood identical of different mechanical wood items that taken a tax almost 182.53 million USD whereas the consequence and trade appear a negative slant adjust (MEFCC, 2018b).

Globally, planted woodlands are expanding and constitute 7% of the whole timberland cover but are mindful for more than 50% of world's mechanical circular wood generation (FAO, 2010). Additionally, the focus was given to set up woodland manors and move forward the wood supply circumstance in Ethiopia, and extraordinary tree species such as eucalypt presented a century back. Particularly, large-scale plantation program was started within the early 1970s, with bolster from Sweden, pointing at progressing timber and fuelwood generation within the nation (Bekele, 2011; EFAP, 1994). Later gauges propose that planted woodlands (mechanical and smallholder ranches together) in Ethiopia sum to over 827 thousand ha (MEFCC, 2018a). In expansion to the advancement of manor with intriguing tree species, distinctive endeavours have been made to create ranches with local trees. The local tree branches are, be that as it may, hampered by numerous components and most imperatively by herbivory. In this way, the existing information appear as it were that victory stories in creating local tree manors are exceptionally negligible, and instep recommend that the planted timberlands in Ethiopia are basically composed of extraordinary tree species (Bekele, 2011; MEFCC, 2018a).

The chosen consider species (*Cupressus torulosa*, *Cordia alliodora*, *Eucalyptus deglupta*, *Eucalyptus grandis*, *Eucalyptus pilularis*, *Cedrela odorata*, *Terminalia ivorensis*) are among the presented timber species.

2. Materials and methods

2.1. Site description

The explore was carried out at Shesheka kebele Aman research site of the Southern Nations, Nationalities and People groups National Territorial State, Ethiopia. Topographically, Shesheka is found between 07° 2' 30" and 07° 6' 0" North and 35° 32' 0" and 35° 37' 0" East.

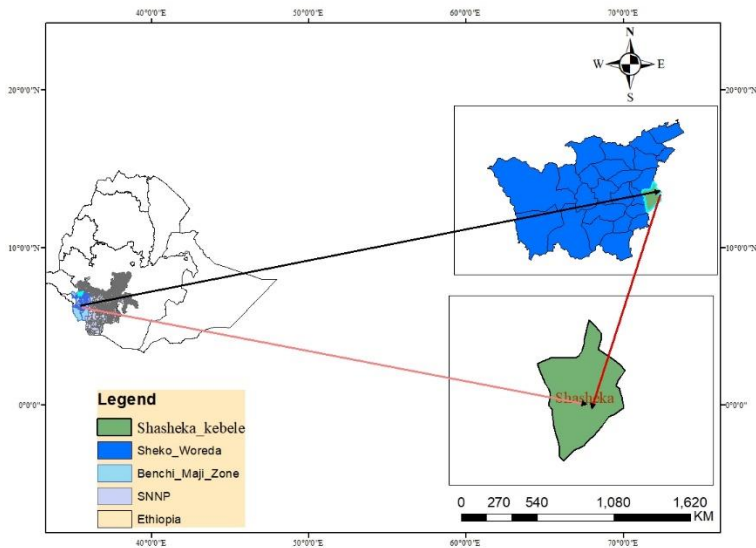


Figure 1: Map of the study site

2.2. Species description

Table 1 presents brief descriptions and ecological ranges of the seven tree species.

2.3. Seed collection and raising seedlings

Seeds of selected timber species (*C. odorata*, *C. alliodora*, *E. deglupta*, *E. grandis* and *E. pilularis*) collected from stands of the Forestry Research Center located in southwest Ethiopia were used. Seeds of *C. torulosa* and *T. ivorensis* were directly taken From Central Ethiopia Environment and Forest Research Center. Seeds of the seven species were sown on a temporary nursery site seed bed on 01 December 2017 and then transplanted to polyethylene bags. All species but *C. odorata* seedlings were grown on white pot sizes of 12cm and *C. odorata* was grown on black pot with size of 20cm with a soil mix of 3:2:1 (local soil, forest soil and sand, respectively). They were provided with the necessary shade with wood support and grass top and watered and weeded until they attained planting height.

2.4. Experiment establishment and data collection

The species were planted out within the field in a randomized complete block design (RCBD) with three replications laid along the contour. 100 seedlings per plot with dispersing of 2 m X 2m between trees, 2 m between plots and 3m between blocks were utilized. The exploratory location was given assurance with live fencing. Weeding and hoeing were carried out continuously three times a year. Information was collected from the inward 64 trees in each plot and the rest were considered as border trees whereas the complete tree number was utilized for survival rate assessment.

Table 1. Tree characteristics, natural distribution and ecology of the eight exotic-species

Species name	Form and size	Distribution and Ecology
<i>Cedrela odorata</i> *	It is a tree to 40 m high; bole straight, cylindrical, branchless for up to 25 m; bark surface harsh and fissured, reddish brown particularly close the base of the bole, grayish higher up.	It is widely distributed in wet forests of low elevations in tropical America with altitude of 0-1900 m, mean annual temperature: 22-26 deg. C, Mean annual rainfall: 1000-3700 mm. It prefers fertile, free draining, weakly acidic soil but tolerates heavy soil.
<i>Cordia alliodora</i> *	Growsto over 30m tall and 30-50cm dbh, usually straight, cylindrical; often clear of branches for up to 50-60% of the total tree height.	It is a pioneer plant found in a wide range of habitats. it is common in drier areas with altitude of 0-2000 m, mean annual temperature: 24 °C, mean annual rainfall: 750-2000 mm.
<i>Cupressus torulosa</i> *	A tree 15-25 (45) m tall and with dbh of 40-60 (90) cm, crown large oval to broadly conical.	It is a shade intolerant species, thriving in tropical and subtropical rainforests with altitude of 800- 3000 m, mean annual temperature: 12-22 °C and mean annual rainfall of 650-1 600 mm.
<i>Eucalyptus deglupta</i> *	It is a huge evergreen tree grown up to 60 (max. 75) m tall; bole generally of good form, 50-70% of the tree height, up to 240 cm in diameter.	It is generally adapted to lowland and lower montane rainforest habitats, with altitude: 0-1800 m, mean annual temperature of 23-31 °C and mean annual rainfall of 2500-5000 mm
<i>Eucalyptus grandis</i> *	It attains a height of 45-55 m, usually with an excellent trunk and a wide-spreading	It grows in tall, open forest in sheltered valleys and on hill slopes, with altitude of 0-2700 m, mean annual temperature between -1 to 40, and mean annual rainfall of 100-1800 mm.
<i>Eucalyptus pilularis</i> **	It is a tree to 70 m high; bark persistent on full trunk, grey-brown, shortly fibrous to stringy, smooth above, white to grey, shedding in long ribbons.	It is widespread and frequently dominant, in wet sclerophyll or grassy coastal forest on lighter soils of medium fertility, north from Eden district.
<i>Terminalia ivorensis</i> *	It is a large deciduous forest tree height from 15 to 46 m, branchless for up to 30 m, dbh 2-4.75 m. Bole clean, very straight with small buttresses and sometimes fluted.	It is found in rainforest conditions but is predominantly a tree of seasonal forest zones with Altitude of 0-1200 m, mean annual temperature 20-33 °C and mean annual rainfall of 1250-3000 Mm

Source: * Agroforestry Database 4.0 (Orwa et al. 2009); ** <http://plantnet.rbg Syd.nsw.gov.au> on 30 September 2019; *** Adapted from the Gymnosperms database, www.conifers.org, on 31 May 2018

Survival count and height measurement were done 8, 21 and 28 months after planting, DBH was measured at 21 and 28 months after planting.

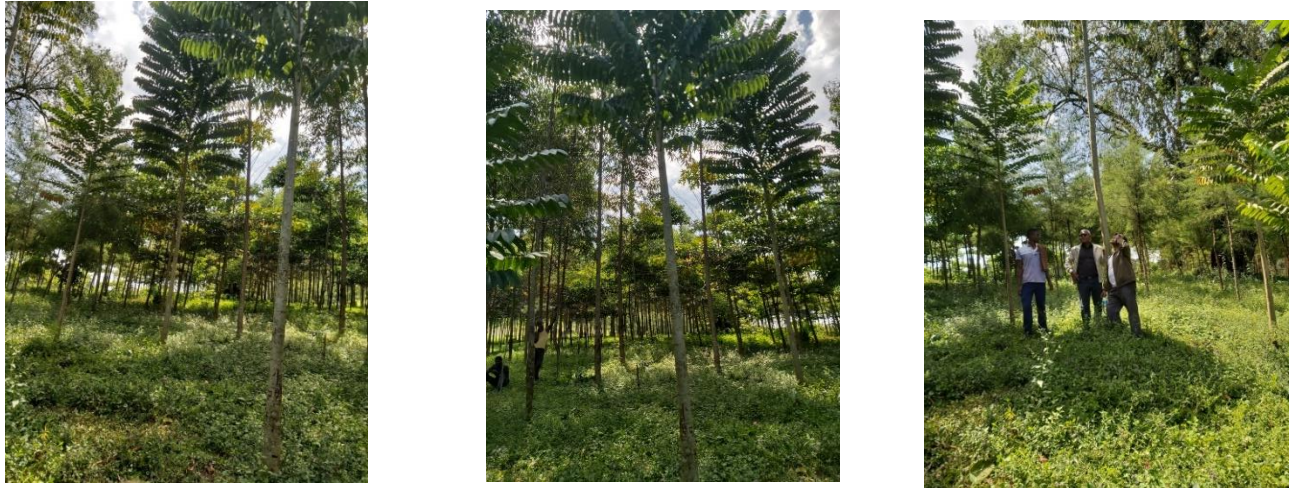


Figure 2: Partial view of the demonstration plot of seven exotic species at Aman site

2.5. Data analysis

Descriptive statistics were computed for survival, diameter and height. Survival evaluation of the timber species was based on the initial number of trees planted. A univariate general linear model (GLM) ($\alpha = 0.05$) was utilized to decide the presence of significant differences among the species for growth and survival.

3. Results

3.1. Survival and growth performance

The percentage survival varied from 81.4% at year 0.7 to 64.9% at 28 months.

Table 2. Mean survival (%) of 28 months old timber species at Aman, South-western Ethiopia

Species	SV (mean \pm SD)
<i>Cedrela odorata</i>	29.3 \pm 13.23
<i>Cordia allidora</i>	34.6 \pm 8.75
<i>Cupressus torulosa</i>	88 \pm 10.64
<i>Eucalyptus deglupta</i>	88.3 \pm 0.94
<i>Eucalyptus grandis</i>	64.3 \pm 1.25
<i>Eucalyptus pillularis</i>	65.6 \pm 4.79
<i>Terminalia ivorensis</i>	84 \pm 7.89
Total	64.9 \pm 24.14
P-value	0.000

3.1.2 Species growth indices

The analysis of variance in growth among the timber species revealed significant differences among the timber species.

Table 3: DBH (cm) and Height(m) of the seven planted species of 28 months of age stand at Aman, South-western Ethiopia

Species	DBH (cm)(Mean ± SD)	Height(m) (Mean ± SD)
<i>Cedrela odorata</i>	6.15±5.77 ^b	3.39±1.71 ^a
<i>Cordia allidora</i>	3.83±1.58 ^a	3.60±1.26 ^{ba}
<i>Cupressus torulosa</i>	4.15±1.51 ^a	4.24±0.92 ^b
<i>Eucalyptus deglupta</i>	6.66±2.28 ^b	8.67±2.68 ^d
<i>Eucalyptus grandis</i>	7.69±2.96 ^c	10.20±3.39 ^e
<i>Eucalyptus pillularis</i>	7.07±2.98 ^b	9.82±3.86 ^e
<i>Terminalia ivorensis</i>	5.23±1.31 ^b	4.23±1.30 ^c
Total	5.88±2.88	6.69±3.70
P-value	0.000	0.000

Means with the same letters across column are not significantly different (P > 0.05)

28 months after planting, the growth data revealed that the plantation mean DBH and Height was 5.88 cm and 6.69 m respectively (Table 3).

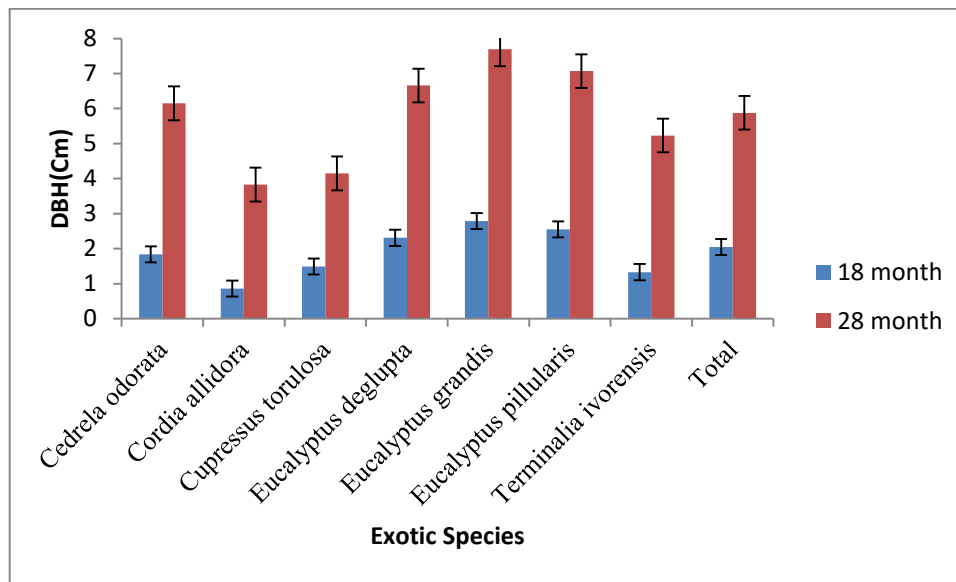


Figure3: Diameter growth of the species from at 18 and 28 months after planting in the field

At 28 months, height growth reaches the maximum point which is clearly attended by species *E. grandis*, while the minimum was observed by *C. odorata* (Table 3).

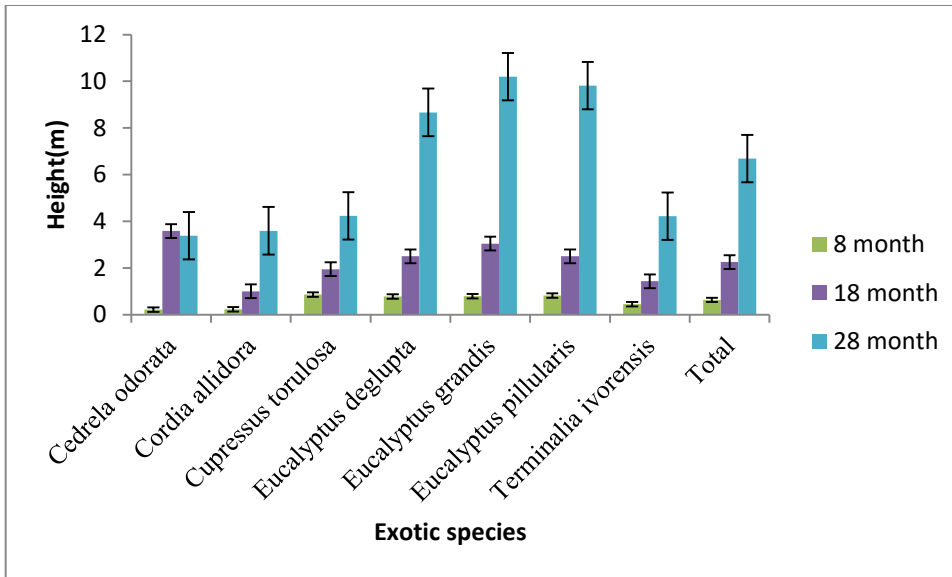


Figure4: Height growth of the species at 8, 18 and 28 months after establishment in the field

4. Conclusions

The study has been able to show the growth performance of seven exotic species up to the age of a 2.33 year (28 months). The three species (*E. grandis*, *E. deglupta* and *E. pillularis*) appeared promising. This is because *E. grandis* grows better, both in height and diameter, at the saplings' age than the rest exotic species in the site. As this study is a preliminary study, further research in this regard can therefore focus more on the simultaneous growth of these at an older age. When this is achieved, ecologist and other tree growers as well as the tree planters will be encouraged to utilize them for the commercial values.

5. Acknowledgments

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6. References

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