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Adaptation of Different Bamboo Species in Central Zone of Tigray, Northern Ethiopia

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Bamboo is the plant species under the family Poaceae, subfamily Bambusoideae. Bamboo is one of the species with greatest diversity in the world comprising about 1,642 species under 121 genera. However, only two species of bamboo are native to Ethiopia. Therefore, this study is designed to evaluate the performance of 9 introduced bamboo species namely: *Dendrocalamus asper, Dendrocalamus fuminensis, Dendrocalamus diananensis, Dendrocalamus membranaceus (CV.grandis), Dendrocalamus barbatus, Dendrocalamus laosensis, Bambusa long internode, Bambusa polymorpha,* and *Bambusa lapidea* in Tahtay-maichew district, central Tigray. The design of the experiment is Randomized Complete Block Design (RCBD) with three replications. The total size of the experimental field is 1,680 m^2 and the spacing between each blocks and plots is 3 m and 2 m, respectively. There are 10 plots having an area of 30 m^2 for each replication. A total of 180 bamboo seedlings were planted in the experiment. The collected data was analyzed using One-way ANOVA. The overall statistical difference in the survival capability of the species was not significant

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(P = 0.47) and 100% survival capability was observed by all species. The root collar diameter of the different bamboo species shows significant variation (P = 0.003). The highest root collar diameter (1.12±0.06 cm) was observed in the species *D. membrenaceus.* The highest diameter at stump height (0.87±0.03 cm) was observed by the species *B. long internode,* followed by *D. membrenaceus* (0.73±0.04 cm). The highest culm height was observed in the species *Bambusa long internode* (128±5.9 cm), followed by *D. membrenaceus* (102±6.8 cm), and the least culm height (49.7±8.8 cm) was observed in *O .abyssinica,* followed *by B. lapidea* (77.9±7.4 cm). In general, all nine species showed a very good adaptability to the site and should be included as part of the natural resource development and utilization process.

Keywords: Adaptation; introduced bamboo; tigray.

1. INTRODUCTION

Bamboo is the plant species under the family Poaceae, subfamily bambusoideae [1]. There are about 1,642 species of bamboo across the globe [2]. Bamboo is one of the fastest-growing plants on the planet [3]. Bamboo has a variety of economic, environmental, and sociocultural importance [4-7]. Bamboo resources covers 0.86% of the total global forest [8].

According to estimates, the world's bamboo forest resources span 35,040,000 hectares of land, or 0.86% of all forest resources worldwide [8]. According to another study [9], there are about 30,538,350 hectares of bamboo in the world. Even though the world's bamboo resource increased between the years 1990 and 2020, this increment is due to only two countries, namely, China and India [8]. Of the global bamboo resources, 3,404,310 hectares of bamboo forest are on the African continent (Du et al., 2018). Of the total bamboo forest resources in Africa (4648000 ha), Ethiopia has a total bamboo stock of one million hectares of land [9, 10]. The distribution of this bamboo stocks has uneven distribution across the country. Of which 425,000 hectares are believed to be found in areas of north-western and western Tigray and part of the Amhara region [11].

Bamboo is one of the species with the highest species diversity in the world. Globally, there are more than 121 genera and over 1642 species of bamboo [2]. Africa is home to 43 and only two species, *Yushania alpina* and *Oxytenanthera abyssinica*, are native to Ethiopia [12]. However, there are currently several initiatives aimed at expanding Ethiopia's bamboo species Diversity. Accordingly, over the past few decades, 25 different species of bamboo have been introduced to Ethiopia [13]. However the need to increase the national bamboo diversity and exploit the various potentials that could be obtained from the various species of bamboo is still important. Therefore, this study is designed to introduce and evaluate the adaptability of the nine exotic bamboo species to the central zone of Tigray.

2. MATERIALS AND METHODS

2.1 Site Selection

This study was conducted in Tahtay Maichew district, central zone of Tigray regional state, north Ethiopia. Tahtay-maichew is the district located southward to Mereb-leke, westward to Laelay maichew, eastward from Medebay-zana, and northward from Adet districts. The specific area of the experiment is in Debre-shewit nursery site.

2.2 Experimental Design

The design of the experiment is Randomized Complete Block Design (RCBD) with three replications and ten treatments (10 bamboo species). There are 9 introduced bamboo species (*Dendrocalamus asper, Dendrocalamus fuminensis, Dendrocalamus diannanensis, Dendrocalamus membranaceus (CV.grandis), Dendrocalamus barbatus, Dendrocalamus laosensis, Bambusa long internode, Bambusa polymorpha,* and *Bambusa lapidea*) and one indigenous bamboo species (*Oxytenanthera abyssinica*). The total size of the experimental field is 1,680 m^2 (70 m × 24 m), and the spacing between each block and plot is 3 m and 2 m, respectively. There are 10 plots having an area of 30 m^2 (6 m × 5 m) for each replication. A total of 180 (3 replications × 10 species × 6 seedlings of the same species per plot) planting materials were used in the experiment, with 6 bamboo seedlings of the same species planted in each plot. The source of the seedlings (species) is the Sustainable Land Management (SLM) project.

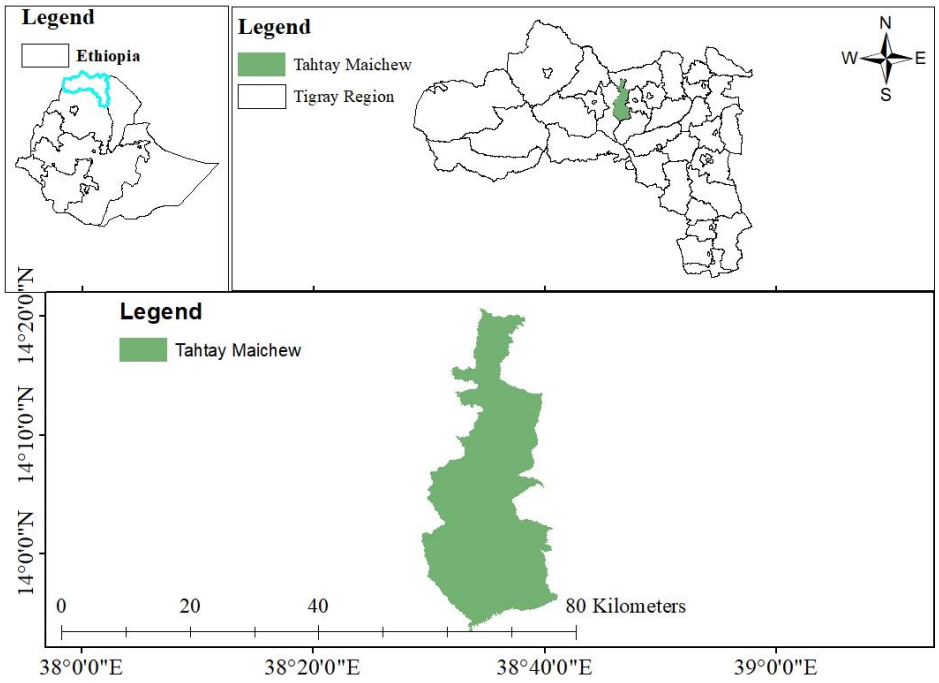

Fig. 1. Map of the study site

2.3 Layout of the Experiment

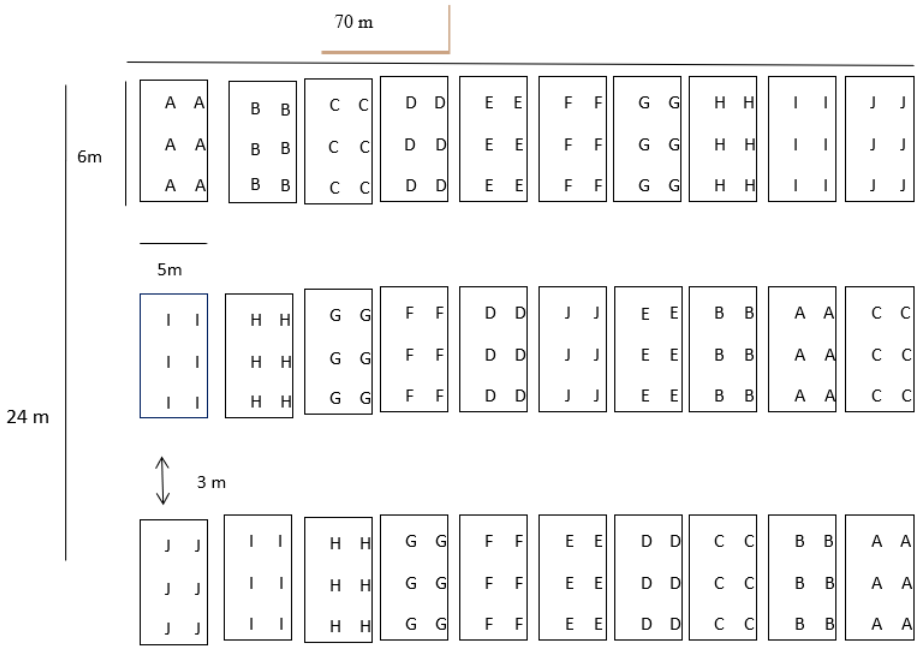

Fig. 2. model indicating experimental layout

Code	Species name	Code	Species name
A	*Dendrocalamus asper*	*F*	*Dendrocalamus laosensis*
B	*Dendrocalamus fuminensis*	*G*	*Bambusa long internode*
C	*Dendrocalamus diananensis*	*H*	*Bambusa polymorpha*
D	*Dendrocalamus membrenaceus (CV.grandis)*	*I*	*Bambusa lapidea*
E	*Dendrocalamus barbatus*	*J*	*Oxytenanthera abyssinica*

2.4 Data Collection

This experiment was conducted in 2019 through 2021. The collected data were: survival count, number of culms (emerging shoots), culm height, root collar diameter, diameter at stump height (DSH).

2.5 Data Analysis

The collected data were analyzed using one-way analysis of variance (ANOVA). To perform those analyses, R -v 4.0.0 was employed.

3. RESULTS AND DISCUSSION

Survival rate (%) of the species: the overall statistical difference in the survival capability of the species was not significant (P = 0.47). This study revealed that all the introduced bamboo species exhibited a survival rate of 100% (see Fig. 2). This indicates that, regardless of the differences in the different growth parameters, all nine introduced bamboo species exhibited high adaptability to the study area. This high adaptability of the introduced bamboo species is agreement with [14] conducted in Mekelle Agricultural Research Center and [15] in Bako area, west shoa, Ethiopia. According to another study by [16], *Dendrocalamus membrenaceus* exhibited 90% survival capability around Fedis district, Harerghe zone, Oromia regional state).

Root collar diameter and diameter at stump height: The root collar diameter of the different bamboo species shows significant variation (P = 0.003). The highest root collar diameter (1.12±0.06 cm) was observed in the species *D. membrenaceus,* followed by *Bambusa long internode,* and this is similar with [17] (1.09±0.05 cm).

On the other hand, the lowest root collar diameter (0.364±0.07 cm) was observed in the species *O. abyssinica,* followed by *Bambusa lapidea* (0.772±0.06 cm). This means that all nine introduced bamboo species show the greatest root collar diameter than the indigenous bamboo, *O. abyssinica*.

The overall statistical significance (P = 0.001) in diameter at stump height was observed between the treatments. The highest diameter at stump height (0.87±0.03 cm) was observed by the species *B. long internode,* followed by D. *membrenaceus* (0.73±0.04 cm) and, and the lowest diameter at stump height (0.29±0.05 cm) was observed in the species *O. abyssinica* and *B. lapidea* (0.56±0.04 cm).

Culm height: The highest culm height was observed in the species *Bambusa long internode* (128±5.9 cm), followed by *D. membrenaceus* (102±6.8 cm), and the least culm height (49.7±8.8 cm) was observed in *O .abyssinica,* followed *by B. lapidea* (77.9±7.4 cm) indicating these species are more vigorous than the local one.

Number of new shoots: The statistical difference in the number of new shoots was highly significant between the different species. The highest mean number of new emerging shoots (13±1.2) was observed in Bambusa long internode, followed by *D. dianensis* (11±1.2) and *D. laosensis* (11±1.2), and the lowest number of emerging shoots (6±1.3) was observed in *O. abyssinica,* followed by *B. lapidea* (8±1.2).

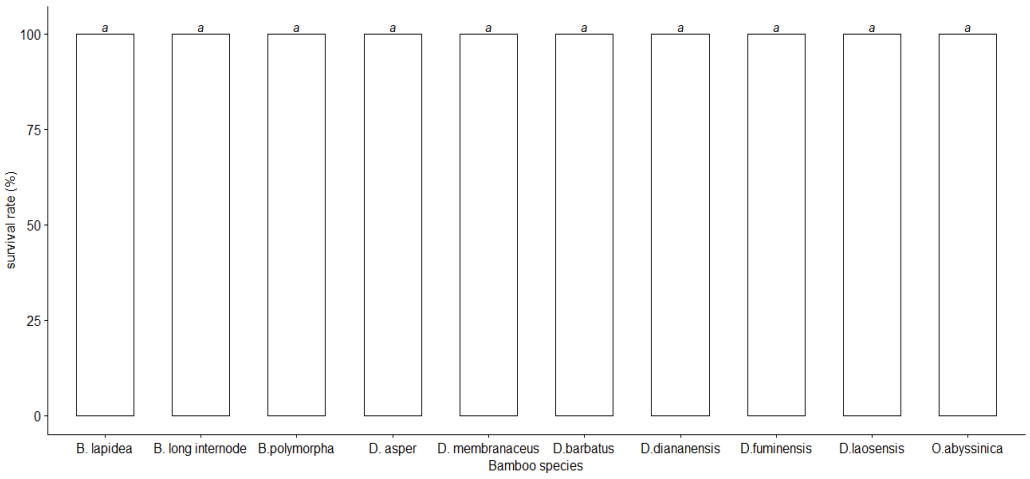

Fig. 3. Survival rate of the different bamboo species

Fig. 4. Performance of the species in the experimental site

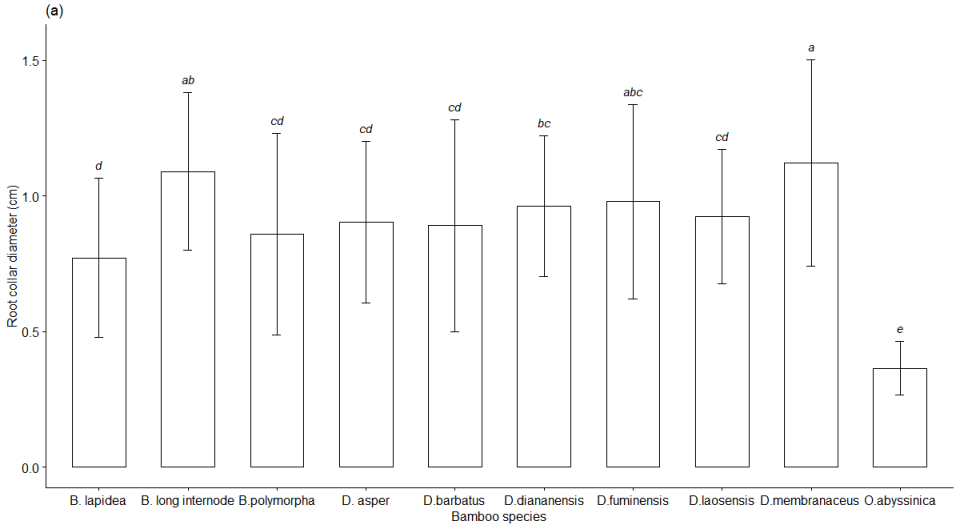

Fig. 5. Root collar diameter of the different bamboo species

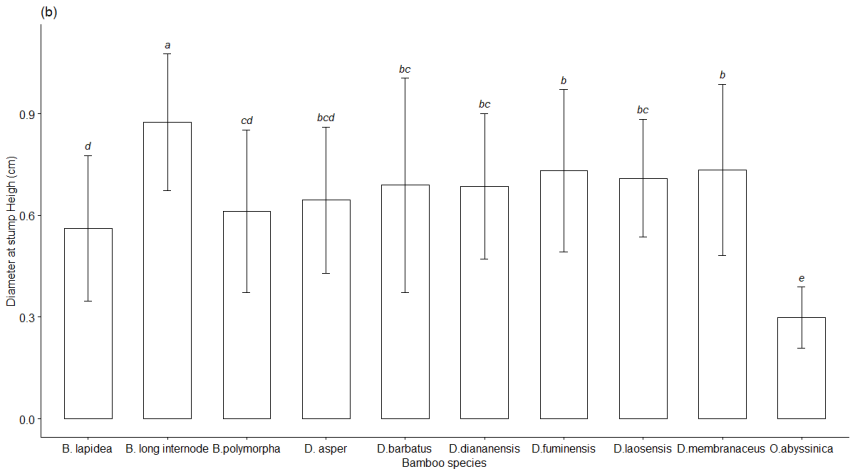

Fig. 6. Diameter at stump height of the species

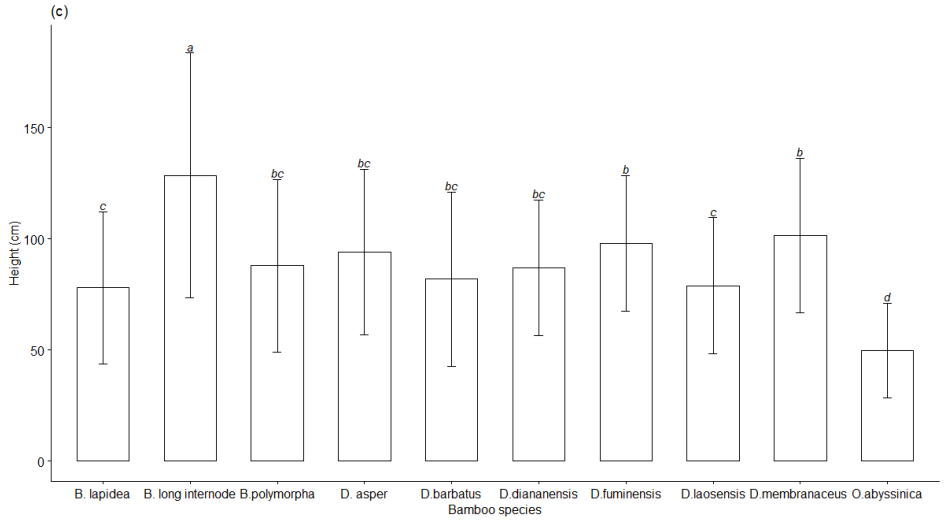

Fig. 7. Culm height of the different bamboo species

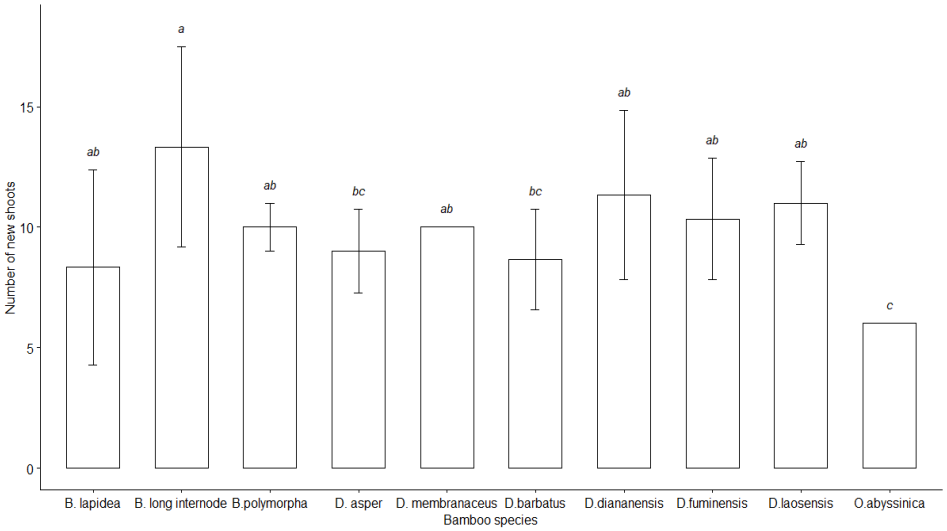

Fig. 8. Number of new emerging shoots of the different bamboo species

4. CONCLUSION AND RECOMMENDATION

This study revealed that, regardless of the difference in the different growth parameters, all nine introduced species, namely, *Dendrocalamus asper, Dendrocalamus barbatus, Dendrocalamus fuminensis, Dendrocalamus diannanensis, Dendrocalamus membranaceus (CV.grandis), Dendrocalamus laosensis, Bambusa long internode, Bambusa polymorpha,* and *Bambusa lapidea*) showed 100% survival rate and can grow well in the study area.

With respect to the different growth parameters like root collar diameter, diameter at stump height, culm height, and number of new emerging shoots, the species *Bambusa long internode* and *Dendrocalamus membrenaceus* exhibited high performance. The least performance was observed in the species Bambusa lapidea and Oxytenanthera abyssinica. In general, all nine species showed a very good adaptability to the site and should be included as part of the natural resource development and utilization process.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image

generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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