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Adaptation and Growth Performance of Lowland Bamboo Species at Haro Sabu Condition

Temam Mama[1], Wegene Negese[2]

Email of corresponding auther:temammama@gmail.com

Oromia Agricultural Research Institute, Haro Sabu Agricultural Research Center, Agroforestry Research Teams

P.O.Box 10, Haro Sabu, Kellem Wollega, Oromia, Ethiopia.

Abstract

Bamboo is a fast growing plant species than other and starts to yield within three or four years of planting. Even though Ethiopia is one of the most endowed countries in having huge coverage of bamboo resource in Africa, the country has narrow genetic diversity only has two species; Yushania alpine (highland bamboo) and Oxytenanthera abyssinica (lowland bamboo). The adaptation of lowland bamboo was conducted at Haro Sabu Agriculture Research Center from 2016 to 2019 to evaluate the adaptability potential of different performance of lowland bamboo species and to identify the best performing of lowland bamboo species around Haro Sabu areas. Based on the objectives, four different lowland bamboo species were collected from Bako Agriculture Research Center. The species are: Oxythenantera abyssinica, Guadua amplexofolia, Dendrocalamus hamlitonii and Dendrocalamus memebranceous among those mentioned only Oxytenanthera abyssinica are indigenous the rest are exotics. The experiment was laid out in RCBD with three replications. The selected bamboo species has good survival and adaptability at Haro Sabu area except some growth variation. Despite this fact, Dendrocalamus asper species is show high difference in new emerging shoots, internodes length, culm height and culm diameter whereas, Oxythenantera abyssinica revealed low in all growth parameters. So, based on these results we recommend Dendrocalamusasper, Dendrocalamus hamlitonii and Dendrocalamus memebranceous for different production since they have a good internodes length, ability to emerge new shoots, culm height and diameter while the growth of Oxythenantera abyssinica is quite different when compare with others. Therefore, the adaptation of lowland bamboo under Haro Sabu and related agro ecologies is reliable so, we recommend for further economic and livelihood benefits for different stakeholders through expanding the plantation.

Keywords: Lowland Bamboo, Exotic, Indigenous, Plantation

Introduction

Bamboo is a perennial plant, which belongs to the Poaceae (sometimes called Gramineae) family ([20]). In terms of taxonomy, it is considered as a giant grass. There are over 1,500 species of bamboo ([3]) and Africa alone has 43 species ([7]). Ethiopia is one of the most endowed countries in area coverage of natural bamboo forest of the country that estimated to have about 1 million ha, which is about 7% of the world total and 67% of the African bamboo forest areas ([4]).

Even though Ethiopia is one of the most endowed countries in having huge coverage of bamboo resource in Africa, the country has narrow genetic diversity only has two species: *Yushania alpine (High land)* and *Oxytenanthera abyssinica (Lowland)*. In addition the most puzzling aspect of the bamboo life cycle is its flowering behavior. Bamboo is mostly monocarpic following it dies after flowering; without appreciating its economic return due to lack of scientific information in Ethiopia.

Oxythenantera abyssinica is a clumping (sympodial) type bamboo with solid culm at maturing age. It has an average culm diameter of 5 cm, and is 7 m high. This species grows at an elevation of between 1000 to 1800 m above sea level and is widely distributed in lowland areas of the country. On other hand bamboos has multiuse and fast growing species that has potential in improving the livelihood of people. It has immense potential in reducing carbon dioxide that is blamed for environmental pollution and the most valuable species for environmental protection. Bamboo is a millennium grass that contributes to government vision of getting itself in the list of the middle-income countries of the world in about the forthcoming two decades by boosting the income of farmers ([2]).

Bamboo is also used in Asia, at household and cottage-industry levels, to produce mats, scaffoldings, ladders, sticks, hand tools, brushes, pipes, umbrellas, toys, sports goods, musical instruments, spears, arrows, rafts, fishing rods, caps, baskets, flower pots and many other items ([9] and [12]).In this way, rural people can satisfy their own needs and supplement their income. Bamboo is also the preferred material for shade construction in plant nurseries, and for props to support the growth of agricultural crops like banana, tomatoes, and flowers

Bamboo shoots are a popular food in Asia, and the nutritional value is comparable to those of many commercial vegetables ([14]). They are also consumed in Ethiopia by the rural people living near the bamboo forests, albeit less popular. Boiled rhizomes are also eaten in these areas. There are reports indicating that “enset” (Ensete ventricosum) helped the Ethiopian people to limit the effects of drought and famine. Bamboo could also, probably, be used to supplement food requirements in Ethiopia. A panel held under the theme Drought in Ethiopia on 19 August 1999, in Addis Ababa, recommends, among other things, drought resistant crops and income-generating activities to resist and minimize the effects of recurring drought ([5]).As a multipurpose, drought resistant species, bamboo (particularly the lowland species) is suitable for these objectives. Deforestation is one of the most serious environmental hazards in Ethiopia ([6]). The country lost 77% of its forest land between 1955 and 1979 ([5].and this decline has continued to the present. The major consequences are losses in protective cover, soil erosion, flooding, water-quality deterioration, drought, and all the synergetic negative effects of these losses. Because it is a fast growing plant, which is adaptable to low quality sites (particularly lowland species) bamboo has the capacity to redress many of the problems in large areas of Ethiopia. It has high soil conservation potential. The rhizomes and roots grow in all directions forming a complex network of up to more than 1 m depth belowground, which effectively holds soil particles together, thereby, preventing soil erosion and promoting water percolation and the litter fall of Bamboo improves soil structure and fertility.

The above ground part of bamboo helps to reduce erosion caused by rain, by interception, and also shelters the soil from wind erosion. Bamboo has effectively restored the vegetation cover in denuded lands in the Philippines ([3]). Bamboo is also planted as an ornamental species owing to its grace, attractive foliage, and easy-to-shape clump ([17]).The high growth rate of bamboo is of course closely associated with high water and nutrient consumption. This makes it suitable for vegetation filter purposes ([11]).a biological means of waste purification, whereby most of the pollutants in the waste are used for biomass production through the plant-growth process. Increased biomass production means that carbon sequestering is enhanced and oxygen release increases. These are not unique characteristics for bamboo, but it does excel most species in growth rate. These qualities all make it an ideal species for urban plantations as hedges, as a buffer near waterbodies and surrounding waste deposits. This is in addition to its uses in production, e.g. to supply biofuel and products for construction and furniture industries for urban populations.

Bamboo is a fast growing and high yielding perennial plant with a considerable potential to the socioeconomic development and environmental protection ([2], [8], [10]). Therefore it is important to introduce and adapt high economic value of exotic bamboos species to improve the income of small farm holder, to divers the genetic resources of bamboos species and for environmental protection in Ethiopia. However the presence study was conducted to evaluate adaptability potential and growth performance of four lowland bamboo Species under Haro Sabu Condition.

MATERIALS AND METHODS

Description of study area

The study was conducted at HaroSabu Agricultural Research Center which is located in Kellem Wollega Zone of Oromia Regional State, Ethiopia. It is found at 550 km away from Addis Ababa, 89 and 110 km from the nearby towns, D/Dollo and Ghimbi, respectively. The elevation of the center is 1300-2000 m.a.s.l and temperature 23-34 0c, rainfall 1000-1300mm.

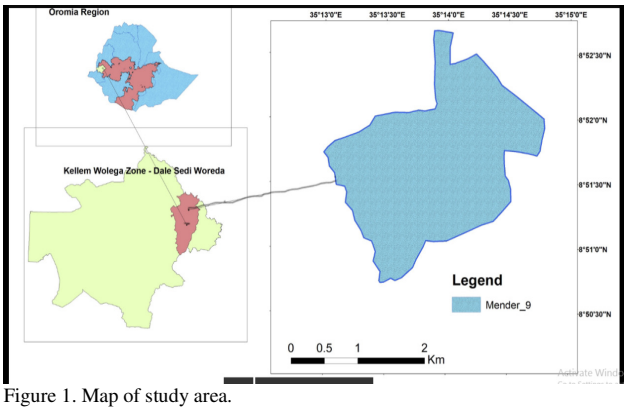

Figure 1. Map of study area.

Treatments and Experimental Design

The experiment was laid out in RCBD with three replications. The distance between blocks and plots was 5 m and 4 m, respectively. The space between each plant was 3 m and the plot size was 1470 m^2 with a total of 4 plants per plot and 48 total plants. As a treatment four lowland bamboo specieswere*Guadua aplexifolia /Dendrocalmus asper, Dendrocalmus Hamletonii,Dendrocalmus Membracias* and*Oxytenanthera abyssinica.*

Data Collection and Analysis

To achieve the given objective data on such parameter were collected; number of Bamboo seedling survived, Number of new emerging bamboo shoots, RCD of the emerging shoots, Culm diameter, Culm height, Internodes length, and Number of nodes per plant. The collected data were analyzed with analysis of variance (ANOVA) following the General Linear Model (GLM) procedure using SAS statistical software of 91.3 versions. The important variation, mean separation using LSD was conducted at 5 % significance level.

RESULTS AND DISCUSSION

Number of Bamboo Seedlings Survived

Mean value of the survival rate showed that there were high significant difference (p<0.000) among lowland bamboo species (Table 1). The highest mean was observed from Guadua aplexifolia /Dendrocalmus asper species that followed by Dendrocalmus Hamletonii, while the least mean was recorded from Oxytenanthera abyssinica. Dendrocalmus asper revealed the good survival rate. This might be due to the suit of the species at Haro Sabu condition. However, Oxytenanthera abyssinica illustrate low survival because the seedlings of Oxytenanthera abyssinica are highly preferred by termite which might have contributed to their poor adaptation compared to other species.

New Emerging Number of Bamboo Shoots

There was significant difference (P<0.000) in mean new emerging shoot between different lowland bamboo species. Based on the analysis results of the four years data *Dendrocalmus asper* bamboo species revealed a highest mean value on the number of new emerging shoots followed by *Dendrocalmus hamletonii* (Table 1). Dendrocalmus asper species showed a good performance in emerging new shoots. This is due to the well performance, adaptability and producing new emerging shoots ability of the species when compare to the other lowland bamboo species. The result is similar with the report from West Hararghe, Mechara on station [1]).

Root Collar Diameter

There was significant difference (P<0.05) between lowland bamboo species in mean root collar diameters of the species. In 4 years growing season, *Dendrocalmus asper* (3.47 cm), *Dendrocalmus Hamletonii* (2.59cm) and *Dendrocalmus membracias* (0.8cm) recorded the highest root collar diameter. However, *Oxytenanthera abyssinica* recorded the least in root collar diameter (0.36)(Table 1). In present study the highest Root Collar Diameter was recorded for *Dendrocalmus asper,* but study done in West Hararghe, Mechara on station ([1]) recorded the highest root collar diameter for *Dendrocalmus Hamletonii*. The difference in the root collar diameter of species can be due to their difference in adaptation to site condition.

Table 1: Means Comparisons between treatments at 0.05 significant levels (Mean ± SE)**.**

Culm Diameter

Dendrocalmus Hamlitonii	66.6± 2.37	1.8±0.50	2.59±1.22
Dendrocalmus asper	100±0	2.1±0.37	3.47±1.53
Dendrocalmus membracias	25±0	0.6±0.35	0.8±0.54
Oxytenanthera abyssinica.	2.27±0	0.27±0.19	0.36±0.13

The mean value of Culm diameter showed significant difference at (p<0.029) between species.

The highest mean was observed from *Dendrocalmus asper* species that followed by *Dendrocalmus hamletonii* and *Dendrocalmus Membracias*, while the least mean was recorded from *Oxytenanthera abyssinica* (Table 2).

Culm Height

The mean value of Culm Height showed no significant difference at (p<0.029) between species.However, study by Terefe et al. (2016) showed that mean value of Culm Height showed significant difference among species in which *Dendrocalmus hamletonii* showed highest Culm height.

Internode Length and Number ofNode

The mean value of an internode length showed significant difference at (p<0.000) level between treatments. The highest mean was observed from *Dendrocalmus asper* that followed by *Dendrocalmus Hamletonii*, while the least mean was recorded from *Oxytenanthera abyssinica* (Table 2).Moreover, the mean value of number of nodes showed significant difference at (p<0.000) between the species. The highest mean was observed from *Dendrocalmus asper* while the least mean was recorded from *Oxytenanthera abyssinica* (Table 2).

Table 2: Means Comparisons between treatments at 0.05 significant levels (Mean ± SE).

Bamboo Species	CD(cm)	CH(cm)	IL(cm)	NN(no)
Dendrocalmus Hamlitonii	2.5±1.35	18.6±30.84	10.68±2.7	15.98±2.7
Dendrocalmus asper	3.3±*1.95*	20.6±34.19	11.46±4.05	26.18±7.64
Dendrocalmus membracias	0.8±0.60	6.28±10.86	2.73±1.29	5.6 ±2.38
Oxytenanthera abyssinica.	0.31±0.17	0.38±0.10	1.246±0.38	1.96±0.49
P value	0.03	0.66	0	0

Conclusion and Recommendation

Among the selected bamboo species *Dendrocalmus asper* were showed highest performance followed by *Dendrocalmus hamletonii and Dendrocalmus memebranceous*, by all parameters. Based on the results of growth parameter, we rank performance of species as *Dendrocalmus asper, Dendrocalmus hamletonii and Dendrocalmus memebranceous* the first, second and third orders respectively.However *Oxytenanthera abyssinica* performed least and failed to adapt in the study site.

Generally we recommend pre-scaling up and demonstration for *Dendrocalmus asper*, *Dendrocalmus hamletonii and Dendrocalmus memebranceous* that have high growth performance. However *Oxytenanthera abyssinica* need further investigation to approve the problem.

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