Original Research Article

Evaluation of different propagation methods of Oxytenanthera *abyssinica* (A. Richard Munro) in northwestern Tigray, Ethiopia

ABSTRACT

Oxytenanthera abyssinica is known to be one of the lowland perennial grass species in Ethiopia with remarkable products and ecological services. The study was conducted with the aim to identify the appropriate propagation techniques of the Oxythenthera abyssinica in Tselemti district northwestern zone of Tigray national regional state. Four different propagation techniques namely rhizomes, culm cuttings, direct seed sowing, and seedlings were used. A randomized complete block design was used for studying different seed and vegetative propagation treatments. Four planting materials were planted in each plot and replicated four times. The survival rate was higher in the direct seed sowing (56.25%) and seedlings (43.75 %) compared to that of the rhizome (12.50 %) and culm cutting (0 %). The numbers of the culms per clumps were significantly higher in seedlings (15.75), direct seed sowing (22) and rhizome (9) than the culm cutting (0) and also the average height of the culms were higher in rhizomes, seedlings, and direct seed sowings than the culm cutting (P<0.05). Significant lower diameter sizes were recorded in direct sowing and culm cuttings compared to the rhizome and seedlings. The present study confirmed that the direct sowing and seedlings propagation techniques of Oxytenanthera abyssinica are more appropriate and recommended to use in the study area.

Keywords: culm cutting, direct seeding, Oxytenanthera abyssinica, rhizome, seedlings,

INTRODUCTION

Worldwide, there are about 1500 species of bamboo (Bystriakova et al. 2004). Of the total bamboo species, highland bamboo (Arundinaria alpine) and lowland bamboo (*Oxytenanthera abyssinica*) are indigenous to Africa (Demelash, 2006). *Oxytenanthera abyssinica* is widely distributed in East and West Africa (Mekonnen et al.2014). Ethiopia has the largest portion of bamboo coverage in Africa (Kassahun, 2015), which constitutes about 67% of the total bamboo coverage (Embaye et al.2005; Kassahun, 2003) and the country has around one million hectares of natural bamboo forest (Embaye et al.2005; Desalegn and Tadesse, 2014; Mekonnen et al.2014). *Oxytenanthera abyssinica* encountered 85% of the bamboo coverage (Embaye, 2000). Naturally, *Oxytenanthera abyssinica* propagates using seed and vegetative parts (Azene et al. 1993; Shanmughauel et al. 2003; Kassahun et al. 2003). However, the offsetting propagation techniques are insufficient for mass scale plantation areas (Kassahun et al. 2003, Purohit et al. 1998). Different authors reported that to enhance the area coverage of the lowland bamboo the propagation technique by seed is the successful method compared to the vegetative (Demelash et al. 2012; Kassahun, 2003).

In Ethiopia, the species is found in lowland regions of western and northwestern parts of Ethiopia (Bahru et al.2018) in Tigray, Gonder, Gojam, and Welega Regions (Hedberg and Edwards. 1989) and Benishangul Gumuz, the western part of Amhara and Oromia Regions (Zhao et al.2018). Annually the country has the potential to earn 1.2 million USD dollar from bamboo products (INBAR, 2010) and the *Oxytenanthera abyssinica* fulfills the international organization for standardization standards for industrial products such as plyboard, laminated bamboo lumber, oriented strand board, medium-density fiberboard and floorboards (Seyoum, 2008). Traditionally *Oxytenanthera abyssinica* is used as a raw material for building and making numerous household utensils, basketry, and handicrafts (Desalegn and Tadesse, 2014; Mekonnen et al. 2014) and used as a source of food for human (Yigardu et al.2016). In addition, bamboo used as ornamental, horticulture, environmental protection and agroforestry benefits (Desalegn and Tadesse, 2014).

Despite their many roles, the natural stands of bamboo decreasing rapidly (Desalegn and Tadesse, 2014). Similarly, in Tigray national regional state, *Oxytenanthera abyssinica* found in the northwestern and western parts of the region. However, due to different factors such as natural and anthropogenic factors, its area coverage has been extremely decreased. Particularly, the study area has been commonly known as the home of bamboo since most of the areas were covered by *Oxytenanthera abyssinica* but by now it founds only in few farmers and in remote areas. Agricultural expansion, lack of scientific knowledge on its management, harvesting, utilization potential, knowledge limitations on its propagation methods, lack of priority in its development and poor management are the major bottlenecks for bamboo resources in Ethiopia (Embaye, 2000; Kassahun, 2003; Mekonnen et al. 2014). However, to restore the population status of *Oxytenanthera abyssinica*, little researcher has been conducted regarding to the effects of the seed pre-treatment methods and number of nodes on growth performance but still there is a gap in identifying the appropriate propagation methods in Tigray as well as in Ethiopia Therefore, the objective of the study was conducted to identify the best propagation method of *Oxytenanthera abyssinica* using seed and vegetative parts.

MATERIALS AND METHODS

Study area

The study was conducted at Tselemti district Northwestern Tigray, Ethiopia (Figure 1). The district founds 400 kilometers away from Mekelle which is the capital city of the region and 190 km north of Gonder (Amhara regional state) (Alem et al. 2018).

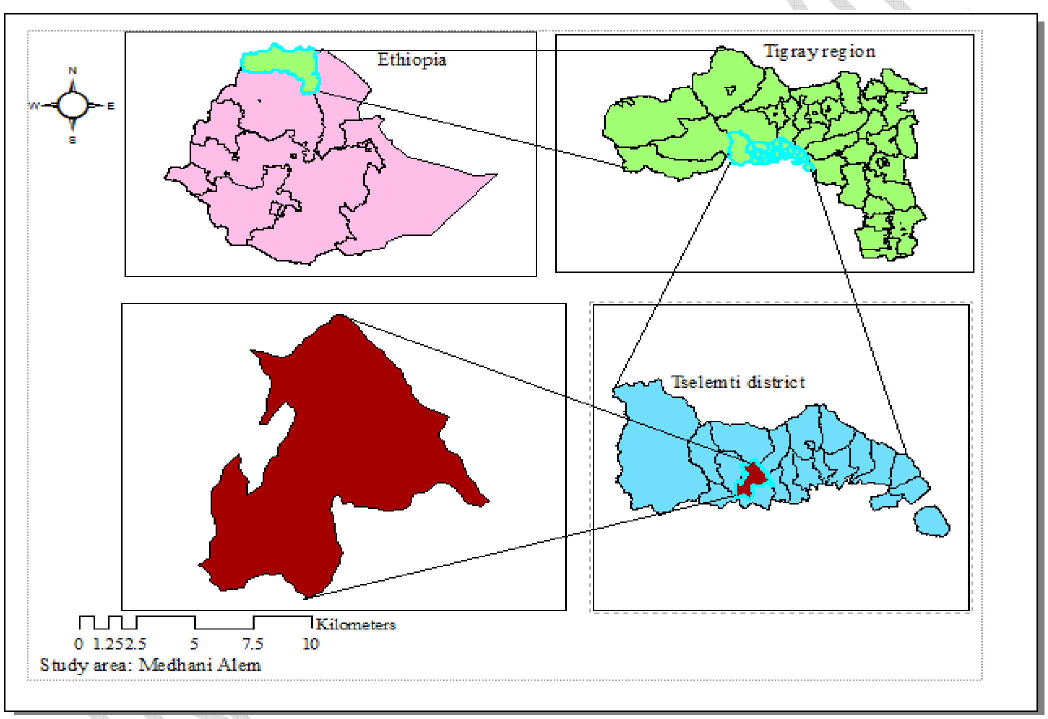

Figure 1: Map of the study area

The field experiment was conducted at Shire- Maytsebri agricultural research center experimental on station starting from June 2016-January 2018. The study area is geographically located at 13°0'05" North latitude and 38°0°08" East longitude with an altitude of 1350 meters above sea level. The agro-climatic condition of the area is hot to dry semiarid lowland plains dictated by very hot temperatures. The consecutive five years (2012-

2016) of the mean monthly rainfall of the district ranges between 1.44- 371 mm per year while the mean monthly minimum and maximum air temperatures are 15.6 and 38.6^{0}C respectively (Tigray meteorological services center).

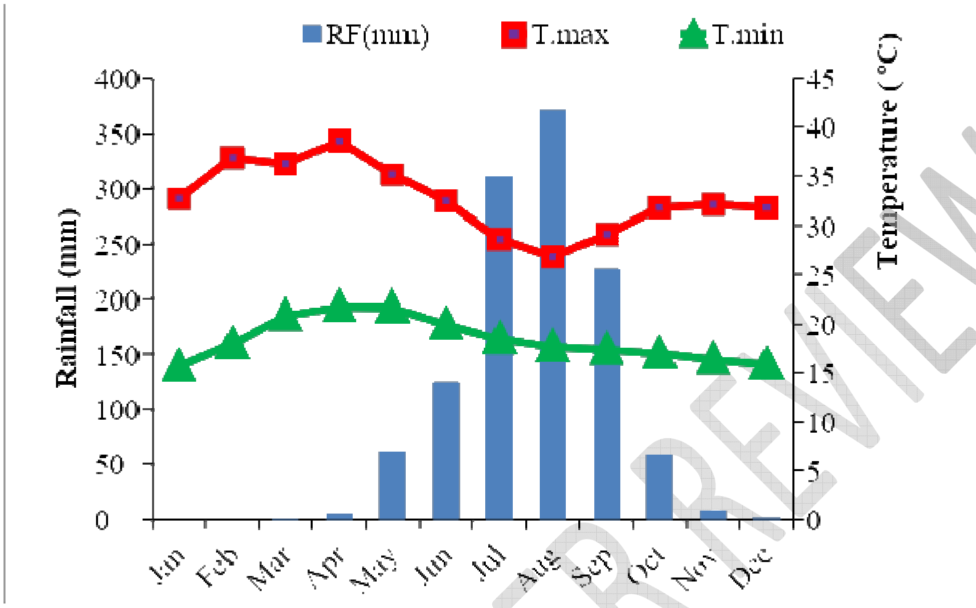

Figure 2: Mean Monthly Rainfall (mm), maximum and minimum Temperature (ºC) (2012-2016) (Source: Tigray meteorological services center)

The most dominant soil types of the study area are cambisols, nitosols, and Vertisols. The major annual crops grown in the district includes Sesame, sorghum, maize, finger millet and Tef (Eragrostis tef). Vegetables such as onion, tomato, potato, pepper, carrot, garlic, and groundnut. *Acacia bussei, Anogeisus leiocarpus, Dalbergia melanoxylon, Dichrostachys cinerea, Dovyalis abyssinica, Boswellia papyrifera, Ziziphus Spina-Christ, Diospyros mespliformis Cordia Africana*, and *Adansonia digitata* are the dominant tree species found in the study area.

Experimental design and treatments

The rhizomes and cuttings were collected from Serako kebele, Tselemti district, the northwestern zone of Tigray where *Oxytenanthera abyssinica* stands to exist while the seeds were collected from Benshangul Gumuz national regional state. The experiment was laid out in randomized complete block design with four replications. There were four treatments, namely, rhizome, direct seeding, seedling, and culm cuttings. There were a total of sixteen plots with a size of 4m*4m (16m^2) and per each plot four planting materials were used and the spacing between plots and blocks was 4m. For the culms cuttings, the vertical and horizontal of placement was used. The mean significance difference of the survival rate, number of culms, new emerging shoots; diameter and average height among the propagation techniques were analyzed by one-way analysis of variance that was conducted with statistical package for social science software version 20. For significant differences, mean separation using the least significant difference was conducted at a 5 % level of significance.

RESULTS AND DISCUSSION

Survival rate

The survival rate of the direct seeding (56.25%) and seedlings (43.75%) were significantly (P<0.05) higher than the rhizomes (12.5%) and culm cutting (0%) (Table 1). In this experiment, the culm cuttings have completely died. The lower survival rate in rhizomes and the completely die of culm cuttings may due to the presence of termites in the area and the lower rooting capacity (Fig 1) and naturally, the vegetative plant propagation method is more susceptible to disease and pests. Environmental factors such as temperature, wind speed, water balance, disease, and pests are the limiting factors for the propagation methods of bamboo using the culm cuttings and rhizomes (Banik 1995). Furthermore, Somashekhar and Manju (2002) reported that the asexual propagation method of plant species is more susceptible to wind, disease and pests compare to the sexual one. In support of this finding, different researchers showed that propagation of *Oxytenanthera abyssinica* through seed is the most successful and effective propagation method (Embaye et al, 2003, Gebrehiwot et al, 2016) but difficult to propagate by culm cuttings (Gebrehiwot et al,2016; Kassahun, 2001). In addition, the research conducted for other tree species by Grossnickle and Ivetić (2017) reported that the survival rate of the transplanted seedlings has a higher survival rate compared to the direct seeding. Besides, rhizome and culm cuttings have a low survival rate when compared with a seed (Banik and Alam, 1987). Similarly, propagating bamboo species via rhizomes method have low survival rates, low regeneration capacity and unsuitable for large scale plantations (Islam et al. 2011; Mudoi et al. 2013). In general, cutting-based propagation is not suitable for cane bamboo species or bamboo species that have a small or no hollow in the middle of the stem (Ray and Ali, 2017).

New emerging shoots and culms per clumps

The number of new emerging shoots of the *Oxytenanthera abyssinica* was significantly ($P<0.05$) higher in the direct sowing and seedlings compared to the rhizome and culm cutting propagation methods (Table 1). The lower new emerging shoots in the rhizome and the reason for completely dismissing for the culm cuttings in the study area may be due to the presence of termites (Fig 1) and the presence of the hot environmental condition and high temperature starting from January-June. Significantly higher ($P<0.05$) culms per clumps were recorded in the rhizome, direct sowing and seedling compared to the culm cutting. In addition, the culms per clump were higher in direct seeding and seedling compare to the rhizome propagation method but statistically similar (Table 1). This lower number of culms per clump in rhizome may be due to the low rooting capacity and more susceptible to disease, wind, pests and temperature. In agreement with this finding, Singh et al. (2013) reported that the vegetative propagation method especially the rhizome have low multiplication potential compared to the sexual propagation methods (transplanting seedlings, direct seeding).

Culm diameter and height

There was a significant difference in diameter size among the propagation methods which is higher in the rhizome and lowers in seedlings, culm cutting and direct sowing methods (Table 1). However, there was no significant difference between seedling and direct sowing. The higher culm diameter in the rhizome propagation technique may due to the initial availability of the stored food. Similar to the present finding, Somashekhar and Manju (2002) reported that the growth performance of plant species propagated by an asexual method is higher compared to the sexual method. In addition, Inoti (2016) and Ruchala (2002) noted that tree species that are propagated through vegetative propagation techniques take a short period of time to attain maturity. The average height of the culm was significantly higher in the rhizome, direct seeding and seedling compared to the culm cutting. Numerically, the average height of the culm which is propagated through rhizome was higher than the direct seeding and seedlings but statistically there was not different (Table 1).

Table 1: Means comparisons among treatments at 0.05 significant levels (Mean ± SE).

Treatment	Rhizome	Culm cutting	Seedling	Direct seeding	*P*-value
	Mean ± Std.SE	Mean ± Std.SE	Mean ± Std. SE	Mean ± Std.SE	
No of shoot	1 ± 0.58[a]	00 ±.00[a]	5.25± 0.48[b]	5 ± 0.91[b]	.000
No of culms	9 ± 3.24[a]	00 ±.00[b]	15.75 ± 9.37[a]	22 ±2.71[a]	.055
culm height (m)	2.12± 0.72[a]	00 ±.00[b]	1.10 ± 0.68[a]	1.32 ±0.21[a]	.071
Survival rate (%)	12.5 ±7.22[a]	00 ±0.00[a]	43.75 ± 6.25[b]	56.25± 12[b]	.001
culm diameter (cm)	2.90±0.15[a]	0.00±0.00[b]	2.51±0.18[c]	1.85±0.06[c]	0.000

CONCLUSION AND RECOMMENDATION

The current study revealed that, except for the culm diameter and culm height, the survival rate, culms per clump and the new emerging shoots were higher in direct seeding and seedlings compare to the rhizome propagation methods. Therefore, from this finding, the direct seeding and seedlings based propagation methods are successful to enhance the population of *Oxytenanthera abyssinica* even if seeds are limited in the study area and recommended to apply. Further research should be conducted on the effect of the number of nodes and culm diameters on the growth performance and survival rate of *Oxytenanthera abyssinica*.

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Figure

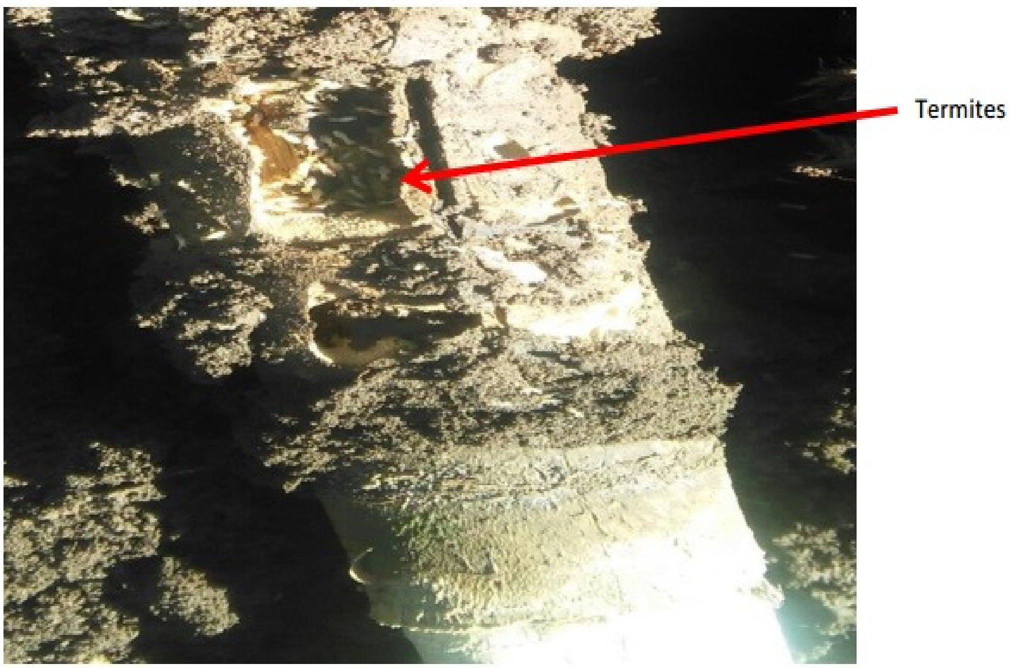

Fig 1: Rhizome damaged by termites