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Growth of *Bambusa vulgaris* and *Araundinaria alpina* under different nursery Site conditions at the higher institute of agriculture and animal husbandry, Northern Rwanda

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Abstract

This study was conducted to compare the sprouting rate and growth performance of *Bambusa vulgaris* and *Araundinaria alpina* culm cuttings planted in pots at ISAE- Busogo polythene-shaded tree nursery and glass-sided green house. An experiment was set up for a period of two months as from June to July 2012 using Complete Randomized Block Design and replicated three times in the two nursery sites. Temperature was recorded twice a day during the entire study period. Data on the days to shoot sprouting, number of sprout culms, shoot height and average number of leaves per culm cutting were collected at an interval of 15 days for a period of 60 days. The mean number of shoots per culm cutting was counted on the 60th day. Data was analyzed using JMP 10 where means were separated using Turkey HSD at $P \leq 0.05$. Shoot sprouts were observed within the first 15 DAP with *B. vulgaris* having more shoot sprouts than *A. alpina* at p=0.0012. *B. vulgaris* had attained a height greater by 19.9 % and 18.6% in comparison to *A. alpina* at the end of 60 DAP in the polythene shaded nursery and greenhouse respectively. The mean number of leaves per culm cutting at 60 DAP was significant at $p \leq 0.05$ for both species in the different sites. Better growth and performance was observed in *B. vulgaris* in both nursery sites and can therefore be recommended as the species that can be used for immediate reforestation programs in the region.

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Introduction

Bamboo is a woody perennial belonging to the family of grasses, Gramineae (Poaceae), with unique qualities (Bareja, 2010) as it is a self-regenerating and renewable non-timber natural resource. It grows very quickly once establish, is self-sustaining and does not need replanting after harvesting (UNIDO 2009). It is a versatile multipurpose forest produce that has immense potential in the industrial and domestic applications (Ahlawat *et al.*, 2002).

In Rwanda, there is substantial deforestation of 3.9% per year as reported by MINITERE and CGIS-NUR (2007), as a result of the demand for fuel wood and food products. The high population growth rate in the country has also led to increase in demand for food and other resources and hence steeper and higher upland areas being cultivated leading to considerable soil erosion which is damaging local ecologies that are supporting agricultural production systems and ecological services such as water capture, recharge and cycles, as well as carbon cycle.

In view of the above problems, Rwandan government decided to put particular effort in the afforestation programs. The government has been promoting planting of bamboos especially in the northern region which is characterized by steep hills. Bamboos are characterized by high growth rate, high level biomass production and are environmental friendly. Most importantly, bamboos not only contribute to the social income generation through sales of high quality products but also play a role in soil stabilization (Ntirugulirwa *et al.*, 2012.). On account of extensive rhizome-root system and accumulation of leaf mulch, bamboo serves as an efficient agent in preventing soil erosion, conserving moisture, reinforcing embankments and stabilizing drainage channels (Zhou *et al.*, 2005).

However, this program is severely constrained by several factors including but not limited to lack of good quality and adapted planting materials for some bamboos. There are also few indigenous species of which *A. alpina,* predominantly found in the north around Volcano National Park and *B. vulgaris* in the forests of Crest-Zaire-Nile region of the country (Ntirugulirwa *et al.*, 2012). *B. vulgaris* and *A. alpina* are very important bamboo species in Rwanda for their ability to grow under a wide range of soil and moisture conditions for easy propagation; additionally, it is often used to fight against water and wind erosion; it is also utilized in various handcrafts, building, food and medicine (Zhou *et al.*, 2005). In addition, the bamboos can be used in fences, houses, little piper or irrigation. The leaves are used for fodder for cattle as they are rich in nitrogenous materials (UNIDO, 2009). For the country to exploit the potential of bamboo, it is therefore, imperative to establish a propagation protocol to effectively multiply and supply the required amount of planting materials for large scale plantation within the country.

Material and methods

The experiment was conducted at Higher Institute of Agriculture and Animal Husbandry, polythene shaded tree nursery and glass sided green house in Musanze District, Northern Province between June and July 2012. The area is located at latitude of 1°33’ S and longitude of 29°33’E at an altitude of 2200 m above the sea level. The climate is predominantly highland tropical and characterized by an annual average temperature range of between 16 and 17°C. The rainfall varies from 1400 mm to 1800 mm per year with a relative humidity of 86% (Ng’etich *et al.*, 2013).

Two-year old single node culm cuttings as recommended by Bareja (2010) for mass propagation of *B. Vulgaris* and *A. alpina* were directly planted on polythene bags in a polythene shaded nursery and greenhouse in a completely randomized block design and replicated three times. Polythene tubes of 20 cm diameter x 40 cm height x 0.04mm thickness were used as recommended by UNIDO (2009). The cuttings were planted slightly slanting in each pot. In each plot, forty culms were planted making a total of 120 culms cuttings. The potting substrate consisted of soil mixed with sand in equal proportions. Watering was administered twice a day for the entire study period. Daily temperatures were recorded twice a day for the entire period of 60 days.

The number of days to sprouting, number of sprout culm cuttings, height of shoot sprout and number of leaves per culm cutting were counted and recorded at an interval of 15 days for 60 days. The mean number of shoots sprouts for each culm was counted on the 60th day. The height of shoots was taken by use of a graduated ruler.

Data was analyzed by use of JMP 10 software where significantly different means were separated using Turkey HSD method for pair wise comparison at $P \leq 0.05$.

Results and discussion

Temperature

The mean temperature recorded in the entire study period of two months in the polythene shaded houses and green house was 25° C. This data was found to be crucial as other studies have shown that temperature plays a critical role in bamboo sprouting and growth and rooting rate with very poor results being achieved at lower temperatures as they present unfavourable climatic conditions (Ahlawat, 2002). Best growth of tropical bamboo species can be observed at temperature range of 15° to 25° C (Solanki *et al.,* 2004) which was the case in both nursery sites in the current study.

Days to sprouting

Sprouting of shoots was observed within the first 15 days as reported by (Ahlawat, 2002). The total number of sprout culm cuttings as well as the sprouting rate of the cuttings varied in the two bamboo species. Although the total number of sprout culm cuttings varied at 79.2% and 88.3% in the polythene-shaded house and 88.8 % and 84.2% in the green house for *B. vulgaris* and *A. alpina* respectively at the end of two months, the results were not statistically different from each other at p=0.567. On the other hand, the sprouting rate at different days after planting was statistically different (p=0.012) for the different species whereby *B. vulgaris* depicted a much faster sprouting rate in comparison to *A alpina* as shown in Fig. 1.

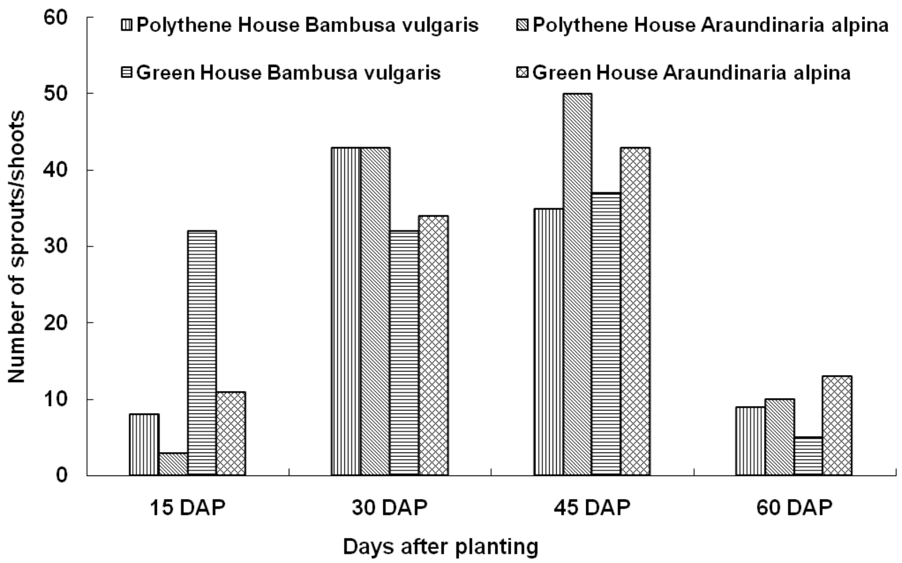

Fig. 1. Number of sprout cuttings of B.vulgaris and A. alpina at different DAP.

The total number of sprout culm cuttings was higher in the green house in comparison to the polythene-shaded nursery where by the performance of the two species varied in the two sites such that *B. vulgaris* planted in the green house had more sprout culm cuttings by 11.6% in comparison to those planted in the polythene-shaded house. On the other hand, *A. alpina* planted in the polythene-shaded house had more sprout culm cuttings by 5% than those raised in the green house. These disparities, despite the same temperature conditions in both sites can be accounted by the availability of sunlight. In the polythene shaded nursery, the cuttings had limited access to sunlight whereas the cuttings in the green house which is glass-sided could access sunlight hence had better stimulation of root development and hence shoot sprouting and growth (Sajad *et al.,* 2011).

Shoot height/ length

The shoot height/length of the two bamboo species were statistically different from each other at p=0.0045 during the entire study period in both sites. *B. vulgaris* had attained a height greater by 19.9 % and 18.6% in comparison to *A. alpina* at the end of 60 DAP in the polythene-shaded nursery and greenhouse respectively. This trend of superiority of *B. vulgaris* over *A. alpina* was generally observed during the entire period of study as shown in Table 1.

Table 1. Shoot height and mean number of leaves at different DAP.

Nursery Site	Parameter	Species	Days after planting 15	30	45	60
Polythene shaded nursery	Shoot height	*Bambusa vulgaris*	10.8 [a*]	16.4 [a]	22.1 [a]	25.3 [a]
		Araundinaria alpina	8.4 [b]	13.6 [b]	19.2 [b]	21.1 [b]
	Number of leaves/ cutting	*Bambusa vulgaris*	3.6 [a]	4.3 [a]	5.2 [a]	6.9 [a]
		Araundinaria alpina	3.0 [b]	3.7 [b]	4.9 [b]	6.1 [b]
Green House	Shoot height	*Bambusa vulgaris*	11.1 [a*]	17.1 [a]	23.0 [a]	28.0 [a]
		Araundinaria alpina	9.8 [b]	14.6 [b]	19.2 [b]	23.6 [b]
	Number of leaves/ cutting	*Bambusa vulgaris*	3.3 [a]	4.6 [a]	6.5 [a]	8.6 [a]
		Araundinaria alpina	2.3 [b]	3.3 [b]	5.9 [b]	7.4 [b]

*Levels not connected by same letter are significantly different at p≤0.05 according to Turkey HSD.

The results on shoot length/height (Table 1.) were comparable to the range of between 18.25 cm and 24.96 cm obtained by Sajad *et al.,* (2011) for *B. vulgaris* during different cropping seasons. Although the results obtained were generally lower than those obtained by Ntirugulirwa *et al*., (2012), they reinforce the superiority of *B. Vulgaris* in comparison to *A. alpina* as the results reported were 36.57 cm and 30.78 cm respectively for the two species at the end of a similar period.

Mean number of leaves per culm cutting

The mean number of leaves per culm cutting was statistically different at p≤0.05 for both species. *B. vulgaris* had more leaves per culm in comparison to *A. alpina* in both nursery sites as shown in Table 1. Further, the mean number of leaves per culm cutting varied in the two sites with more leaves per cutting being observed in the green house. These differences can be attributed to the accessibility of sunlight as earlier indicated (Sajad *et al.,* 2011).

Mean number of shoots sprouts per cutting at 60 DAP

A. alpina had a lower average number of shoots of 2.8 per culm cutting in the polythene-shaded nursery while *B. vulgaris* had an average of 3.2 shoots per culm cutting at 60 DAP. Both species had the same number of 5 shoots per culm cutting in the green house. These results for *B. vulgaris* are generally comparable to the average number of shoots ranging from 2.77 to 3.52 sprouts per culm cutting at different seasons of 3 months as obtained by Sajad *et al.,* (2011) in the polythene shaded nursery.

Conclusion

Bamboos can be propagated either by seeds or vegetatively. Propagation by seed is seldom used because of the rare and irregular flowering of most bamboo species. Besides, most bamboos produce infertile seeds or they rarely develop seeds. Moreover, most bamboos generally die soon after flowering (Nath *et al.*, 2009). This leaves vegetative propagation as a more viable option.

In relation to species performance, *B. vulgaris* showed better growth than *A. alpina* in qualities considered except in number of culm cutting sprout in which it performed better. *B. vulgaris* has been found to be more prolific than most of the bamboo species as evaluated by Cariño (1990) and Ramoran *et al.*, (1993).

Both species had a better performance in the green house in comparison to the polythene shaded nursery house. The generally good performance in the green house is due to not only optimal temperature conditions but also accessibility to sunlight which not only stimulate root and shoot growth but also leaf growth (Sajad *et al.,* 2011).

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