

Research Article

The Growth Performance of Three Selected Indigenous Tree Species at Boye Nursery Site, Southwestern Ethiopia

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Received 13 November 2024; Accepted 2 May 2025

Academic Editor: Anna Żróbek

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The vitality of seedlings is significantly impacted by nursery activities. Among other things, the size of containers and growing media are the most important variables in producing healthy and high-quality seedlings. For that reason, this experiment took place at the Boye Nursery Site in the Jimma Zone of Ethiopia, aimed to evaluate the impact of varying growing media and pot sizes on the growth of seedlings of three significant indigenous tree species: *Prunus africana*, *Croton macrostachyus*, and *Millettia ferruginea*. For this purpose, three distinct soil mixtures comprising local soil, forest soil, and sand, with ratio of 3:3:1, 3:2:1, and 3:1:1, were combined with three different pot sizes (8, 10, and 12 cm). Based on a 3 × 3 factorial design with four replications, a complete randomized block design was employed. Measurements of seedling height and root collar diameter were made. According to the findings, seedlings grown in large pots exhibited significantly greater height (mean heights of 26.17, 25.19, and 22.67 cm for *Millettia ferruginea*, *Croton macrostachyus*, and *Prunus africana*, respectively) and larger root collar diameters (mean diameters of 0.384, 0.39, and 0.32 cm for the same species) compared to those grown in smaller pots. On the other hand, the soil mix had no effect. Therefore, to ensure better success in tree establishment, we advise using large pots for the production of *Millettia ferruginea*, *Croton macrostachyus*, and *Prunus africana* seedlings in these places.

Keywords: *Croton macrostachyus*; *Millettia ferruginea*; pot size; *Prunus africana*; soil mix

1. Introduction

The vitality of seedlings is significantly impacted by nursery methods [1] and ultimately by their survival after being transplanted into the field [2]. Among other things, the size of containers and growing media may be the most important variables in producing healthy and high-quality seedlings [3]. In essence, potting substrate serves as a plant's first food source, supporting seedling growth and providing, storing, and distributing nutrients [4], and large planting pots encourage the formation of a deep root system in the field by giving seedlings with longer tap roots during the nursery stage [5, 6].

In addition to container size, the soil mix's impacts on aeration, nutrition, and the root plug's ability to hold water can have a significant impact on the seedling's vigor [7]. Generally speaking, growth medium and pot size are significant factors in determining the quality of seedlings [8, 9]; however, they differ between the different species of trees [9] because of a variety of characteristics, such as species, growth density, climate, and duration of the growing season. Additionally, a major issue with containers is the propensity of roots to spiral around the interior of them when circular, smooth-walled plastic containers are utilized [9], which, following planting, may significantly lower seedling quality and field performance.

However, due to the aforementioned sources of variation, there are not many studies on how growing media and potting size affect parameters related to seedling growth and development in Ethiopia, including the number of leaves, root collar diameter, plant height, root length, root weight, shoot weight, and root to shoot ratio, as well as biomass accumulation and partitioning, photosynthesis, leaf chlorophyll content, plant water relations, nutrient uptake, respiration, and flowering [4, 10]. To the best of our knowledge, no study has reported on the effects of planting pot size and varied soil mixture ratios on selected indigenous tree species, especially in Southwest Ethiopia. This suggests that Southwest Ethiopia has a significant information gap.

Because healthy seedlings are necessary for the successful afforestation and restoration of degraded lands in Southwest Ethiopia, trees are becoming an increasingly significant part of this process, which calls for more research and site-specific data. Before beginning any field planting program, choosing a balanced soil mix and pot size is important to guarantee proper root and shoot growth for the planting stock. However appropriate potting mixtures and pot sizes for use were lacking. Thus, this study aims to determine how planting pot size and soil mixture ratio affect the growing performance of seedlings of three native tree species: *Prunus africana*, *Croton macrostachyus*, and *Millettia ferruginea*.

2. Materials and Methods

2.1. Description of Study Area. The study was carried out at the Jimma City Boye Nursery Site (Figure 1), which is situated at 7°40'24"N and 36°50'5"E in Southwest Ethiopia [11]. The entire yearly rainfall varies between 1400 and 2400 mm, with the total monthly rainfall ranging from 37.8 mm in January to 229.1 mm in August. It is 30.50°C on average throughout the year. September through November has the lowest recorded temperature (24°C), while February through April has the warmest (37°C) [11]. Jimma City is located between 1720 meters above sea level (m.a.s.l.) at the airstrip (Kitto) and 2010 m.a.s.l. at Jiren, the location of Abba Jifar Palace (Masara) [12]. In the research area, nitisols are the most prevalent form of soil [13].

2.2. Experimental Design and Treatments. A factorial experiment comprising three species, three pot sizes, and three soil mixes was conducted in this study. It used a randomized complete block design (RCBD) with four replications and nine observations per species. To find the ideal nursery soil mix and pot size that contribute to improved parameters for seedling growth and development, three different types of pot sizes and three different ratios of soil mix were employed as treatments. In the natural forest of Southwest Ethiopia, a participatory study was carried out with local communities to identify three native indigenous tree species: *Millettia ferruginea*, *Croton macrostachyus*, and *Prunus africana*.

All tree species' seeds were collected from mature, healthy individuals and sown in the Boye Nursery Seed Bed in April 2020. Water was applied twice a day to every seed bed and shade was constructed by using wood. Using

three different ratios in factorial RCBD, the seedlings were transplanted into pots of varying sizes that were filled with a combination of local soil, forest soil, and fine sand. Pot sizes (8, 10, and 12 cm) and potting mixture ratios (3:3:1, 3:2:1, and 3:1:1) were examined.

2.3. Data Collection and Analysis. From January 19, 2021, to September 7, 2021, data on the parameters of seedling growth were taken every 2 weeks. A two-way analysis of variance (ANOVA) was performed using SPSS software (Version 20) to assess the effects of pot size and mixing ratio on seedling height and root collar diameter. This analysis tested for significant variations in growth parameters (seedling height and root collar diameter) across different pot sizes and growing media types. The Tukey significant difference (Tukey-HSD) comparison test ($p < 0.05$) was used to separate means when there was a significant difference between treatments.

3. Result and Discussion

3.1. Effects of Pot Size on Selected Indigenous Tree Species. The three pot sizes differed significantly in terms of height and root collar diameter (Table 1). The findings showed that the three species *Prunus africana*, *Croton macrostachyus*, and *Millettia ferruginea* raised in large pots (12 cm) had considerably greater height and root collar diameter than other pot sizes and showed significant differences ($p < 0.05$) (Table 1). In comparison to other pot types, large pot-raised seedlings of all examined species generally displayed a faster and steadier height increment (Table 1). All studied species' seedlings grown in large pots also showed faster and more consistent increases in root collar diameter than seedlings grown in other kinds of pots.

Many plant species have demonstrated that larger planting pots positively influence seedling height and root collar diameter growth. For instance, Abera et al. (2017) [10] found that pot size significantly improved growth in *A. tortilis*, *Z. spina-christi*, and *A. nilotica*. Similarly, Segaw (2016) observed comparable effects in *Cajanus cajan* and *Sesbania sesban* in Ethiopia's dryland areas (2011) [14]. These findings align with earlier studies, such as those by Dumroese et al. (2011) further supporting the benefits of larger pot sizes for seedling development [15]. Our findings support that seedlings grown in larger pots would mature more quickly and produce more than seedlings grown in smaller pots. Greater growth space, improved water retention, and the ability to support the early development of a long tap root are the reasons why larger pots provide better seedling performances [10, 15].

A related investigation by Segaw [14] and Gülcü et al. [16] confirmed that seedlings grew faster and produced larger seedlings when planted in larger containers. Our findings indicate that container size is a crucial factor to take into account when producing tree seedlings for tested species in nurseries, as seen by the larger effects of container size on chosen native tree species on both height and root collar diameter (Table 1).



FIGURE 1: Location of study area.

TABLE 1: Effects of pot size on selected indigenous tree species.

	Height (cm)	RCD (cm)
<i>Pot size for Millettia ferruginea (cm)</i>		
8	21.769 ± 1.181 ^a	0.321 ± 0.009 ^a
10	24.045 ± 1.181 ^{ab}	0.350 ± 0.009 ^b
12	26.171 ± 1.181 ^b	0.384 ± 0.009 ^c
<i>Pot size for Croton macrostachyus (cm)</i>		
8	21.052 ± 1.401 ^a	0.327 ± 0.009 ^a
10	22.898 ± 1.401 ^{ab}	0.357 ± 0.009 ^b
12	25.193 ± 1.401 ^b	0.390 ± 0.009 ^c
<i>Pot size for Prunus africana (cm)</i>		
8	18.988 ± 1.211 ^a	0.292 ± 0.012 ^a
10	20.903 ± 1.211 ^{ab}	0.310 ± 0.012 ^{ab}
12	22.670 ± 1.211 ^b	0.332 ± 0.012 ^b

Note: A similar letter in columns shows no significant difference and different letters indicate significant differences between pot sizes at $p < 0.05$.

TABLE 2: Effects of soil mix ratio on selected indigenous tree species.

	Height (cm)	RCD (cm)
<i>Soil mix ratio for Millettia ferruginea</i>		
3:1:1	23.484 ± 1.181 ^a	0.346 ± 0.009 ^a
3:2:1	23.717 ± 1.181 ^a	0.344 ± 0.009 ^a
3:3:1	24.784 ± 1.181 ^a	0.364 ± 0.009 ^a
<i>Soil mix ratio for Croton macrostachyus</i>		
3:1:1	22.583 ± 1.401 ^a	0.352 ± 0.009 ^a
3:2:1	22.496 ± 1.401 ^a	0.348 ± 0.009 ^a
3:3:1	24.063 ± 1.401 ^a	0.374 ± 0.009 ^a
<i>Soil mix ratio for Prunus africana</i>		
3:1:1	20.565 ± 1.211 ^a	0.296 ± 0.012 ^a
3:2:1	20.811 ± 1.211 ^a	0.312 ± 0.012 ^a
3:3:1	21.185 ± 1.211 ^a	0.325 ± 0.012 ^a

Note: A similar letter in columns shows no significant difference and different letters indicate significant differences between soil mix at $p < 0.05$.

3.2. Effects of Soil Mix Ratio on Selected Indigenous Tree Species. The selected species, *Millettia ferruginea*, *Croton macrostachyus*, and *Prunus africana*, showed no significant variation in height or root collar diameter with the potting mixture (Table 2). The only soil mix that significantly differs from the others in terms of root collar diameter for *Croton macrostachyus* is 3:3:1, but not in terms of height. The overall outcome of our study suggests that the growing medium used for nursery seedlings does not significantly impact the quality of seedlings that are produced.

Significant growth variations under different soil mixtures have been documented in some investigations; for example, Mulugeta [4] utilized varying amounts of compost, sandy soil, and forest soil in the Hawassa region

of Ethiopia; however, the results showed a significant variation in the treatments. According to a study on the seedling growth morphology of *Cajanus cajan* and *Sesbania sesban* carried out in drier areas of Southern Ethiopia, the species showed a response to the type of soil used [14]. In the southwest of Turkey, another author likewise noted notable growth differences between various treatment levels of sand, humus, and forest soil [16]. This should not be taken too broadly, either, as our findings do not indicate any appreciable variations in seedling growth across the evaluated soil mixtures. This emphasizes the necessity of measuring the physical and chemical characteristics of the substrates utilized to analyze these findings [10, 17].

This implies that soil mix requirement will vary from species to species and region to region, and pot size matters for the target species in our case. Our findings imply that soil mix is not a significant factor to be taken into account when producing tree seedlings in nurseries for tested species, given the observed lack of impacts of soil mix on chosen indigenous tree species on both height and root collar diameter (Table 2).

3.3. Interaction Effect of Pot Size and Growing Media on Selected Indigenous Tree Species. In three chosen species, the current study shows that there is no significant interaction effect among the dependent variables. This is because according to our findings, there are no significant variations in seedling growth between the investigated soil mixes for the chosen species; instead, the primary factor that varies among them is pot size. Similarly, a study by Abera et al. [10] revealed that, instead of soil mix, pot size has a greater effect on the growth of seedlings of four native tree species in Ethiopia's semiarid climate conditions.

However, another study revealed that in drier areas in the southern parts of Ethiopia, pot sizes and soil mixture had an interaction effect on the growth of *Cajanus cajan* and *Sesbania sesban* seedlings [14]; also, Abebe [18] reported that the *Azadirachta indica* species in the Bale Zone of the Oromia area is affected by those elements in combination. The causes of this could be attributed to climate variables, physical and chemical characteristics of the soil, and species type.

4. Conclusion

Container size significantly influenced seedling growth in *Millettia ferruginea*, *Croton macrostachyus*, and *Prunus africana*, while the growing medium had no notable effect. We recommend using larger pots for optimal seedling production of these species. Further research should explore how environmental factors interact with container size to enhance nursery practices.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

No fund is available for this study.

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