

Influence of Growth Media and Pot Sizes on the Early Agronomic Growth Performance of *Grevillea robusta* A. Cunn. ex R. Br.

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Abstract: *Grevillea robusta* A. Cunn. ex R. Br., belongs to the Proteaceae family. *Grevillea robusta* is native to coastal eastern Australia. In our country, people started to use *Grevillea robusta* for different purposes as a windbreak, alley cropping, bees feed, fuel wood and for construction. The tree produces an attractively figured, easily worked wood, which was once a leading face veneer in world trade. Due to this all purposes, three polyethylene pots of (8, 10 and 12cm) lay flats diameter and 15cm length and Five different growing media (GM) or soil mix proportion based on volume GM₁= (2Top soil: 2 part forest soil: 1 part sand; GM₂=2 part Top soil: 2 compost: 1 part sand; GM₃=1part Top soil: 2 part forest soil: 2 part sand; GM₄=3part Top soil: 2 part compost: 1sand soil and GM₅=3 Top soil: 2 forest soil: 1sand=control) treatments were used, which containing different ratios of top soil (TS), forest soil (FS), compost (Co) and sand soil (SS) were collected from local, natural forest environments and highly decomposed compost (the different materials get from locally easily available). The experimental design was a Randomized Complete Block Design with 3 replications under open field conditions at Sinana forestry nursery. Some morphological properties of the seedlings, such as seedling height and root collar diameter growth parameters were measured ever two weeks for four (4) months old seedlings. Finally, this experimental study shown GM₃ and GM₁ growing media with bothe 10cm and 8cm polythene pot sizes were confirmed appreciate for raising *Grevillea robusta* tree species to achieve or attained the best seedling quality for successful plantation.

Keywords: Growth Media, Pot Size, *Grevillea robusta* (Silk Oak), Seedling Quality

1. Introduction

Grevillea robusta A. Cunn. ex R. Br. (Silk Oak), belongs to the family Proteaceae. *Grevillea robusta* is native to coastal eastern Australia and it is introduced in Ethiopia since few years ago. *Grevillea robusta* is a medium to large tree commonly planted as an ornamental in many warm-temperate and semitropical climates. *Grevillea robusta* is planted either in rows (alley cropping) or in less regular spatial arrangements (intercropping). In Kenya [7], *Grevillea robusta* is intercropped with maize, beans, bananas, coffee, etc. and sometimes *Grevillea robusta* is planted in pure stands (wood-lots) but the most common practice is to plant along the boundaries of a land. In Ethiopia, people started to

use *Grevillea robusta* as a windbreak and shade trees between the plantation of coffee and tea. It is an important honey tree and good fuel wood product [13]. Raising seedlings in pots have the best in initial growth and survival rate in plantations. In addition, they can be used in wider areas or in areas having different characteristics [5]. If no limitations are imposed on seedling management, the growing media and the containers size are possibly the most determinant factors in growing high-quality and healthy seedlings [3]. Basically, potting substrate is a plant's first food and its primarily support is for growing seedling, storing and supplying nutrients, water and air to the root system as long as they are in the nursery [8]. This implies that by careful selection, mixing, and handling of the components of

the potting soil, once can provide the best possible growing conditions to the plants to survive after transplanting into in the field. In the case of eastern African countries, few data are available on the effects of growing medium and potting size on seedling growth and development parameters such as the number of leaves, root collar diameter, plant height, root length, root weight, shoot weight and root to shoot ratio as well as on biomass accumulation and partitioning, photosynthesis, leaf-chlorophyll content, plant water relations, nutrient uptake, respiration and flowering [6, 8].

A appropriate substrate (growing medium) should be light in weight to ease transport to the planting site, retain enough moisture to avoid need for frequent watering, porous enough for excess water to drain easily and allow sufficient aeration of the roots and high survival rate [1, 2, 11, 12]. Therefore, research is needed to find out the optimal substrate (growing media) and appropriated container sizes (pot sizes) for any tree/shrub species. When mixing, it is important that all components are finely ground and sieved through a 2 mm-sieve to remove excessively large particles [14]. Overall, the production of quality seedlings requires nutrient management, which was reported as a potential means to change morpho-functional traits of tree seedlings [15]. Since different areas are characterized by different soil types, soil

conditions and prefer container/pot sizes that affect the growth and the quality of seedlings. However, no comprehensive study has been conducted on the appropriate growing media and container or pot sizes. The objective of this experiment was to determine the best soil mixture proportion and pot sizes for optimum early growth performance of the *Grevillea robusta* (Silk oak) seedlings, to enhance its success in propagation, cultivation and plantation.

2. Materials and Methods

2.1. Description of Study Area

This study was conducted at the Forestry Nursery of the Department of Forestry, at Sinana Agricultural Research Center, which located an altitude about 2400 m.a.s.l in Oromia Regional State (7°N latitude and 40°E longitudes). The area is high altitude; sub humid with bimodal rainfall pattern, experiencing an average annual rainfall of 860 mm and monthly mean maximum and minimum air temperatures were 19.5°C and 9.6°C, and for the long term (mean) was 21.1°C and 9.4°C, respectively. The dominant soil type is pellic Vertisol and slightly acidic.

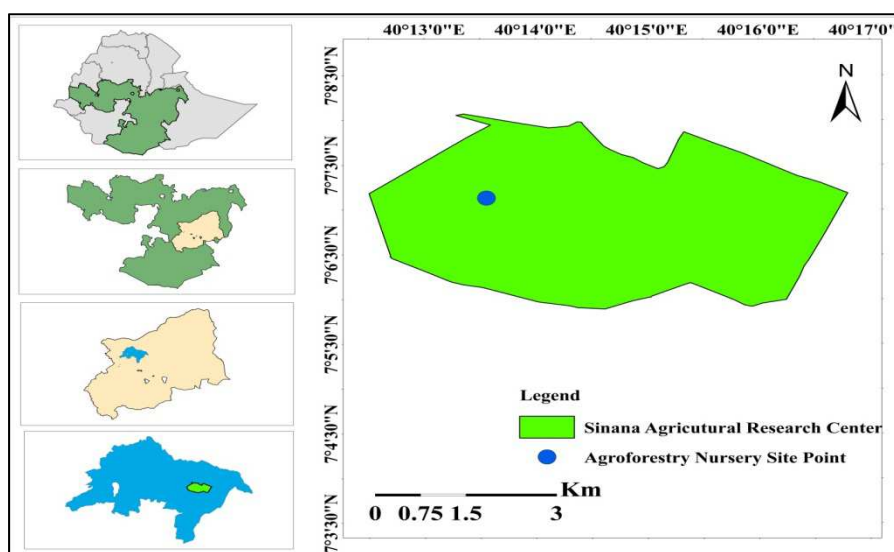


Figure 1. Map of the study Site.

2.2. Seed Procurement, Pots Filling and Seed Sowing

The *Grevillea robusta* seeds were purchased from the National Tree Seed Project; Ethiopia Forestry Research Center which well-known in the country that provided good trees/shrub seeds quality. Perforated bottom polythene pots were filled with various planting media of (forest soil, compost, sand soil and Top soil) in different pots size (PS₁, PS₂ and PS₃) flat diameter with 15cm in length and the growing media (GM) or soil mix proportion based on volume GM₁=2:2:1 (Top soil: forest soil: sand); GM₂= 2:2:1 (top soil: compost: sand); GM₃=1:2:2 (top soil: forest soil: sand); GM₄=3:2:1 (top soil: compost: sandy soil) and GM₅=3:2:1

(top soil: forest soil: sand)=control. Compost was prepared from locally easily available materials five months ahead and, all materials were sieved through a 2 mm-sieve to remove excessively large particles [14]. The seeds of *Grevillea robusta* were planted directly into the polythene pots filled with the different planting/growing media. Finally ever important seedling managements (watering, weeding,...) were provided accordingly.

2.3. Experimental Design

Experiment was laid out in Randomized Complete Block Design (RCBD) at the Forestry nursery in the study area. The study involved the use of five planting media (GM₁; GM₂;

GM₃, GM₄ and GM₅ (control) and three different plastic pots size (PS₁, PS₂ and PS₃) in three replicates were used as treatments. This study was observed for the duration of four (4) months while variables were measured ever two weeks starting from the one month after the required plant seed uniformly germinated and some were transplanted.

2.4. Data Collection and Analysis

Growth variables data were measured; these include seedling heights were measured from the collar region to the tip of the seedlings using graduated ruler. Collar diameters were measured using a veneer or digital caliper. The growth variables were measured in every two (2) weeks interval for a period of four (4) months. The growth variables (seedling heights and collar diameter) data obtained was subjected to two-way analysis of variance (ANOVA) by using Duncan's Multiple Range Test (DMRT) to identify whether there was a significant difference (at the 5% probability threshold) between the means of the treatments as a function of the variables studied. To do this, Genstat 18th EDITION (VERSION) statistical software used to analyze the data.

3. Results

3.1. Growth Parameter (Height and Root Collar Diameter)

3.1.1. Growing Containers

The result and analysis of ANOVA shown that the mean

measured height of *Grevillea robusta* (Silk oak), seedling plants on PS₂ (6.57 cm) was significantly different ($p=0.046$) from that observed on PS₁ (5.77 cm). However, the height measured on PS₁ and PS₂ is not significantly that of PS₃ (5.8 cm). In terms of root collar diameter, PS₂ were 0.225cm girth thicker than those grown in PS₁ (0.216cm) and PS₃ (0.203cm), respectively. The difference observed among other sources root collar diameter (RCD) measured parameter of variation were not statistically significant.

3.1.2. Substrates

Analysis of variance which shown that mean measured height of *Grevillea robusta* seedlings plants on media growth soil mixture (composite) ratio of GM₁ was (7.61cm) highly significantly different with GM₂ (4.44cm) and GM₄ (4.83cm) $p=0.000$, and GM₅ (6.22cm) $p=0.001$, respectively. In case of root collar diameter (RCD) GM₁ highest girth (0.245cm) statistically significant different with GM₂ $p=0.000$ and GM₄ (0.195cm) $p=0.0016$, respectively.

3.2. Interaction Effects

The growing media (GM) and pot size (PS) interaction effects on the optimum seedling early growth performance of *Grevillea robusta* were different in different interactions treatments. According to the ANOVA the mean measured parameters of height and root collar diameter of the *Grevillea robusta* (Silk oak), plant seedlings shown on (Table 1) below.

Table 1. ANOVA Result on the Comparative (two-way interactions) Effects of Different Growing Media (GM) and Pot Size (PS) on *Grevillea robusta* A. Cunn. ex R. Br Seedling's height (Ht) and Root Collar Diameter (RCD) after four (4) months.

Treatment combination	Variables		Treatment combination	Variables	
	Ht (cm)	RCD (cm)		Ht (cm)	RCD (cm)
1. Pot Size (PS)			3. Interaction effects		
PS ₁	5.767 ^a	0.2158 ^a	GM ₁ xPS ₁	7.833 ^{fg}	0.2657 ^f
PS ₂	6.567 ^b	0.2252 ^a	GM ₂ xPS ₁	4.167 ^a	0.1737 ^{ab}
PS ₃	5.807 ^{ab}	0.2035 ^a	GM ₃ xPS ₁	6.50 ^{cdef}	0.2567 ^{ef}
CV	17.4	14.1	GM ₄ xPS ₁	4.333 ^{ab}	0.175 ^{ab}
LSD (5%)	0.785	0.2267	GM ₅ xPS ₁	6.00 ^{bcd}	0.208 ^{bcd}
2. Growth media (GM)			GM ₁ xPS ₂	7.667 ^{efg}	0.2437 ^{def}
GM ₁	7.611 ^c	0.2451 ^b	GM ₂ xPS ₂	4.333 ^{ab}	0.1763 ^{abc}
GM ₂	4.444 ^a	0.1666 ^a	GM ₃ xPS ₂	8.667 ^g	0.2547 ^{ef}
GM ₃	7.122 ^{bc}	0.2423 ^b	GM ₄ xPS ₂	5.167 ^{abc}	0.2117 ^{def}
GM ₄	4.833 ^a	0.1953 ^a	GM ₅ xPS ₂	7.00 ^{defg}	0.240 ^{def}
GM ₅	6.222 ^b	0.2248 ^b	GM ₁ xPS ₃	7.333 ^{defg}	0.226 ^{cdef}
CV	17.4	14.1	GM ₂ xPS ₃	4.833 ^{abc}	0.1497 ^a
LSD (5%)	1.013	0.2927	GM ₃ xPS ₃	6.20 ^{cdef}	0.216 ^{bcd}
			GM ₄ xPS ₃	5.00 ^{abc}	0.1993 ^{abcd}
			GM ₅ xPS ₃	5.667 ^{abcd}	0.2263 ^{cdef}
			CV	17.4	14.1
			LSD (5%)	1.755	0.507

**Means on the same column with different superscripts letter(s) are statistically significant ($p<0.05$) using Duncan's Multiple Range Test (DMRT)

Growing Media (GM) =GM₁=2top soil: 2Forest soil: 1sand soil; GM₂=2Top soil: 2Compost: 1Sand soil; GM₃=1Top soil: 2Forest soil: 2Sand soil; MG₄=3top soil: 2Compost: 1Sand soil; and GM₅=Control=3top soil: 2Forest soil: 1Sand soil.

Pot Size (PS) =PS₁=8cm=control; PS₂=10 cm and PS₃=12 cm lay flats and 15cm length for all pot size.

3.2.1. Height Measured Parameter

The ANOVA shown that the mean height measured of *Grevillea robusta* A. Cunn. ex R. Br plant seedlings on the interactions of growing media soil mixture or composite

ratios and different pot sizes GM₃xPS₂ (8.67cm) was significantly different ($p=0.000$) from that observed on GM₂xPS₁ (4.17cm); GM₂xPS₂; and GM₄xPS₁ (4.33cm) were, respectively. In another way seedlings height of

Grevillea robusta shown GM₃xPS₂ as had 8.67 cm highest mean height recorded followed by GM₁xPS₁ (7.83cm), GM₁xPS₂ had a mean height of 7.67cm while both GM₂xPS₂ and GM₄PS₁ had relatively lowest mean seedlings height (4.33 cm).

3.2.2. Root Collar Diameter

In case of root collar diameter growth parameter ANOVA shown that the mean measured root collar diameters of *Grevillea robusta* plant seedlings on GM₁xPS₁ (0.266cm) root collar thickness was statistically significantly different ($p=0.0001$, 0.0010 , and 0.0009) from that seedlings root collar diameter measured on GM₂xPS₃ (0.149cm); GM₄xPS₁ (0.175cm); and GM₂xPS₁ (0.173cm), respectively. The mean measured root collar diameters growth of plant seedlings ranged from 0.266cm (GM₁xPS₁) to 0.149cm (GM₂xPS₃) and GM₂xPS₃ had relatively the lowest collar diameter of all (Table 1).

4. Discussion

The results of the experimental study on the height growth performances of *Grevillea robusta* (Silk oak), shown that the highest height was recorded on both composite growing media ratio 1:2:2 (TS: FS: SS) and 2:2:1 (TS: FS: SS) with in the same 10cm plastic pot and the mean root collar diameter (girth) thicker was recorded in both 2:2:1 (TS: FS: SS) and 1:2:2 (TS: FS: SS) composite soil ratios with in 8cm plastic pot. Relatively slow growth recorded on 2:2:1 (TS: Co: SS) mixed soil ratios with in 12cm plastic pot size. The finding collaborates with the work of Ngwuta AA *et al.* (2016) who reported highest plant height of *Jatropha curcas* and Mathowa T, *et al.* (2014b) of *Adansonia digitata* in the mixture [9, 8]. The result disagrees with Okunomo *et al.* (2009) who recorded better increment in topsoil of *Persea Americana* [10]. This also contradicts the work of Dickens D. (2011) who recorded better performance of *Irvingia wombolu* in river sand [4]. These findings agree with the work of Omokhua GE. *et al.* (2015) who recorded least diameter of *Terminalia ivorensis* in fines and [10]. The finding disagrees with the report of Mathowa T, *et al.* (2014a) who observed highest stem diameter of *Corchorus olitorius* in clay soil [7]. The study has demonstrated that *Grevillea robusta* (Silk oak), seedling early growth responded differently to the various composite soil mixture growing media and different polythene pot sizes. However, 1:2:2 (TS: FS: SS) with in 10cm pot size, 2:2:1 (TS: FS: SS) with in 8, 10 and 12cm pot sizes respectively were give the best result with respect to all measured growth parameters of the *Grevillea robusta* (Silk oak).

5. Conclusion

The output of this experimental study shown that relatively higher growth were recorded in GM₁ and GM₃ composite growing media; this could be good soil characteristics with in 10cm pot size (PS₂) which favoring

the rapid early growth of *Grevillea robusta* tree species. Based on this finding the following combinations treatments are proposed to get optimum and quality seedling growth in nursery for *Grevillea robusta* specie were first 1:2:2 (Top soil: Forest soil: Sand soil) followed by 2:2:1 (top soil: Forest soil: sand) and 3:2:1 (top soil: Forest soil: Sand soil) or control composite growing ratio as 3rd option for plant growing media in 10cm lay flats polythene pot. So, to obtain the best or optimum seedling quality the interaction effects of growing media and appropriated containers were important and basic than doing experiment separately but knowing and identifying the best growing media was the major determinant to get the good quality seedlings for successful plantation. Finally this study revealed and shown growth media affect plant growth parameter characteristics (height, root collar diameter) were significantly than growing containers. This is due to nutrient variation in the growth media which is needs investigation on nutrients analysis in the future.

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