International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 8 Issue 4, Jul-Aug 2024 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

# Effect of Soil Mixing Ratios and Pot Size on Early Seedling Growth Performance of Selected Tree Species Under Nursery Condition at Harar, Ethiopia

**Musa Abdella Hamido, Bira Cheneke Feyissa, Megersa Ketema Shumi**

Fedis Agricultural Research Center of Oromia Agricultural Research Institute, Harar, Ethiopia

## ABSTRACT

The growing media and pot size affects seedling growth and development. The aim of the study were to evaluate the effect of different pot size and soil mixing ratio on the seedling growth at FARC nursery. The experiment was laid out in a factorial (4 species×3 pot size×6 soil mixtures) RCBD with three replications. The results revealed that seedling growth performance were significantly (P≤0.05) affected by pot size and soil mixture. The smaller pot size (8cm) had a significant effect on A. indica. However, medium pot (10cm) had significant effect on G.robusta. Large pot (12cm) significant effect on C.africana and M.stenopetala. The soil mixture had significant effect on A.indica, C.africana, M. stenopetala and G.robusta seedling growth. In the case of A.indica, and G.robusta grown in the smaller pot and medium pot were comparable with respect to many parameters. However, since the study area has shortage of rainfall using 10 cm pot would be advantageous. In the case of C.africana and Moringa the larger pot would be advantageous. Thus, using soil ratio of 6:3:2 followed by 5:2:1 for pot of 8 cm and a ratio of 3:2:1 and 4:2:1 for pot 10cm are found to be appropriate to grow seedling of A.indica, and G.robusta. However, in larger pot for C.africana and Moringa, the growing medium of 3:2:1 gave the highest growth parameters. Therefore, further research should be directed towards study the effect of different substrates of high nutrients on pot along with a study on seedling survival after transplanting in the field.

***KEYWORDS:*** *Early growth performance, Germination, Growing media, Pot size, Root to shoot ratio*

***How to cite this paper:*** Musa Abdella Hamido | Bira Cheneke Feyissa | Megersa Ketema Shumi "Effect of Soil Mixing Ratios and Pot Size on Early Seedling Growth Performance of Selected Tree Species Under Nursery Condition at Harar, Ethiopia" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-8 | Issue-4, August 2024, pp.834-841, URL: www.ijtsrd.com/papers/ijtsrd67254.pdf

IJTSRD67254



## INTRODUCTION

Production of high-quality forest tree seedlings in nurseries is very important as far as tree nurseries are concerned for reversing the current degradation of natural forests. Nursery practices affect the vigor of seedlings and accordingly on the success of their transplantation in the field (Del Campo et al. 2010). The soil mixture can greatly influence both the vigour and the water status of the seedling through its effects on aeration, nutrition, and water-holding capacity of the root plug (Marfà et al. 2002). Soil mixture is the most important factor in the nursery environment. This is because, it is a plant's food; it physically supports a growing seedling and it is stores and supplies nutrients, water, and air to the root system (Poorter et al. 2012). The purpose of a potting media is to satisfy the needs for good seedling growth within the limited space of a polythene tube/container and to prepare it for successful transplanting into the field. The potting substrate is a plant's first food and its primary support is for growing seedlings, storing and supplying nutrients, water, and air to the root system as long as they are in the nursery (Mulugeta, 2014).

In that sense, the quality of the potting medium is universally recognized as being one of the foundation stones upon which the successful growing of pot plants is built (Bunt, 1988). This implies that by careful selection, mixing, and handling of the components of the potting soil, once can provide the best possible growing conditions for the plants to survive after transplanting into 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, and shoot (Mulugeta, 2014). The ratio of soil to sand and compost varies from place to place and from species to species. Some Ethiopian government nurseries adopted ratios such as 3:1:1 during 1998. A mix containing soil, sand, and compost in the ratio of 2:1:1 is recommended as adequate for the healthy growth of the majority of species in Eritrea. One of the well-recognized problems with regard to growing plants in dry land areas is not only the harsh climatic conditions under which the plants are grown but also the limited information on how growing media and container size affects seedling growth and development of selected tree species along with the lack of locally standardized growing media for the production of high-quality seedlings. The larger-scale tree planting, which is becoming increasingly important in East Hararghe for both commercial as well as environmental reasons, requires healthy seedlings for success. A balanced soil substrate should be found prior to any field-planting program to ensure good root and shoot development for the planting stock, but appropriate soil mixtures for use were lacking. The available information about this study is scanty along with the lack of locally standardized growing media for the production of quality tree seedlings in the study area. Therefore, the present study was initiated to find out the effect of appropriate soil mixing ratio and pot size on seedling growth of selected tree species and the production of quality seedlings suitable for out planting in the study area.

**Objective**

- To evaluate the effect of different pot size and soil mixing ratio on the seedling growth performance and survival

## MATERIALS AND METHODS

**Description of study area:** The study was conducted *at* FARC nursery for two years *from 2021* to 2022. FARC nursery is *located* in the eastern part of the country *at about 554 km East of Addis Ababa and in* Harar town. The geographical location of the study area is 9° 19′ 22″- 9° 24′42″ N and 42° 06′ 30″-42° 16′ 24″ E as indicated in Figure 3. *The annual rainfall ranging from 650 to 850 mm, the average annual rainfall being 750 mm. The mean annual maximum temperature is* 31°C *and monthly values range between* 10.0°C *and* 31.0°C.

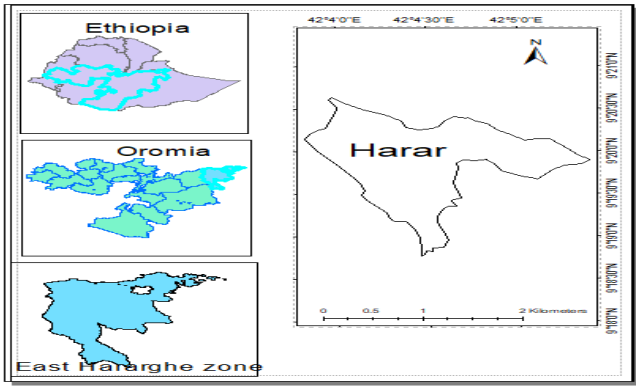


**Figure 1. Study area map (Harar)**

**Potting mixture preparation and Seedling production**: FARC nursery station. Local soil obtained top surface from the study area. The soil mixing ratio of local soil, compost, and sand soil was prepared by the different proportions/ratios and used as treatments**.** The tree seeds of A.indica, *M.olifera*, *G.robusta,* and *C.africana* species were collected from the mother tree around the study area. The seedlings of the experimental tree species were raised in polythene tubes at the nursery.

**Treatments and Experimental Design:** The experiment has three factors; A full factorial (4 species × 3 pot size × 6 soil mixtures) randomized complete block design (RCBD) with three replications. Soil mixing ratio=6 levels. Soil mixing ratio: SR1. 6 Local soil: 3 Compose/forest soil: 2 Sandy soil (6:3:2), SR2. 3 Local soil: 2 Compose/forest soil: 1 Sandy soil (3:2:1), SR3. 5 Local soil: 2 Compose/forest soil: 1 Sandy soil (5:2:1), SR4. 4 Local soil: 2 Compose/forest soil: 1 Sandy soil (4:2:1), SR5. 6 Local soil: 2 Compose/forest soil: 2 Sandy soil (6:2:2) and SR6. 5 Local soil: 2 Compose/forest soil: 2 Sandy soil (5:2:2). Plot size=3 levels (8cm, 10cm, 12cm). Tree species=4 levels (*A.indica*, *M.olifera*, *G.robusta,* and *C. africana)*. Experimental Design: 6*3*4 factorial arrangement of treatments in a randomized complete block design replicated three times, 6*3*4*3 =216 total treatment combinations were used in this study. Plot size =4m*4m (total size 16 $m^2$).

**Data collected:** Data on seedling growth and development parameters were collected at nursery site (seedlings and Sapling). Number of leaves per seedling, root collar diameter, plant height, shoot length, root length, percent survival (germination), and root to shoot ratio were assessed.

**Methods of Data analysis**

The collected data were statistically analyzed by using analysis of variance (Two- way ANOVA) to check any differences between the means. Data were then subjected to SAS univariate analysis of variance

for each parameter and Duncan multiple range tests were used to test significant differences. All data are represented as mean ± standard error. Values are reported as significantly different ($p \leq 0.05$).

## RESULTS AND DISCUSSIONS

**Composite soil sample analysis:** Results indicated that soil sample before planting belongs to the textural class sandy loam and has a slightly alkaline pH (7.73). Cation exchange capacity (14.04) and organic carbon (1.35) were medium rating (Tekalign, 1991). TN% (0.12) was low and the available P(11.75) was rated medium (London, 1991).Thus, the soil was appropriate for tree seedling growth and development (Brady and Weil, 2010).

### Effect of different potting sizes on the seedling growth

Effects of pot size on *A. indica*, *C. africana*, *M. stenopetala* and *G. robusta* seedlings**.** The result revealed that smaller pot size (8 cm) had significantly higher no. of leaves (p=0.039), seedling height (p=0.01), and germination percent (p=0.01), while large pot size (12 cm) had significantly higher root length and root to shoot ratio (p=0.04) for ***A. indica***. For *C. africana* large pot size had significantly higher seedling height (p=0.01) and germination percent (p=0.01), for *Moringa large* pot size had significantly higher only germination percent (p=0.01). However, 10 cm pot size had significantly higher no. of leaves, root collar diameter (RCD)**,** seedling height, shoot length, root length, germination and root to shoot ratio as compared to smaller (8 cm) pot size for *G. robusta* (p=0.03, 0.02, 0.01, 0.04, 0.04, and 0.03, respectively) (Table 1).

**Table 1: Mean (SE±) growth values of tree seedlings influenced by different pot size by tree species at the nursery**

| Pot size and Trees | leaves No. | RCD (mm) | Height (cm) | Shoot Length(cm) | Root Length (cm) | Root/shoot ratio | Germination (%) |
|---|---|---|---|---|---|---|---|
| **Pot size for *A. indica*** | | | | | | | |
| 8 cm | 2.59±1.07$^{a}$ | 0.81±0.66$^{b}$ | 23.26±3.46$^{a}$ | 0.34±0.23 | 0.28±0.26$^{b}$ | 0.18±0.1$^{b}$ | 64.82±9.30$^{a}$ |
| 10 cm | 1.04±1.07$^{b}$ | 1.59±0.66$^{a}$ | 17.88±3.46$^{b}$ | 0.84±0.23 | 0.49±0.26$^{a}$ | 0.22±0.1$^{a}$ | 51.85±9.30$^{b}$ |
| 12 cm | 1.71±1.07$^{b}$ | 0.96±0.66$^{b}$ | 13.82±3.46$^{c}$ | 0.45±0.23 | 0.23±0.26$^{b}$ | 0.08±0.1$^{c}$ | 38.89±9.30$^{c}$ |
| **Pot size for *C. africana*** | | | | | | | |
| 8 cm | 3.01±1.07 | 3.16±0.86 | 16.03±3.46$^{b}$ | 0.99±0.23 | 0.73±0.26 | 0.43±0.1 | 90.29±9.30$^{ab}$ |
| 10 cm | 4.11±1.07 | 3.68±0.86 | 21.71±3.46$^{a}$ | 1.17±0.23 | 0.84±0.26 | 0.44±0.1 | 96.74±9.30$^{a}$ |
| 12 cm | 4.59±1.08 | 3.72±0.86 | 15.75±3.46$^{b}$ | 1.01±0.23 | 0.64±0.26 | 0.32±0.1 | 81.48±9.30$^{b}$ |
| **Pot size for *Moringa*** | | | | | | | |
| 8 cm | 0.93±1.07 | 7.41±0.86 | 41.56±3.46 | 1.54±0.23 | 1.06±0.26 | 0.69±0.1 | 84.60±9.30$^{b}$ |
| 10 cm | 1.04±1.07 | 6.37±0.86 | 47.89±3.46 | 1.78±0.23 | 1.70±0.26 | 0.44±0.1 | 94.47±9.30$^{a}$ |
| 12 cm | 0.91±1.07 | 6.75±0.86 | 47.89±3.46 | 1.34±0.23 | 1.08±0.26 | 0.69±0.1 | 94.07±9.30$^{a}$ |
| **Pot size for G. *robusta*** | | | | | | | |
| 8 cm | 9.27±1.07$^{b}$ | 2.62±0.86$^{b}$ | 18.29±3.46$^{b}$ | 0.82±0.23$^{b}$ | 0.74±0.26$^{b}$ | 0.49±0.1$^{b}$ | 74.07±9.30$^{b}$ |
| 10 cm | 11.56±1.07$^{a}$ | 5.04±0.86$^{a}$ | 28.84±3.46$^{a}$ | 1.98±0.23$^{a}$ | 1.35±0.26$^{a}$ | 0.57±0.1$^{a}$ | 83.33±9.30$^{a}$ |
| 12 cm | 9.96±1.07$^{b}$ | 5.25±0.86$^{a}$ | 24.67±3.46$^{a}$ | 1.17±0.23$^{a}$ | 0.86±0.26$^{b}$ | 0.45±0.1$^{b}$ | 83.33±9.30$^{a}$ |

Note CRD= root collar diameter

Overall growth parameters were significantly higher in larger pots (10 cm) than in smaller pots (8 cm). Our results confirm that seedlings raised in large pots would be better developed and produced in a shorter time than seedlings raised in pots of smaller size. A similar study by Marriott et al., (2015) and Vaknin et al., (2009) showed that seedlings grown in larger containers generally grew more and produced the largest seedling. The higher root -to-shoot ratio tend to survive better, as relatively large root system supply the water requirements (West, 2006). The effect of pot sizes on seedling growth depends on the species type to be grown (Yadessa *et al.,* 2001).

### Eeffect of different soil mixing ratio on the seedling growth

Effects of growing media on *A. indica*, *C. africana*, *M. stenopetala,* and *G. robusta* seedlings. The potting mixture had a significant effect on *A. indica* seedling growth except for shoot length (p=0.46), root length (p=0.39) and root-to-shoot ratio (p=0.44), the potting mixture had a significant effect on *C. africana* seedling except for root length (p=0.53), root to shoot ratio (p=0.43) and germination (p=0.43), had a significant effect on *M. stenopetala* seedling except number of leaves (p=0.22), root collar diameter(p=0.22) and root to shoot ratio (p=0.43) and on *G. robusta* seedling except for height (p=0.49), root to shoot ratio (p=0.44) and germination (p=0.43). The mixing ratio of 6:3:2 and 3:2:1 had significantly higher growth parameters followed by the mixing

ratio of 5:2:2. However, the mixing ratio of 5:2:1 was the least with regard to growth measurements of *A. indica* while the mixing ratio of 3:2:1 had significantly higher growth parameters followed by mixing ratio of 6:3:2 on *C. africana* seedling. The mixing ratio of 6:3:2 and 3:2:1 had significantly higher growth parameters followed by the mixing ratio of 5:2:1 and 4:2:1. The mixing ratio of 4:2:1 was the least concerning growth measurements of *M. stenopetala* while the mixing ratio of 6:3:2 and 3:2:1 had significantly higher growth parameters on *G. robusta* seedlings (Table 2). This result indicated that nursery seedling growing medium has a profound effect on the quality of seedlings to be produced. Many previous works found the effect of growing media on the quality of seedling growth (Ibironke, 2016; Ugese, 2010). The better seedling performance in the potting media of 6:3:2 and 3:2:1 could be due to the balanced additional nutrient supplement from the forest soil.

**Table 2: Mean (SD±) growth values of tree seedlings influenced by different soil mixtures at the nursery (interaction effects between species and soil mixtures)**

| Soil ratio and Trees | leaves No. | RCD (mm) | Height (cm) | Shoot Length (cm) | Root Length (cm) | Root/shoot ratio | Germination (%) |
|---|---|---|---|---|---|---|---|
| **Soil ratio for *A. indica*** | | | | | | | |
| 6:3:2 | 4.15±1.51$^{a}$ | 2.59±1.21$^{a}$ | 26.77±4.89$^{a}$ | 1.13±0.33 | 0.60±0.37 | 0.27±0.12 | 59.86±11.3$^{a}$ |
| 3:2:1 | 2.29±1.51$^{ab}$ | 0.86±1.21$^{b}$ | 17.95±4.89$^{ab}$ | 0.62±0.33 | 0.32±0.37 | 0.12±0.12 | 51.85±11.3$^{ab}$ |
| 5:2:1 | 2.29±1.51$^{ab}$ | 0.40±1.21$^{b}$ | 12.49±4.89$^{b}$ | 0.33±0.33 | 0.16±0.37 | 0.15±0.12 | 40.74±11.3$^{ab}$ |
| 4:2:1 | 0.96±1.51$^{b}$ | 1.04±1.21$^{ab}$ | 21.15±4.89$^{a}$ | 0.33±0.33 | 0.31±0.37 | 0.21±0.12 | 55.56±11.3$^{ab}$ |
| 6:2:2 | 2.15±1.51$^{ab}$ | 1.30±1.21$^{ab}$ | 11.39±4.89$^{b}$ | 0.40±0.33 | 0.31±0.37 | 0.17±0.12 | 37.06±11.3$^{b}$ |
| 5:2:2 | 1.78±1.51$^{ab}$ | 1.53±1.21$^{ab}$ | 22.97±4.89$^{a}$ | 0.44±0.33 | 0.30±0.37 | 0.15±0.12 | 66.67±11.3$^{a}$ |
| **Soil ratio for *C. Africana*** | | | | | | | |
| 6:3:2 | 4.04±1.51$^{ab}$ | 4.75±1.21$^{a}$ | 20.99±4.89 | 1.25±0.33$^{a}$ | 0.96±0.37 | 0.51±0.12 | 100.0±11.3 |
| 3:2:1 | 6.11±1.51$^{a}$ | 4.77±1.21$^{a}$ | 14.24±4.89 | 1.62±0.33$^{a}$ | 0.86±0.37 | 0.39±0.12 | 85.19±11.3 |
| 5:2:1 | 4.26±1.51$^{ab}$ | 2.61±1.21$^{ab}$ | 18.30±4.89 | 1.50±0.33$^{a}$ | 0.93±0.37 | 0.51±0.12 | 92.59±11.3 |
| 4:2:1 | 3.15±1.51$^{ab}$ | 1.75±1.21$^{b}$ | 20.15±4.89 | 0.55±0.33$^{b}$ | 0.44±0.37 | 0.27±0.12 | 92.59±11.3 |
| 6:2:2 | 2.74±1.51$^{b}$ | 0.91±1.21$^{b}$ | 16.11±4.89 | 0.54±0.33$^{b}$ | 0.46±0.37 | 0.28±0.12 | 85.19±11.3 |
| 5:2:2 | 3.11±1.51$^{ab}$ | 2.33±1.21$^{ab}$ | 17.19±4.89 | 0.88±0.33$^{b}$ | 0.76±0.37 | 0.41±0.12 | 85.48±11.3 |
| **Soil ratio** for *M. stenopetala* | | | | | | | |
| 6:3:2 | 1.01±1.51 | 6.81±1.21 | 49.24±4.89$^{ab}$ | 1.52±0.33$^{ab}$ | 2.12±0.37$^{a}$ | 0.56±0.12 | 100.0±11.3$^{a}$ |
| 3:2:1 | 0.83±1.51 | 5.34±1.21 | 41.71±4.89$^{ab}$ | 1.33±0.33$^{ab}$ | 1.08±0.37$^{ab}$ | 0.58±0.12 | 83.33±11.3$^{ab}$ |
| 5:2:1 | 1.01±1.51 | 5.72±1.21 | 47.01±4.89$^{ab}$ | 2.27±0.33$^{a}$ | 1.27±0.37$^{ab}$ | 0.65±0.12 | 100.0±11.3$^{a}$ |
| 4:2:1 | 1.22±1.51 | 6.75±1.21 | 55.49±4.89$^{a}$ | 1.71±0.33$^{ab}$ | 1.25±0.37$^{ab}$ | 0.71±0.12 | 100.0±11.3$^{a}$ |
| 6:2:2 | 0.74±1.51 | 8.09±1.21 | 37.31±4.89$^{b}$ | 1.75±0.33$^{ab}$ | 1.26±0.37$^{ab}$ | 0.70±0.12 | 62.96±11.3$^{b}$ |
| 5:2:2 | 0.96±1.51 | 5.96±1.21 | 43.98±4.89$^{ab}$ | 0.77±0.33$^{b}$ | 0.67±0.37$^{b}$ | 0.42±0.12 | 100.0±11.3$^{a}$ |
| **Soil ratio for *G. robusta*** | | | | | | | |
| 6:3:2 | 14.01±1.51$^{a}$ | 5.22±1.21$^{a}$ | 22.42±4.89 | 1.97±0.33$^{a}$ | 1.31±0.37$^{a}$ | 0.63±0.12 | 74.07±11.3 |
| 3:2:1 | 11.41±1.51$^{ab}$ | 4.94±1.21$^{ab}$ | 23.01±4.89 | 1.54±0.33$^{ab}$ | 1.11±0.37$^{a}$ | 0.57±0.12 | 74.07±11.3 |
| 5:2:1 | 9.85±1.51$^{ab}$ | 2.11±1.21$^{ab}$ | 27.66±4.89 | 1.36±0.33$^{ab}$ | 1.01±0.37$^{ab}$ | 0.51±0.12 | 96.30±11.3 |
| 4:2:1 | 8.93±1.51$^{ab}$ | 1.52±1.21$^{b}$ | 22.26±4.89 | 1.08±0.33$^{ab}$ | 0.83±0.37$^{ab}$ | 0.44±0.12 | 70.37±11.3 |
| 6:2:2 | 10.22±1.51$^{ab}$ | 2.01±1.21$^{ab}$ | 24.92±4.89 | 1.21±0.33$^{ab}$ | 0.98±0.37$^{ab}$ | 0.54±0.12 | 81.48±11.3 |
| 5:2:2 | 7.17±1.51$^{b}$ | 2.03±1.21$^{ab}$ | 23.32±4.89 | 0.78±0.33$^{b}$ | 0.64±0.37$^{b}$ | 0.36±0.12 | 85.19±11.3 |

Note: CRD= root collar diameter,

**Interaction effect of different soil mixing ratio and pot size on the seedling growth**

Interaction effect of pot size and growing media on *A. indica*, *C. africana*, *M. stenopetala* and *G. robusta* seedlings significant**.** The current study showed a significant interaction effect among the all growth parameters except root length and root to shoot ratio in *A. indica* species. In smaller pot size of *A. indica*, *C. africana*, *M. stenopetala* and *G. robusta* higher seedling growth were recorded at the mixing ratio of 6:3:2 and at a ratio of 3:2:1 and 5:2:1 respectively. However, in larger pot sizes a mixing ratio of 5:2:1 and 4:2:1 gave the highest growth parameters (Table 3). Similarly Yadessa and Bekere (2001) found higher shoot and root dry weight in larger pots of 10cm than in smaller pots of 8cm for *Leucaena pallida*. Besides pot size, Mulugeta (2014) found higher growth performance of the seedlings when a higher amount/part of compost was used in the nursery soil substrate. There was a differential response of the tree species to the difference in nursery soil mixture; that is, a

potting mixture with more farmyard manure was better for Eucalyptus camaldulensis (3 part local soil: 1 part sand: 2 part farmyard manure) than for Acacia. mearnsii, but with more sand for Acacia (Mulugeta, 2014).

The application of organic manure in a substrate might provide nutrients and also improve the physicochemical properties of the substrate. Mustafa *et al*. 2016 also recorded the highest germination in treatments containing composts. Similarly, Gebre (2009) observed the best shoot size in lowland nurseries with the highest content (30%) of manure. The highest growth parameters in a 10 cm pot size could be due to the presence of high forest soil in the growing medium. Many previous works found the effect of soil media on the quality of seedling growth (Ugese, 2010). The better seedling performance in the potting media of 6:3:2 and 3:2:1 could be due to the balanced additional nutrient supplement from the compost/forest soil.

**Table 3: Mean (SD±) growth values of tree seedlings influenced by different soil mixtures and by pot size at the nursery**

| Pot size, soil ratio, and tree species | No. of leaves | RCD (mm) | Height (cm) | Shoot Length(cm) | Root Length(cm) | Root/shoot ratio | Germination (%) |
|---|---|---|---|---|---|---|---|
| **Pot size and soil ratio for *A. indica*** | | | | | | | |
| **8 cm** | | | | | | | |
| 6:3:2 | 3.56±2.62 | 1.98±2.98$^{ab}$ | 37.10±10.9$^{a}$ | 0.40±0.82 | 0.37±0.91 | 0.31±0.29 | 88.89±24.03$^{a}$ |
| 3:2:1 | 3.56±2.62 | 2.26±2.98a | 23.56±10.9$^{ab}$ | 0.07±0.82 | 0.05±0.91 | 0.01±0.29 | 55.56±24.03$^{ab}$ |
| 5:2:1 | 2.67±2.62 | 0.54±2.98$^{b}$ | 18.89±10.9$^{ab}$ | 0.02±0.82 | 0.02±0.91 | 0.03±0.29 | 66.67±24.03$^{ab}$ |
| 4:2:1 | 2.56±2.62 | 0.44±2.98$^{b}$ | 21.01±10.9$^{ab}$ | 0.51±0.82 | 0.47±0.91 | 0.30±0.29 | 55.56±24.03$^{ab}$ |
| 6:2:2 | 2.33±2.62 | 0.14±2.98$^{b}$ | 9.670±10.9$^{b}$ | 0.51±0.82 | 0.47±0.91 | 0.31±0.29 | 33.33±24.03$^{b}$ |
| 5:2:2 | 2.89±2.62 | 2.23±2.98$^{a}$ | 29.36±10.9$^{ab}$ | 0.67±0.82 | 0.37±0.91 | 0.18±0.29 | 88.89±24.03$^{a}$ |
| **10 cm** | | | | | | | |
| 6:3:2 | 4.01±2.62 $^{a}$ | 1.12±2.98$^{ab}$ | 27.10±10.9$^{ab}$ | 2.01±0.82$^{a}$ | 0.97±0.91 | 0.37±0.29 | 66.67±24.03$^{a}$ |
| 3:2:1 | 3.01±2.62$^{ab}$ | 2.42±2.98$^{a}$ | 21.84±10.9$^{ab}$ | 0.87±0.82$^{ab}$ | 0.51±0.91 | 0.19±0.29 | 66.67±24.03$^{a}$ |
| 5:2:1 | 4.01±2.62 $^{a}$ | 0.51±2.98$^{b}$ | 9.93±10.9$^{ab}$ | 1.01±0.82$^{ab}$ | 0.51±0.91 | 0.17±0.29 | 33.33±24.03$^{b}$ |
| 4:2:1 | 2.22±2.62$^{ab}$ | 2.13±2.98$^{a}$ | 28.67±10.9$^{a}$ | 0.48±0.82$^{ab}$ | 0.47±0.91 | 0.33±0.29 | 66.67±24.03$^{a}$ |
| 6:2:2 | 1.22±2.62$^{b}$ | 0.06±2.98$^{b}$ | 4.67±10.9$^{b}$ | 0.02±0.82$^{b}$ | 0.04±0.91 | 0.01±0.29 | 22.22±24.03$^{b}$ |
| 5:2:2 | 1.89±2.62$^{b}$ | 2.37±2.98$^{a}$ | 23.44±10.9$^{ab}$ | 0.67±0.82$^{ab}$ | 0.53±0.91 | 0.27±0.29 | 55.56±24.03$^{ab}$ |
| **12 cm** | | | | | | | |
| 6:3:2 | 1.13±2.62$^{a}$ | 1.67±2.98$^{ab}$ | 16.11±10.9 | 1.01±0.82$^{a}$ | 0.47±0.91 | 0.16±0.29 | 22.22±24.03 |
| 3:2:1 | 0.74±2.62$^{b}$ | 0.16±2.98$^{b}$ | 8.44±10.9 | 1.01±0.82$^{a}$ | 0.47±0.91 | 0.16±0.29 | 33.33±24.03 |
| 5:2:1 | 1.01±2.62$^{a}$ | 0.16±2.98$^{b}$ | 8.67±10.9 | 0.01±0.82$^{b}$ | 0.01±0.91 | 0.06±0.29 | 22.22±24.03 |
| 4:2:1 | 1.01±2.62$^{a}$ | 0.06±2.98$^{b}$ | 13.78±10.9 | 0.01±0.82$^{b}$ | 0.03±0.91 | 0.02±0.29 | 44.45±24.03 |
| 6:2:2 | 0.67±2.62$^{b}$ | 2.77±2.98$^{a}$ | 19.83±10.9 | 0.71±0.82$^{b}$ | 0.47±0.91 | 0.22±0.29 | 55.56±24.03 |
| 5:2:2 | 0.87±2.62$^{b}$ | 0.02±2.98$^{b}$ | 16.12±10.9 | 0.01±0.82$^{b}$ | 0.22±0.91 | 0.01±0.29 | 55.56±24.03 |
| **Pot size and soil ratio for *C. Africana*** | | | | | | | |
| **8 cm** | | | | | | | |
| 6:3:2 | 3.56±1.07$^{b}$ | 4.87±2.98$^{ab}$ | 22.67±11.9$^{a}$ | 1.17±0.82$^{ab}$ | 0.97±0.91$^{ab}$ | 0.56±0.3$^{ab}$ | 100.0±24.7$^{a}$ |
| 3:2:1 | 6.56±1.07$^{a}$ | 7.42±2.98$^{a}$ | 19.62±11.9$^{ab}$ | 1.33±0.82$^{ab}$ | 0.80±0.91$^{ab}$ | 0.40±0.3$^{b}$ | 88.89±24.7$^{b}$ |
| 5:2:1 | 5.67±1.07$^{ab}$ | 3.39±2.98$^{b}$ | 17.67±11.9$^{ab}$ | 1.90±0.82$^{a}$ | 1.03 ±0.91$^{a}$ | 0.76±0.3$^{a}$ | 100.0±24.7$^{a}$ |
| 4:2:1 | 1.01±1.07$^{c}$ | 2.12±2.98$^{c}$ | 13.56±11.9$^{b}$ | 0.02±0.82$^{ab}$ | 0.01 ±0.91$^{c}$ | 0.03±0.3$^{c}$ | 100.0±24.7$^{a}$ |
| 6:2:2 | 2.89±1.07$^{b}$ | 2.11±2.98$^{c}$ | 15.88±11.9$^{ab}$ | 0.57±0.82$^{ab}$ | 0.47 ±0.91$^{b}$ | 0.27±0.3$^{b}$ | 88.89±24.7$^{b}$ |
| 5:2:2 | 4.33±1.07$^{ab}$ | 3.12±2.98$^{b}$ | 16.77±11.9$^{ab}$ | 1.07±0.82ab | 0.87±0.91$^{ab}$ | 0.57±0.3$^{ab}$ | 100.0 ±24.7$^{a}$ |
| **10 cm** | | | | | | | |
| 6:3:2 | 3.22±1.07$^{b}$ | 1.05±2.98$^{b}$ | 20.24±11.9ab | 1.33±0.82ab | 0.97±0.91 | 0.48±0.3ab | 100.0±24.7a |
| 3:2:1 | 6.22±1.07$^{a}$ | 1.40±2.98$^{b}$ | 18.42±11.9b | 1.97±0.82a | 0.93±0.91 | 0.36±0.3b | 88.89±24.7ab |
| 5:2:1 | 3.23±1.07b | 1.68±2.98$^{b}$ | 23.34±11.9ab | 1.67±0.82ab | 0.91±0.91 | 0.52±0.3a | 88.89±24.7ab |
| 4:2:1 | 4.67±1.07ab | 2.37±2.98a | 28.01±11.9a | 1.05±0.82b | 0.90±0.91 | 0.57±0.3a | 100.0±24.7a |
| 6:2:2 | 3.67±1.07b | 1.86±2.98b | 22.01±11.9ab | 1.47±0.82ab | 0.93±0.91 | 0.51±0.3a | 100.0±24.7a |
| 5:2:2 | 3.68±1.07b | 2.78±2.98a | 18.28±11.9b | 1.04±0.82b | 0.93±0.91 | 0.41±0.3ab | 66.67±24.7b |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **12 cm** | | | | | | | |
| 6:3:2 | 5.33±1.07$^{a}$ | 8.33±2.98$^{a}$ | 20.06±11.9$^{a}$ | 1.27±0.82$^{ab}$ | 0.93±0.91$^{a}$ | 0.49±0.3$^{a}$ | 100.0±24.7$^{a}$ |
| 3:2:1 | 5.56±1.07a | 5.51±2.98$^{ab}$ | 14.68±11.9$^{b}$ | 1.56±0.82$^{a}$ | 0.93±0.91$^{a}$ | 0.43±0.3$^{a}$ | 77.89±24.7$^{b}$ |
| 5:2:1 | 3.89±1.07$^{b}$ | 3.76±2.98$^{ab}$ | 13.90±11.9$^{b}$ | 1.43±0.82$^{ab}$ | 0.90±0.91$^{a}$ | 0.24±0.3$^{b}$ | 88.89±24.7$^{ab}$ |
| 4:2:1 | 3.78±1.07$^{b}$ | 2.88±2.98$^{bc}$ | 18.89±11.9$^{ab}$ | 0.61±0.82$^{b}$ | 0.97±0.91$^{a}$ | 0.24±0.3$^{b}$ | 77.78±24.7$^{b}$ |
| 6:2:2 | 1.67±1.07$^{c}$ | 1.73±2.98$^{b}$ | 10.44±11.9$^{b}$ | 0.60±0.82$^{b}$ | 0.41±0.91$^{b}$ | 0.26±0.3$^{b}$ | 66.67±24.7$^{c}$ |
| 5:2:2 | 1.33±1.07$^{c}$ | 1.11±2.98$^{b}$ | 16.52±11.9$^{ab}$ | 0.60±0.82$^{b}$ | 0.03±0.91$^{b}$ | 0.26±0.3$^{b}$ | 77.78±24.7$^{b}$ |
| **Pot size and soil ratio for *M. stenopetala*** | | | | | | | |
| **8 cm** | | | | | | | |
| 6:3:2 | 0.78±1.1$^{b}$ | 3.66±2.98$^{b}$ | 44.15±11.9$^{ab}$ | 0.82±0.82$^{c}$ | 0.45±0.91$^{b}$ | 0.84±0.3$^{a}$ | 97.33±24.7$^{a}$ |
| 3:2:1 | 0.93±1.1$^{ab}$ | 7.48±2.98$^{ab}$ | 30.55±11.9$^{b}$ | 1.51±0.82$^{b}$ | 0.76±0.91$^{ab}$ | 0.51±0.3$^{b}$ | 54.13±24.7$^{b}$ |
| 5:2:1 | 1.01±1.1$^{a}$ | 9.43±2.98$^{a}$ | 50.94±11.9$^{a}$ | 2.48±0.82$^{a}$ | 1.26±0.91$^{a}$ | 0.51±0.3$^{b}$ | 100.0±24.7$^{a}$ |
| 4:2:1 | 1.01±1.1$^{a}$ | 8.84±2.98$^{ab}$ | 49.16±11.9$^{a}$ | 1.81±0.82$^{b}$ | 0.92±0.91$^{ab}$ | 0.52±0.3$^{b}$ | 100.0±24.7$^{a}$ |
| 6:2:2 | 0.89±1.1$^{b}$ | 9.68±2.98$^{a}$ | 30.36±11.9$^{b}$ | 1.81±0.82$^{b}$ | 0.83±0.91$^{ab}$ | 0.46±0.3$^{b}$ | 55.56±24.7$^{b}$ |
| 5:2:2 | 1.01±1.1$^{a}$ | 5.41±2.98$^{ab}$ | 44.15±11.9$^{ab}$ | 0.81±0.82$^{c}$ | 0.43±0.91$^{b}$ | 0.53±0.3$^{b}$ | 100.0±24.7$^{a}$ |
| **10 cm** | | | | | | | |
| 6:3:2 | 1.08±1.1$^{a}$ | 6.05±2.98 | 20.10±11.9$^{a}$ | 2.09±0.82$^{a}$ | 3.48±0.91$^{a}$ | 0.53±0.3$^{a}$ | 99.86±24.7$^{a}$ |
| 3:2:1 | 0.83±1.1$^{b}$ | 7.23±2.98 | 14.67±11.9$^{ab}$ | 1.67±0.82$^{b}$ | 1.29±0.91$^{b}$ | 0.47±0.3$^{ab}$ | 100.0±24.7$^{a}$ |
| 5:2:1 | 1.02±1.1$^{a}$ | 6.12±2.98 | 13.90±11.9$^{ab}$ | 2.77±0.82$^{a}$ | 1.37±0.91$^{b}$ | 0.44±0.3$^{ab}$ | 100.0±24.7$^{a}$ |
| 4:2:1 | 1.67±1.1$^{a}$ | 6.85±2.98 | 18.89±11.9$^{a}$ | 1.73±0.82$^{b}$ | 1.30±0.91$^{b}$ | 0.56±0.3$^{a}$ | 100.0±24.7$^{a}$ |
| 6:2:2 | 0.67±1.1$^{b}$ | 7.17±2.98 | 10.44±11.9$^{b}$ | 1.87±0.82$^{b}$ | 1.31±0.91$^{b}$ | 0.53±0.3$^{a}$ | 66.67±24.7$^{b}$ |
| 5:2:2 | 1.01±1.1$^{a}$ | 7.79±2.98 | 16.52±11.9$^{ab}$ | 0.57±0.82$^{c}$ | 0.47±0.91$^{c}$ | 0.08±0.3$^{b}$ | 100.0±24.7$^{a}$ |
| **12 cm** | | | | | | | |
| 6:3:2 | 1.13±1.1$^{a}$ | 10.73±2.98$^{a}$ | 52.28±11.9$^{ab}$ | 1.65±0.82$^{a}$ | 1.24±0.91$^{a}$ | 0.76±0.3$^{a}$ | 100.0±24.7$^{a}$ |
| 3:2:1 | 0.74±1.1$^{b}$ | 13.30±2.98$^{ab}$ | 51.05±11.9$^{ab}$ | 0.81±0.82$^{b}$ | 0.61±0.91$^{b}$ | 0.36±0.3$^{b}$ | 95.59±24.7$^{a}$ |
| 5:2:1 | 1.01±1.1$^{a}$ | 10.61±2.98$^{a}$ | 46.33±11.9$^{ab}$ | 1.57±0.82$^{a}$ | 1.27±0.91$^{a}$ | 0.81±0.3$^{a}$ | 100.0±24.7$^{a}$ |
| 4:2:1 | 1.11±1.1$^{a}$ | 4.57±2.98$^{b}$ | 63.53±11.9$^{a}$ | 1.56±0.82$^{a}$ | 1.27±0.91$^{a}$ | 0.81±0.3$^{a}$ | 100.0±24.7$^{a}$ |
| 6:2:2 | 0.67±1.1$^{b}$ | 7.43±2.98$^{ab}$ | 35.74±11.9$^{b}$ | 1.56±0.82$^{a}$ | 1.26±0.91$^{a}$ | 0.81±0.3$^{a}$ | 66.67±24.7$^{b}$ |
| 5:2:2 | 0.89±1.1$^{b}$ | 5.89±2.98$^{b}$ | 38.44±11.9$^{b}$ | 0.93±0.82$^{b}$ | 0.83±0.91$^{b}$ | 0.59±0.3$^{b}$ | 100.0±24.7$^{a}$ |
| **Pot size and soil ratio for *G. robusta*** | | | | | | | |
| **8 cm** | | | | | | | |
| 6:3:2 | 16.67±1.07a | 5.24±2.98$^{ab}$ | 18.30±11.9 | 1.63±0.82 | 1.37±0.91 | 0.84±0.37 | 77.78±24.7abc |
| 3:2:1 | 11.67±1.07a | 6.68±2.98$^{a}$ | 21.64±11.9 | 1.87±0.82 | 1.77±0.91 | 0.58±0.37 | 100.0±24.7a |
| 5:2:1 | 4.67±1.07b | 4.63±2.98$^{ab}$ | 20.67±11.9 | 1.51±0.82 | 1.47±0.91 | 0.31±0.37 | 100.0±24.7a |
| 4:2:1 | 5.67±1.07b | 4.44±2.98$^{ab}$ | 17.51±11.9 | 1.51±0.82 | 1.47±0.91 | 0.31±0.37 | 33.33±24.7c |
| 6:2:2 | 2.33±1.07c | 2.33±2.98$^{b}$ | 17.67±11.9 | 1.52±0.82 | 1.46±0.91 | 0.31±0.37 | 44.45±24.7bc |
| 5:2:2 | 2.89±1.07c | 2.51±2.98$^{b}$ | 20.01±11.9 | 1.97±0.82 | 1.91±0.91 | 0.62±0.37 | 88.89±24.7ab |
| **10 cm** | | | | | | | |
| 6:3:2 | 15.33±1.07 | 9.69±2.98$^{a}$ | 26.02±11.9$^{b}$ | 2.63±0.82$^{a}$ | 1.63±0.91 | 0.63±0.37 | 66.67±24.7$^{b}$ |
| 3:2:1 | 11.01±1.07 | 7.41±2.98$^{a}$ | 24.79±11.9$^{b}$ | 2.67±0.82$^{a}$ | 1.63±0.91 | 0.63±0.37 | 66.67±24.7$^{b}$ |
| 5:2:1 | 14.01±1.07 | 4.62±2.98$^{ab}$ | 35.67±11.9$^{a}$ | 2.33±0.82$^{a}$ | 1.62±0.91 | 0.23±0.37 | 100.0±24.7$^{a}$ |
| 4:2:1 | 10.01±1.07 | 2.47±2.98$^{b}$ | 34.82±11.9$^{a}$ | 1.51±0.82$^{b}$ | 1.06±0.91 | 0.49±0.37 | 100.0±24.7$^{a}$ |
| 6:2:2 | 10.01±1.07 | 3.05±2.98$^{b}$ | 30.66±11.9$^{a}$ | 1.41±0.82$^{b}$ | 1.11±0.91 | 0.49±0.37 | 100.0±24.7$^{a}$ |
| 5:2:2 | 10.01±1.07 | 2.98±2.98$^{b}$ | 21.05±11.9$^{b}$ | 1.37±0.82$^{b}$ | 1.03±0.91 | 0.47±0.37 | 66.67±24.7$^{b}$ |
| **12 cm** | | | | | | | |
| 6:3:2 | 10.01±1.1$^{a}$ | 0.73±2.98 | 22.95±11.9 | 1.67±0.82$^{a}$ | 0.93±0.91$^{a}$ | 0.39±0.37$^{ab}$ | 77.78±24.7$^{ab}$ |
| 3:2:1 | 11.56±1.1$^{a}$ | 0.73±2.98 | 22.60±11.9 | 1.23±0.82$^{ab}$ | 0.93±0.91$^{a}$ | 0.51±0.37$^{ab}$ | 55.56±24.7$^{b}$ |
| 5:2:1 | 10.89±1.1$^{a}$ | 1.09±2.98 | 26.65±11.9 | 1.23±0.82$^{ab}$ | 0.26±0.91$^{ab}$ | 0.49±0.37$^{ab}$ | 88.89±24.7$^{ab}$ |
| 4:2:1 | 11.11±1.1$^{a}$ | 1.64±2.98 | 24.47±11.9 | 1.23±0.82$^{ab}$ | 0.96±0.91$^{a}$ | 0.53±0.37$^{ab}$ | 77.78±24.7$^{ab}$ |
| 6:2:2 | 15.33±1.1$^{a}$ | 2.73±2.98 | 26.44±11.9 | 1.71±0.82$^{ab}$ | 0.41±0.91$^{ab}$ | 0.82±0.37$^{a}$ | 100.0±24.7$^{a}$ |
| 5:2:2 | 9.89±1.1$^{b}$ | 0.59±2.98 | 24.89±11.9 | 0.03±0.82$^{b}$ | 0.03±0.91$^{b}$ | 0.02±0.37$^{b}$ | 100.0±24.7$^{a}$ |

## CONCLUSION

The present study showed that the growth of *A.indica, Cordia, Moringa,* and *G. robusta* seedlings was significantly affected by pot size and nursery soil mixture. From the results, it can be concluded that both pot size and growing media had a significant effect on **the** growth parameters of *A.indica, Cordia, Moringa,* and *G. robusta* tree seedlings. Besides, the result showed a significant interaction effect between pot size and growing media. In the case of *A.indica,* and *G. robusta* seedlings grown in the smaller pot size and large pot size were comparable to many parameters. In the case of *Cordia africana* and *Moringa* the larger pot size had significantly higher root length and root-to-shoot ratio. Therefore, using a larger pot size is preferable compared to the smaller one. However, since the study area has a shortage of rainfall using a 10 cm pot size would be advantageous. Accordingly, the 10 cm pot size is the optimal size, and hence it is recommendable to use in the nursery for raising *tree* seedlings. The study results showed that there was a significant interaction effect between pot size and soil mixing ratio. For the soil mixing ratio of *A.indica, Cordia africana, Moringa,* and *G. robusta***,** using the 3:2:1 ratio gave better results. However, the soil mixing ratios of 6:3:2 followed by 5:2:1 for a pot size of 8 cm and a ratio of 4:2:1 for a pot size of 10 cm are found to be appropriate for growing seedlings of *A.indica,* and *G. robusta***.**

## RECOMMENDATIONS

Thus, the growth parameters in smaller pot sizes were enhanced when the soil mixing ratio was 6:3:2 for *A.indica, Cordia africana, Moringa,* and *G. robusta* seedling growth. However, in larger pot sizes for *Cordia africana* and *Moringa,* the growing medium of 3:2:1 gave the highest growth parameters. In the same larger pot, the growing medium of 4:2:1 might be appropriate to raise seedlings species of *Moringa* in the nursery in the case of Fedis district. Since seedling growths and development parameters of *A.indica, Cordia africana, Moringa,* and *G. robusta* were affected by growing medium and pot size. Therefore, further research should be directed toward assessing the effect of different substrates of high nutrients on pot size along with a study on seedling survival after transplanting in the field condition.

**Acknowledgments**

The authors thank to Oromia Agricultural Research Institute for financial support and the Fadis Agricultural Research Center for the provision of the necessary facilities for research work. The authors are also grateful to Agroforestry team members for their diligent efforts in making the project a success.

## REFERENCES

[1] Bunt AC (1988). Media and mixes for container-grown plants, 2nd Ed: A manual on the preparation and use of growing media for pot plants

[2] Dayton, E. A., Whitacre, S. D., Dungan, R. S., & Basta, N. T. (2010). Characterization of physical and chemical properties of spent foundry sands pertinent to beneficial use in manufactured soils. *Plant and soil*, *329*, 27-33.

[3] Del Campo AD, Navarro RM, Ceacero CJ. 2010. Seedling quality and field performance of commercial stocklots of containerized holm oak (*Quercus ilex*) in Mediterranean Spain: an approach for establishing a quality standard. New Forest. 39:19–37.

[4] Gebre, G. (2009). *Influence Of Media Compositions On Emergence And Shoot Performance Of Coffee (Coffea Arabica (L.) Seedlings at Dale-Sidama Southern Ethiopia* (Doctoral Dissertation).

[5] Ibironke OA (2016). Evaluation of the Effect of Different Nursery Media on the Emergence and Growth of Three**.**Tropical Tree Species, Global Journal of Science Frontier Research: Agriculture and Veterinary, 16(3):31-36

[6] Marfa O, Lemaire F, Caceres R, Giuffrida F, Guerin V. 2002. Relationships between growing media fertility, percolate composition and fertigation strategy in peat-substitute substrates used for growing ornamental shrubs. Sci Hortic. 94:309–321.

[7] Mariotti, B., Maltoni, A., Jacobs, D. F., & Tani, A. (2015). Container effects on growth and biomass allocation in Quercus robur and Juglans regia seedlings. *Scandinavian Journal of Forest Research*, *30*(5), 401-415.

[8] Mariotti, B., Maltoni, A., Jacobs, D. F., & Tani, A. 2015. Container effects on growth and biomass allocation in Quercus robur and Juglans regia seedlings. *Scandinavian Journal of Forest Research*, *30*(5), 401-415.

[9] Mulugeta G (2014). Effect of different potting mixture on the seedling growth and survival of *Albizia gummifera* and *Cordia africana*. Journal of Natural Sciences Research, 4(3): 25-33

[10] Mustafa, G., Ali, M. A., Abid, M., Masood, (2016). Comparison of various potting media for their influence on nutrients supply, germination, and growth of muskmelon

(cucumis melo L.) seedlings. *Compost Science & Utilization*, *24*(1), 61-71.

[11] Poorter H, Buhler J, van Dusschoten D, Climent J. 2012. Pot size matters: a meta-analysis of the effects of rooting volume on plant growth. Funct Plant Biol. 39:839–850.

[12] Tekalign Tadese. 1991. Soil, plant, water, fertilizer, animal manure and compost analysis. Working
Document No. 13. International Livestock Research Center for Africa, Addis Ababa.

[13] Ugese, F. 2010. Effect of nursery media on emergence and growth of tamarind (Tamarindus indica L.) seedlings. *Journal of Animal and Plant Sciences*, *8*(2), 999-1005.

[14] Vaknin, Y., Dudai, N., Murkhovsky, L., Gelfandbein, L. 2009. Effects of pot size on leaf production and essential oil content and composition of Eucalyptus citriodora Hook.(Lemon-Scented Gum). *Journal of herbs, spices & medicinal plants*, *15*(2), 164-176.

[15] Walkley, A. J., and Black, I. A. 1934. Estimation of soil organic carbon by chromic acid titration method. ***Journal of Soil Science,*** 37: 29-38

[16] West, 2006.Higher rootto-shoot ratio and root weight tend to survive better, as relatively large root system supply the water requirements of their relatively small shoot

[17] Yadessa, A., and Bekere, D. (2001). Determination of optimum nursery soil mixture and pot size for propagation of Leucaena pallida: A promising browse species at Bako. *Livestock in Food Security–Roles and Contributions*, 235.