Effect of growing media on seedling growth of African baobab (Adansonia digitata L.)

Thembinkosi Mathowa*, Mpho Bosenakitsi1, Witness Mojeremane1, Christopher Mpofu1 and Gabatshele M. Legwaila1

1Department of Crop Science and Production, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana

*Corresponding author: tmathowa@yahoo.com

Abstract

Adansonia digitata L. is a major multipurpose tree species which has an important economic value not only for food but also medicine and fibre. A pot experiment was conducted in the net-shade at Botswana College of Agriculture from January to May 2014 to evaluate the growth response of A. digitata potted seedlings to different growth media. The experimental design was a completely randomized design (CRD) with four treatments each replicated four times. The four treatments were as follows; top garden soil (TGS), top forest soil (TFS), commercial compost (CC) and a mixture of the three (TGS+TFS+CC) being treatments 1-4, respectively. The results revealed a non-significant treatment effect (p>0.05) on plant height across treatments in weeks 2 and 4. The mixture (TGS+TFS+CC) significantly (p<0.05) increased seedling plant height from week 6 to 8 and a highly significant effect was observed from week 10 to 12 compared to other treatments. A non-significant (p>0.05) treatment effect was observed in A. digitata seedling leaf number across treatments in weeks 2 and 4. The number of leaves were significantly (p<0.05) higher in the TGS+TFS+CC treatment in weeks 8 and 10 and highly significant in week 12. The collar girth of A. digitata seedlings was significantly (p<0.01) lower in the commercial compost than other treatments in the first two weeks following transplanting. A non-significant treatment effect was observed in weeks 4 and 6, but the collar girth was significantly increased in the TGS+TFS+CC treatment from week 10 until the end of the study. The TGS+TFS+CC treatment significantly (p<0.01) increased both total (roots + shoots) fresh and dry weights. TGS revealed significantly (p<0.05) lower plant biomass than the TFS and the TGS+TFS+CC treatments. Based on these results the soil mixture (TGS+TFS+CC) is recommended as the most suitable medium that can be used by tree growers to propagate A. digitata seedlings.

Keywords: Adansonia digitata, growth media, completely randomized design, tree nursery

Introduction

The successful production of quality seedlings in a nursery is largely dependent on the composition of the growing media (Wilson et al., 2001; Osaigbovo and Orhue, 2012). A suitable potting medium should be well drained with the ability to retain sufficient water to reduce the frequency of watering (Unal, 2013). The selection of the proper media components is critical to the successful production of seedlings (James and Michael, 2009) because media play an important role in seed germination and directly affect the development and later maintenance of the extensive functional rooting system (Bhardwaj, 2014). Suitable growing medium provides sufficient anchorage or supports the plant, serves as a reservoir for nutrients and water, allows oxygen diffusion to the roots and gaseous exchange between the roots and atmosphere outside the root substrate (Abad et al., 2002).

The quality of nursery seedlings is influenced by potting media (Agbo and Omaliko, 2006) because it does not only act as a growing media but as a source of nutrients (Bhardwaj, 2014). Quality of growth
media used to raise containerized seedlings is a key determinant factor to successful tree planting programmes (Manenoi et al., 2009). The performance of seedlings when planted out in the field is determined by their performance in the nursery (Agbo and Omaliko, 2006). It is critical to use growth media with a balanced supply of nutrients to support the production of healthy and vigorous seedling while ensuring adequate root development and plant hardiness (Mason and Aldhous, 1994). Adding organic matter to potting media is important because it supplies essential nutrients required by seedlings (Khan et al., 2006). Soil organic matter determines the biological, physical and chemical properties of soils (Merino et al., 2004; Grace et al., 2006) and is important in sustaining the productivity of many ecosystems (Hirschel et al., 1997; Kirchmann et al., 2004).

Baobab (A. digitata) belongs to the family Bombacaceae (Roodt, 1998; Palgreave, 2002; Sidibé and Williams, 2002; Assogbadjo et al., 2006) and is indigenous to Africa where it is found in many countries (Venter and Venter 1996; Gebauer et al., 2002; Bosch et al., 2004; Kamatou et al. 2011) from 0–1000 m above sea level (Bosch et al., 2004) as a component of secondary forest (Woolfe et al., 1977). It is a large iconic deciduous tree attaining a height of 12–20 m or more (Mulofwa et al., 1994; Storrs, 1995; Venter and Venter, 1996; Palgreave, 2002; Bosch et al., 2004) and may live for thousands of years (Wickens, 1982; Storrs, 1995; Gebauer et al., 2002; Palgreave, 2002). A. digitata has a thick, angular, wide spreading branches and short trunk which grows 4.5–14 m or more in diameter (Storrs, 1995; Venter and Venter, 1996; Gebauer et al., 2002; Palgreave, 2002).

A. digitata has a conical shape when young (Storrs, 1995; Gebauer et al., 2002) which becomes massively fluted as the tree grows and occasionally swollen at the base (Storrs, 1995). The bark is smooth, reddish brown or grey and later rough and wrinkled (Mulofwa et al., 1994; Storrs, 1995; Gebauer et al., 2002). Leaves are alternate and hand shaped, with 39 sessile tapering leaflets (simple on young trees) at the end of branches (Venter and Venter, 1996). The wood is whitish, soft, spongy and light (Storrs, 1995; Venter and Venter, 1996) and has little use except for making fishing boats (Storrs, 1995). Flowers are large and white opening at night and their unpleasant-smelling nectar attracts pollinators such as bats (Harris and Baker 1959; Start, 1972; Mulofwa et al., 1994; Baum, 1995; Storrs, 1995). The flowers do not live more than 24 hours (Gebauer et al., 2002). The fruit has various shapes but is mostly ovoid 100–50 mm long (Venter and Venter, 1996) with a hard woody shell covered with velvety hairs (Venter and Venter, 1996; Palgreave, 2002). The ovoid shell contains numerous edible hard brown seeds, round or ovoid up to 15 mm long embedded in a floury acidic pulp (Gebauer et al., 2002; Palgreave, 2002).

A. digitata is a multipurpose tree species that is valued for food, fibre and medicine in Africa (Kamatou et al., 2011; Venter and Witkowski, 2011). Baobab products are sold in informal markets and form an important source of income for thousands of rural people (Sidibé and Williams, 2002). Leaves are sources of protein (Gebauer et al., 2002) and minerals (Prentice et al., 1993; Yazzie et al., 1994; Nordeide et al., 1996; Smith et al., 1996; Glew et al., 1997; Lockett et al., 2000; Boukari et al., 2001). The fruit pulp contains vitamin C almost ten times that of orange (Gebauer et al., 2002). The plant parts are used to treat various ailments such as diarrhoea, malaria and microbial infections (Kamatou et al., 2011). It is an excellent anti-oxidant due to the high vitamin C content (Gebauer et al., 2002; Kamatou et al., 2011).

Little is known about growth media suitable for propagating seedlings of indigenous trees in arid and semi-arid areas. There has been an increasing demand for multi-purpose trees in recent years, and farmers’ attempts to propagate them have not succeeded due to lack of information on their agronomic requirements. Most indigenous species grow naturally in the wild and are popular for their multiple uses. Very few species have been raised in tree nurseries because their nursery requirements are not understood. Therefore the objective of this study was to evaluate the effect of growing media on the growth of A. digitata in a tree nursery.

Materials and Methods

Experimental site

The study was conducted at the tree nursery of Botswana College of Agriculture (BCA). The College is situated in Sebele content farm, Gaborone. Sebele is
located between latitude 24°33'S and longitude 25°54'E at an elevation of 994 m above sea level, 10 km from Gaborone city, along Gaborone-Francistown highway. Seeds used in this study were obtained from Botswana National Tree Seed Centre, Department of Forestry and Range Resources, Ministry of Environment, Wildlife and Tourism, Gaborone. Analysis of growth media physical and chemical properties was conducted at the Department of Crop Science and Production, Soil Science Laboratory, Botswana College of Agriculture.

**Seedling pre-treatment and germination**

Seeds were treated using a hot wire method to break the dormancy, and they were germinated in a seedbed measuring 2 m × 5 m filled with a layer of sand and compost (leaf mould). The seedbed was watered twice a day when required. Weeds were carefully hand removed whenever they appeared to avoid pulling out seedlings. After germination and development of true leaves, seedlings were transplanted into black polyethylene pots filled with different growth media (inside diameter 25 cm).

**Determination of growth media physical and chemical properties**

Growth media pH was measured from a soil-water suspension (1:1, v/v) by a pH meter (model: Hannah HI 110). Cation exchange capacity (CEC) was determined by the ammonium acetate saturation method (Schollenberger and Simon, 1945). Total nitrogen (N) content was determined by Kjeldahl method (Bremner, 1965) and measured on a distillation unit (model: BuchiK-350). Available phosphorus (P) was determined by the Bray II method (Bray and Kurt, 1945) and measured on an inductively coupled plasma - optical emission spectrophotometer (model: Perkinelmer DV 2100). Exchangeable potassium (K⁺) was measured by flame photometer (model: Sherwood 410) after extraction with 1 N ammonium acetate pH 7.0.

**Experimental design**

The experiment was laid out in a completely randomized design (CRD) with four treatments (growth media) each replicated four times. The four treatments were as follows; top garden soil (TGS), commercial compost (CC), top forest soil (TFS) and mixture of TGS+CC+TFS (1:1:1, v/v), being treatments 1–4, respectively. There were 10 polythene pots, each with a seedling per replicate which were randomly located in the nursery (Fig. 1). This gave a total of one hundred and sixty (160) pots. The experiment was conducted under a 60% green net-shade to minimize loss of water. Seedlings were watered twice a day, in the morning and in the afternoon when necessary throughout the duration of the experiment. Weeds were removed manually by hands whenever they occurred. No fertilizer was supplied to the seedlings.

**Growth parameters**

The experiment was monitored for twelve (12) weeks after transplanting (WAT) and the growth parameters measured were: plant height, number of leaves, collar girth and total (roots + shoots) fresh and dry weight. Measurements were taken bi-weekly after transplanting except for fresh and dry weights which were taken at the end of the study. Plant height (cm) was measured using a meter ruler from the soil level to the terminal bud. The number of leaves was measured quantitatively by counting. The collar girth (mm) was measured at about 2.5 cm above the soil level using a calibrated digital caliper (0-150 mm). A destructive method was used to determine both fresh and dry weights (g) which were measured at week 12 and 5 seedlings were used per replicate. The average was then taken to represent the replicate. The seedlings were uprooted from the polyethylene pots and placed into weighing paper bags. The fresh samples were taken to the laboratory and measured using a bench top electric balance (PGW 4502e). The samples were then oven dried to constant weight at 80°C using a hot air oven (Scientific Series 2000) and dry weight was recorded.

**Data analysis**

The data collected was subjected to analysis of variance (ANOVA) using the STATISTIX-8 program. Where a significant F-test was observed and means comparison test were carried out using Least Significant Difference (LSD) at p ≤0.05 to separate treatment means.

**Results and Discussion**

The physical and chemical properties of growth media data presented in Table 1 shows that the pH ranged from 5.0 to 7.1, slightly acidic to neutral. Soil pH is an
important chemical property of any soil or growing media that influences essential mineral nutrients availability (Roberts, 2006). Growth media with a higher pH can be deficient in iron and phosphorus, whereas acidic media lack calcium and magnesium (Kramer and Kozlowski, 1979). The CEC ranged from 0.80 to 1.63 cmol kg$^{-1}$ and was high in the TGS and the TGS+TFS+CC. Total N ranged from 0.52–1.01% and was high in the TGS+TFS+CC followed by TGS and CC, respectively. Values for available P ranged from 7.0 to 98.0 ppm and the highest was recorded in the CC and lowest in the TGS. Exchangeable K$^+$ ranged from 1.61 to 2.98% and the highest was recorded in the CC and the lowest in the TGS treatment. Results presented in Table 1 shows that, overall, the growth media are sandy loam, slightly acidic to neutral, with good aeration, high permeability, and low water holding capacity, low in nitrogen content, phosphorus and potassium.

**Plant height**

Results presented in Table 2 shows that plant height across treatments was not significantly (p>0.05) affected by growth media between weeks 2 and 4. Plant height was significantly (p<0.05) affected by growth media from week 6 to 8 with the tallest seedlings recorded in the TGS+TFS+CC treatment. A highly significant increase in plant height was also observed in the TGS+TFS+CC treatment from week 10 to 12. The significant increase in plant height observed in the TGS+TFS+CC treatment could suggest the mixture is the best medium for raising *A. digitata* seedlings in a tree nursery. A balanced growth medium that contains an adequate supply of nutrients is critical if seedlings raised in a tree nursery are to develop and attain maximum growth (Mehmood *et al.*, 2013). The use of media with sufficient essential nutrients is important for seedlings to attain maximum height (Ikram *et al.*, 2013). The TGS+TFS+CC medium increased plant height (Table 2) because the addition of compost, which is organic matter, affects soil physics, chemistry and biology as it binds soil aggregates together and is source of soil nutrients. Clay and organic matter colloids adsorb a lot of cations and the media such a TGS+TFS+CC with sufficient organic matter and clay content has a much higher CEC (Table 1) which enhanced seedling height. The compost in the mixture could also have improved aeration and the water holding capacity (Osaigbovo and Orhue, 2012) which enhanced plant height.
Most tree nurseries use natural soils to produce containerized seedlings (Tariq et al., 2012). These soils lack essential nutrients required for plant growth and hence the compost in the TGS+TFS+CC medium could have ameliorated the physical and chemical properties, and ultimately improved the water holding capacity and nutrient availability (Khan et al., 2006; Kung’u et al., 2008). Our results are consistent with other studies conducted elsewhere using different plants which recorded tall plants in mixtures of soils combined with organic manures such as yard manure (Shamet et al., 1994; Sudhakara et al., 1995; Nayital et al., 1995; Thakur et al., 2000; Baiyeri, 2003; Nandeshwar and Patra, 2004; Radhakrishnan and Mahendran, 2010). For example, Thakur et al. (2000) recorded tall Albizia lebbeck Benth seedlings in a mixture composed of sand+soil+farm yard manure. Nandeshwar and Patra (2004) reported that a mixture of soil+sand+compost in the ratio of 1:1:2 was the best media for growing and improving the survival of Acacia catechu seedlings.

### Leaf number

Results presented in Table 3 shows that the number of leaves was not significantly (p>0.05) affected by growth media across treatments in weeks 2 and 4. The number of leaves increased with time and seedlings in the TGS+TFS+CC treatment recorded significantly more leaves in week 8 to 10 (p<0.05) and 12 (p<0.01) than in other treatments. Plants manufacture most of their food in leaves whose development is influenced by several factors, soil being one of the most critical. The number of leaves recorded in our treatments at week 12 is as follows: TGS+TFS+CC (31.72), TFS (22.20), TGS (19.98) and CC (19.08). The high number of leaves in the TGS+TFS+CC treatment could be due to higher production of photosynthesizing functional leaves (Borah et al., 1994) enhanced by a well-balanced media with sufficient organic matter and clay (Table 1). This result is consistent with results from other experiments, which collectively found that using soil mixtures with organic substrates such as leaf manure (Riaz et al., 2008) and farmyard manure (Sudhakara et al., 1995; Malewar et al., 1998; Parasana et al., 2013) enhanced the number of leaves. Organic matter in potting mixtures regulates water and nutrient availability (Peter-Onoh et al., 2014) and enhances seedling production (Baiyeri, 2003) and the compost in our mixture may have released nutrients for seedling growth in addition to improving the water holding capacity.

### Collar girth

Planting media has large effect on the plant growth characteristics (Shah et al., 2006; Riaz et al., 2008). A. digitata seedling collar girth was significantly affected by growth media (Table 4). The collar girth in the TGS, TFS and TGS+TFS+CC treatments was significantly (p<0.01) increased compared to CC in week 2. Compost constitutes a slow release source of nutrients that supply plants with essential nutrients when they needed them (Chaoui et al., 2003; Nevens and Reheul, 2003) and this could have affected the development of seedlings in the CC treatment in the first two weeks of this work. At weeks 4 and 6, collar girth across treatments was not affected by growth media (p>0.05). The recorded collar girth values ranged from 2.91 to 3.16 mm in week 4 and 3.14 to 3.56 mm in week 6, respectively. At week 8, the collar girth in the TFS and TGS+TFS+CC treatment was significantly (p<0.01) higher than in the other two treatments. Collar girth increased with time and from week 10 to 12 seedlings in the TGS+TFS+CC treatment had a significantly higher collar girth than their counterparts in other treatments. Compost added to the growing media has shown to improve the performance of a wide range of plants (Grigatti et al., 2007; Peter-Onoh et al., 2014) because of enhanced nutrients apply (Grigatti et al., 2007) which was probably the case with the TGS+TFS+CC treatment (Table 1). The presence of compost in potting media has also been shown to supress soil-borne plant pathogens (Hoitink and Boehm, 1999; Szczech, 1999; Scheuerrl et al., 2005; Noble and Coventry, 2005; Termorshuizen et al., 2006), enhance microbial activity (Domínguez, 2004) and mycorrhiza colony formation (Cavender et al., 2003) and hence improve the plant growth.

### Fresh, dry weights and biomass

Plant dry weight is an important parameter which reflects the interaction between genetic, environment and physiology process in plants (Prameswari and Tata, 2004). Results in Table 5 shows that fresh weight of plants grown in the TGS+TFS+CC treatment was significantly (p<0.01) higher than in the TFS and CC. There were no significant (p>0.05) differences in fresh weight between the TGS and
Table (1): Physical and chemical properties of growth media

<table>
<thead>
<tr>
<th>Growth media</th>
<th>pH (H₂O)</th>
<th>CEC (cmolkg⁻¹)</th>
<th>Total N (%)</th>
<th>Available P (ppm)</th>
<th>Exchangeable K⁺ (%)</th>
<th>Textural class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top garden soil (TGS)</td>
<td>6.3⁵</td>
<td>1.61¹</td>
<td>0.87ᵃ</td>
<td>7.00³</td>
<td>1.78³</td>
<td>87</td>
</tr>
<tr>
<td>Top forest soil (TFS)</td>
<td>7.1⁴</td>
<td>0.80ᵇ</td>
<td>0.52ᵃ</td>
<td>11.00³</td>
<td>1.61³</td>
<td>75</td>
</tr>
<tr>
<td>Commercial compost (CC)</td>
<td>5.0ᵈ</td>
<td>-</td>
<td>0.74ᵇ</td>
<td>98.00ᵃ</td>
<td>2.98ᵃ</td>
<td>-</td>
</tr>
<tr>
<td>Mixture (TGS+TFS+CC)</td>
<td>6.7ᵇ</td>
<td>1.63ᵃ</td>
<td>1.01ᵃ</td>
<td>41.00ᵇ</td>
<td>2.37ᵇ</td>
<td>87</td>
</tr>
</tbody>
</table>

Significance ** Highly significant at p<0.01. Means separated by Least Significance Difference (LSD) Test at p ≤ 0.05, means within columns followed by the same letters are not significantly different, ppm denotes parts per million.

Table (2): A. digitata seedlings height (cm) under various growth media.

<table>
<thead>
<tr>
<th>Growth media</th>
<th>Week 2</th>
<th>Week 4</th>
<th>Week 6</th>
<th>Week 8</th>
<th>Week 10</th>
<th>Week 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top garden soil (TGS)</td>
<td>11.40</td>
<td>12.28</td>
<td>14.65ᵇ</td>
<td>17.32ᵇ</td>
<td>18.80ᵇ</td>
<td>19.98ᵇ</td>
</tr>
<tr>
<td>Top forest soil (TFS)</td>
<td>10.42</td>
<td>11.13</td>
<td>13.50ᵇ</td>
<td>17.10ᵃ</td>
<td>19.53ᵇ</td>
<td>22.20ᵇ</td>
</tr>
<tr>
<td>Commercial compost (CC)</td>
<td>8.90</td>
<td>9.58</td>
<td>11.65ᵇ</td>
<td>15.83ᵇ</td>
<td>17.03ᵇ</td>
<td>19.08ᵇ</td>
</tr>
<tr>
<td>Mixture (TGS+TFS+CC)</td>
<td>10.55</td>
<td>10.99</td>
<td>17.95ᵃ</td>
<td>24.79ᵇ</td>
<td>27.92ᵃ</td>
<td>31.72ᵃ</td>
</tr>
</tbody>
</table>

Significance ns non-significant at p>0.05. Means separated by Least Significance Difference (LSD) Test at p ≤ 0.05, means within columns followed by the same letters are not significantly different.

** Highly significant at p<0.01, * significantly at p<0.05.

Table (3): Leaf number of A. digitata seedlings under various growth media.

<table>
<thead>
<tr>
<th>Growth media</th>
<th>Week 2</th>
<th>Week 4</th>
<th>Week 6</th>
<th>Week 8</th>
<th>Week 10</th>
<th>Week 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top garden soil (TGS)</td>
<td>5.15</td>
<td>6.35</td>
<td>9.30ᵇ</td>
<td>10.35ᵇ</td>
<td>11.50ᵇ</td>
<td>12.20ᵇ</td>
</tr>
<tr>
<td>Top forest soil (TFS)</td>
<td>5.65</td>
<td>7.15</td>
<td>9.25ᵇ</td>
<td>9.95ᵇ</td>
<td>10.70ᵇ</td>
<td>12.05ᵇ</td>
</tr>
<tr>
<td>Commercial compost (CC)</td>
<td>5.00</td>
<td>6.50</td>
<td>9.25ᵇ</td>
<td>10.40ᵇ</td>
<td>11.80ᵇ</td>
<td>13.60ᵇ</td>
</tr>
<tr>
<td>Mixture (TGS+TFS+CC)</td>
<td>5.25</td>
<td>7.00</td>
<td>10.88ᵃ</td>
<td>13.05ᵃ</td>
<td>14.95ᵃ</td>
<td>16.75ᵃ</td>
</tr>
</tbody>
</table>

Significance ns non-significant at p>0.05. Means separated by Least Significance Difference (LSD) Test at p ≤ 0.05, means within columns followed by the same letters are not significantly different.

** Highly significant at p<0.01, * significantly at p<0.05.
Table (4): Collar girth (mm) of *A. Digitata* under various growth media.

<table>
<thead>
<tr>
<th>Growth media</th>
<th>Week 2</th>
<th>Week 4</th>
<th>Week 6</th>
<th>Week 8</th>
<th>Week 10</th>
<th>Week 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top garden soil (TGS)</td>
<td>2.50a</td>
<td>2.91a</td>
<td>3.56</td>
<td>4.83b</td>
<td>6.29b</td>
<td>7.09b</td>
</tr>
<tr>
<td>Top forest soil (TFS)</td>
<td>2.34a</td>
<td>3.00a</td>
<td>3.41</td>
<td>4.98ab</td>
<td>7.09b</td>
<td>8.21b</td>
</tr>
<tr>
<td>Commercial compost (CC)</td>
<td>1.98b</td>
<td>2.87a</td>
<td>3.14</td>
<td>4.89b</td>
<td>6.71b</td>
<td>7.54b</td>
</tr>
<tr>
<td>Mixture (TGS+TFS+CC)</td>
<td>2.33a</td>
<td>3.16a</td>
<td>3.56</td>
<td>5.92a</td>
<td>8.92a</td>
<td>9.98a</td>
</tr>
</tbody>
</table>

** Significance **

LSD 0.05 0.26 ns ns 0.95 1.33 1.64

CV (%) 7.43 6.13 7.99 11.92 11.92 12.96

** Highly significant at p<0.01, * significantly at p<0.05, ns non-significant at p>0.05. Means separated by Least Significance Difference (LSD) Test at p ≤ 0.05, means within columns followed by the same letters are not significantly different.

Table (5): Total fresh and dry weights (roots + shoots) and biomass of *A. digitata* under various soil media.

<table>
<thead>
<tr>
<th>Growth media</th>
<th>Fresh weight (g)</th>
<th>Dry weight (g)</th>
<th>Biomass (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top garden soil (TGS)</td>
<td>289.08ab</td>
<td>72.88b</td>
<td>25.31b</td>
</tr>
<tr>
<td>Top forest soil (TFS)</td>
<td>223.65bc</td>
<td>68.74b</td>
<td>30.65a</td>
</tr>
<tr>
<td>Commercial compost (CC)</td>
<td>209.25c</td>
<td>60.21b</td>
<td>28.67ab</td>
</tr>
<tr>
<td>Mixture (TGS+TFS+CC)</td>
<td>340.25a</td>
<td>105.61a</td>
<td>31.06a</td>
</tr>
</tbody>
</table>

** Significance **

LSD 0.05 71.08 23.17 3.97

CV (%) 17.37 19.57 8.92

** Highly significant at p<0.01, * significantly at p<0.05. Means separated by Least Significance Difference (LSD) Test at p ≤ 0.05, means within columns followed by the same letters are not significantly different.

TFS and between the TGS+TFS+CC and TGS. Overall, maximum fresh and dry weight was observed in the TGS+TFS+CC treatment. This is not surprising because the treatment produced vigorous seedlings in terms of height and stem girth which may have contributed to the observed large weight. This could be attributed to the general improvement in the soil physical and chemical properties of the TGS+TFS+CC growth media (Table 1) which also improved the fresh and dry weight. Our results are consistent with Khayyat *et al.* (2007) and Mehmood *et al.* (2013) who observed high dry weight in seedlings of other plant species grown in silt + top soil mixed with either leaf mould or and peat moss. Parasana *et al.* (2013) also reported maximum fresh and dry weight in *Mangifera indica* L. seedlings grown in a mixture of soil+sand+farm yard manure. Maximum biomass percentage was recorded in the TGS+TFS+CC probably because the combination of the three improved the physical conditions and nutrient availability.

Conclusion and recommendations

Our results demonstrated that the TGS+TFS+CC delivered the best results with respect to all measured *A. digitata* growth parameters. Based on these results the mixture is recommended as the most suitable medium that can be used to propagate *A. digitata* seedlings. However, top garden soil could also be used by *A. digitata* growers. It is recommended that the experiment can be repeated and run for two growing seasons using bigger pots.

Acknowledgment

Mpho Bosenakitso was supported by the Ministry of Education Skills and Development undergraduate scholarship. We owe our gratitude to Botswana College of Agriculture for providing resources (tree nursery and laboratory facilities). We also thank National Tree Seed Centre, Ministry of Environment, Wildlife and Tourism for providing seeds.
References


Woolfe, M. L., Chaplind, M. F. and Otchere, G. 1977. Studies on the mucilages extracted from okra fruits (Hibiscus esculentus L.) and baobab leaves.