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Evaluation of the Effect of Different Pot Sizes and Growing Media on the Seedling Growth Morphology of Cajanus Cajan and Sesbania Sesban in Dryland Areas, Southern Parts of Ethiopia

Hayleyesus Agonafer Segaw Feyisa Seboka Tura Siraj Kelil Gobelle Desta Negeyo Komicho
Sisay Taye Gifawesen
Yabello Pastoral and Dryland Agriculture Research Center, Yabello, Ethiopia

Abstract
The experiment conducted at the site of Yabello Pastoral and Dryland Agriculture Research Center Nursery in Ethiopia aims at evaluating the effect of different pot size and nursery growing media on the growth of the 3 months seedlings of Cajanus cajan and Sesbania sesban. Six potting media of Agricultural soil, forest soil and animal manure in a ratio of 4:1:0, 2:1:0,3:2:0,1:3:0,1:5:0 and 1:1:1 respectively that were mixed in two pot sizes of 8cm and 10cm diameter of 14cm length each were all used. A complete randomize block design were used with pots as block and media as treatment on a basis of 2x6 factorial design with three replications. Physicochemical analyses were also performed to investigate the nutrients content of the different growing media. 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 were measured. It was observed that both pot size and growing media had significant effects ($P < 0.05$) on the growth and development of both seedlings species. There were also a significant ($P < 0.05$) interaction effects between pot size and growing media for both seedlings. In a smaller pot size, the growth of both Cajanus cajan and Sesbania sesban were significantly higher in a growing medium of 2:1:0 (ratio of agricultural soil, forest soil and animal manure) compared to others growing medium. However, in a large pot size, the growth of Cajanus cajan was relatively better in the growing media of 1:1:1 than others growing media. In the same pot size type, the growth of Sesbania sesban was also relatively better in a growing medium of 1:5:0 compared to others growing medium. Further studies should be directed towards assessing the effect of different substrates of high nutrients on pot size along with a study on seedling survival after transplanting. This has to do with the fact that the nutrients found in forest soil of Yabello district were very small.
Keywords: Cajanus cajan, growing medium, Nursery, pot size, Sesbania sesban, Substrate

Introduction

Pigeon pea (Cajanus cajan L. Millsp.) is one of the important protein yielding grain legume crop among the smallholder poor farmers in Africa including Ethiopia The genus Cajanus is a member of the plant family Fabaceae. Pigeon pea is one of the most drought-tolerant legumes that improve long-term soil quality and fertility when used as green manure, cover crop or alley crop (). Pigeon pea also used as fodder and feed for livestock with high biomass productivity and most nutrient and moisture contributions to the soil (Odeny DA, 2007). Sesbania sesban is a leguminous shrub widely used for agroforestry in several rural development and energy projects in Eastern Africa. It is a member of the plant family Fabaceae The rainfall range of Sesbania sesban is from 500-2,000 mm which can be grown in moisture stress area. It tolerates both saline and alkaline soil conditions. Sesbania sesban has shown particular promise in Ethiopia to altitudes of 2,000 m (Anon. 1987a). It is also a useful browse species in Kenya. Sesbania sesban is a nitrogen fixing tree that can be used for green manure and mulch, or in a short term rotation fallow to improve soil fertility and in alley cropping (Yamoah CF et al., 1990)

Physiological experiments are often being conducted in controlled environments where plants are grown in open rooted also called bare stock or in containers of limited volume (West, 2006). Elsewhere, the effects of growing media 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 are well documented.

Container grown material has become favored potting material over bare root seedlings in many cases for restoration projects (Greer & Diver, 2000) for many reasons: i) greater chance for survival and establishment after transplanting; and ii) lack of good soil requirement and limited soil needed for seedling growth (Greer & Diver 2000; Das, 1992), iii) easy transport and storage during staging iv) planting possibility during any time of the year (Tinus & Owston, 1984; Lambert et al., 2010), and v) opportunity to plant whenever the ground is not frozen and soil moisture is adequate.

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 (Das, 1992). 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 (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 on (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 to the plants to survive after transplanting into in the field. This might also be true in the case of dry land areas of east Africa.

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 (Mulugeta, 2014; Kung'u et al., 2008) The ratio of soil to sand and compost vary from place to place and from species to species. For example the ratio of soil to sand and compost that has been usually used in Eritrea in recent years is 7:1:1. 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 well-recognized problem with regards 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 Cajanus cajan and Sesbania sesban along with the lack of locally standardized growing media for the production of high quality seedlings.. Therefore, the current research aims at investigating the effect of container size and appropriate growing media on the growth of the 3 months seedlings of Cajanus cajan and Sesbania sesban in dryland areas, Ethiopia. It has been hypothesized that growth and morphological attributes of both seedlings would vary among the containers and the different growing media and that a given medium would enhance morphological attributes compared to others at Yabello Pastoral and Dryland Agriculture Research Center Nursery site in Ethiopia.

Material and methods

Description of the Study Area

Borana rangeland found in the Southern parts of Ethiopia is located approximately between 4˚3′N37˚4′E and 5˚ N 38˚2′E with a total area of about 95,000km². The landscape is slightly undulated with altitude ranges in from 1000 to 1500m.a.s.l and pick at 2000m.a.s.l (Coppock, 1994). Borana zone is characterized by erratic rainfall with most areas receiving between 238 mm and 896 mm annually and a high coefficient of rainfall variability falling between 18% and 69% (Angassa & Oba, 2007). The rainfall patterns of the zone is distinctly bimodal with 59 % of annual precipitation occurring from March to May and 27% between September and November (Coppock, 1994)

Growing media preparation

In terms of growing media, forest soil was collected from the nearby Junipers procera plantation which is about 5km away from the nursery site. The different growing media that were collected includes the agriculture soil, forest soil and animal manure of 6 months old from farmyard, and potting mixtures that were crushed and sieved. The potting mixtures were sieved in a 2mm mesh wire prior it was mixed and the following ratios were used as a treatment (Table 1). The agricultural soil was collected from the nearby agricultural field.

Table 1 Treatments of Soil mix ratio used for experimentations

Mixing ratio	Agricultural Soil	Forest Soil	Animal Manure
R1	4	1	0
R2	2	1	0
R3	3	2	0
R4	1	3	0
R5	1	5	0
R6	1	1	1

The soils that were used for the treatments were analyzed for its physico-chemical properties at Zuway soil laboratory.

Seedling production

The tree seeds of Cajanus cajan and Sesbania sesban were purchased from the National Tree Seed Project of Forestry Research Center, Addis Ababa, Ethiopia. The seedlings of the experimental tree species raised in polythene tubes without treating it with fungicide at Yabello Pastoral and Dryland Agriculture Research Center's nursery site. The plants were grown in an open compound and the tree seeds were sowed and measurements were made after 3 months of growth in the nursery. All pots were watered on daily basis using overhead sprinkler irrigation system. The tree seedlings were uprooted and its root and shoot was measured using plastic ruler. The seedling diameters at the base were measured using digital caliper. the seedlings were oven dried at a temperature of 750C until constant weight obtained

Experimental design and treatments

In this study, two types of pot sizes and six different growing media (soil mix ratios) were used to determine optimum nursery soils and pot size that contribute to a better 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.

In total, 12 treatment combinations were arranged in a randomized complete block design with three replications for six growing media and two container sizes. The total number of seedlings for each container type was 60 and the total number of seedlings used for each species was 120. The pot sizes were 8cm and 10cm in diameter and 14 cm length.

Data collection and analysis

Data on seedling growth and development parameters as well as physiochemical analyses were recorded. In total for each species 120 seedlings were up rooted destructively and weighted before and after being oven dried. The whole parameters have been taken on average basis on all uprooted seedlings while considering the number of trees in the experimental plot. In addition, chemical and physical analysis of samples of seedling of both plants were analyzed for available C, N, K Na, Ca, Mg as well as pH, and the soil used as part of the medium mixtures were also analyzed for texture and organic matter content.

The collected data were statistically analyzed by using analysis of variance (Two way ANOVA) to check any differences between the means seedling growth and development parameters and pot size and the type of growing media. The effects of pot size and mixing ratio on number of leaves, plant height, root collar diameter, root length, fresh shoot weight, fresh root weight and root to shoot ratio were performed through SPSS software version 20. Data were then subjected to SPSS univariate analysis of variance for each parameter and Duncan multiple range tests was used to test significant differences. The data were checked for the assumption of normality (Shapiro-Wilk) test and homogeneity of variance (Levene's test). All data are represented as mean ± standard error. Values are reported as significantly different if $p \leq 0.05$.

Result and discussion

Potting substrate analysis

Prior to potting determination the forest and agricultural soil was analyzed for selected parameters (Table 2). The result revealed that the both agricultural soil and forest soil substrate has a slightly acidic pH which seems to be best to promote the availability of plant nutrients for the growing medium (Brady and Weil, 2010).

Table 2. Mean value of physico-chemical properties of agricultural and forest soil taken from the top surface (0-30 cm).

parameters	Agricultural soil	forest soil
% sand	65.8±1.2	53.8±1.02
% silt	13.2±1.96	27.6±1.17
% clay	21±2.76	18.6±0.75
Textural class	Sandy clay loam	Sandy loam
EC(mmhos/cm at 25^{0}C)	0.04±0.01	0.1±0.01
pH	6.47±0.18	6.98±0.02
Total Carbon (%)	1.67±0.41	1.51±0.07
Total Nitrogen (%)	0.09±0.03	0.1±0.02
C:N ratio	23.22± 6.02	16.91± 3.50
Ca (meq/100m soil)	16.5±0.96	18.3±0.93
Mg (meq/100m soil)	9.35±1.05	9.3±1.11
Av.K(ppm)	67.5±25.46	329.3±18.98
Av. P(ppm)	5.3±1.9	7.31±3.31
Exch.Na (ppm)	0.11±0.01	0.05±0.01
Exch.K (ppm)	0.19±0.05	1.06±0.03

Effects of pot size on Cajanus cajan and Sesbania sesban plant species

The result revealed that smaller pot size had significantly higher fresh shoot weight ($p=0.025$) while large pot size had significantly higher root to shoot ratio ($p=0.03$) for Cajanus cajan. However, bigger pot size (10cm) had significantly higher root length, fresh root weight, root dry matter and root to shoot ratio as compared to smaller (8cm) pot size for Sesbania sesban ($p=0.012$,0.021,0.016 and 0.035 respectively) (Table 3). A similar study by Barbara et al., (2015) and Vaknin et al (2009) shown that seedlings grown in larger containers generally grew more and produced the largest seedlings. Plant size can influence out planting performance. Balanced bigger seedlings are frequently more successful especially in semi-arid environments (Villar-Salvadoret al. 2010). The higher root-to-shoot ratio and root weight tend to survive better, as relatively large root system supply the water requirements of their relatively small shoot (West, 2006) and it is considered a desirable trait in dryland areas (Villar-Salvadoret

al., 2010), as relatively large root system supply the water requirements of their small shoot (West, 2006). The effect of pot sizes on seedling growth depend on the species type to be grown(Yadessa &bekere, 2001; Yadessa, et al., 2001).

Table 3. Mean growth values of Cajanus cajan and Sesbania sesban seedlings influenced by pot size at the end of three months nursery life span

category	No. leaves	CRD (mm)	Height (cm)	Root length (cm)	Fresh shoot weight(g)	Fresh root weight (g)	shoot DM (g)	Root DM (g)	Root / Shoot ratio
Pot size for Cajanus									
8cm	15.10±0.34ns	4.29±0.06ns	63.73±0.80 ns	17.28±0.30 ns	16.16±0.44^{a}	3.24±0.11 ns	3.92±0.13 ns	0.83±0.03 ns	0.23±0.01^{b}
10cm	15.28±0.34ns	4.39±0.06ns	65.72±0.80 ns	16.82±0.30 ns	14.74±0.44^{b}	3.12±0.11 ns	3.85±0.13 ns	0.862±0.03ns	0.25±0.01^{a}
Pot size for Sesbania									
8cm	18.88±0.46ns	4.2±0.11 ns	52.67±0.86 ns	17.27±0.42^{b}	11.63±0.41 ns	5.31±0.26^{b}	3±0.12 ns	1.64±0.07^{b}	0.61±0.03^{b}
10cm	19.77±0.46ns	4.05±0.11 ns	53.57±0.86 ns	18.8±0.42^{a}	11.12±0.41 ns	6.17±0.26^{a}	2.89±0.12 ns	1.89±0.07^{a}	0.7±0.03^{a}

Note CRD= root collar diameter, DM= Dry matter

Effects of growing media on Cajanus cajan and Sesbania sesban plant species

The potting mixture had significant effect on Cajanus seedling morphology except root length (p=0.386) and on Sesbania seedling except root length (p=0.528) and root to shoot ratio (p=0.057) .The mixing ratio of 2:1:0 and 1:1:1 had significantly higher growth and weight parameters followed by mixing ratio of 1:5:0 and 3:2:0. However, the mixing ratio of 1:3:0 were the least with regard to growth and weight measurements of Cajanus while the mixing ratio of 2:1:0 had significantly higher growth and weight parameters followed by mixing ratio of 3:2:0 and 1:1:1 respectively on Sesbania seedling (Table 4). This result indicated that nursery seedling growing medium has a profound effect on the quality of seedling to be produced.

Many previous works found the effect of growing media on the quality of seedling growth and weight (Ibironke, 2016; Jeonget al., 010; Ugese, 2010). The better seedling performance in the potting media of 1:1:1 and 2:1:1 could be due the balanced additional nutrient supplement from the animal manure and forest soil. Nutrient availability is one of the main environmental factors affecting seedling growth Using organic fertilizer enhanced biomass production of loblolly pine (Pinus taeda L.) which increased its foliage mass (Gough et al., 2004). Similarly Red and black pine seedlings growing with fertilization had greater dry mass than those growing in without fertilization. In addition, fertilization may have a direct effect on both photosynthetic capacity and biomass allocation, which result in greater foliage mass and enhance growth (Gough et al., 2004).

Table 4. Mean growth values of Cajanus cajan and Sesbania sesban seedlings influenced by growing media at the end of three months nursery life span

Category	No. leaves	CRD (mm)	Height (cm)	Root length (cm)	Fresh shoot weight(g)	Fresh root weight (g)	shoot DM (g)	Root DM (g)	Root / Shoot ratio
Growing media for *Cajanus cajan*									
4:1:0	13.95±0.59^{d}	4.11±0.10^{b}	61.65±1.39^{c}	17.50±0.52 ns	14.33±0.76^{b}	3.07±0.18^{bc}	3.57±0.23^{bc}	0.72±0.05^{cd}	0.23±0.01^{bc}
2:1:0	18.15±0.59^{a}	4.45±0.10^{ab}	73.55±1.39^{a}	17.25±0.52 ns	19.49±0.76^{a}	3.08±0.18^{bc}	4.83±0.23^{a}	0.90±0.05^{ab}	0.20±0.01^{c}
3:2:0	14.05±0.59^{cd}	4.24±0.10^{bc}	57.70±1.39^{d}	17.40±0.52 ns	13.63±0.76^{b}	3.46±0.18^{ab}	3.47±0.23^{c}	1.01±0.05^{a}	0.31±0.01^{a}
1:3:0	13.30±0.59^{d}	3.80±0.10^{d}	54.15±1.39^{d}	16.30±0.52 ns	10.32±0.76^{c}	2.65±0.18^{c}	2.64±0.23^{d}	0.62±0.05^{d}	0.25±0.01^{b}
1:5:0	15.70±0.59^{bc}	4.70±0.10^{a}	72.85±1.39^{a}	16.45±0.52 ns	17.57±0.76^{a}	2.99±0.18^{bc}	4.18±0.23^{ab}	0.78±0.05^{bc}	0.21±0.01^{bc}
1:1:1	16.00±0.59^{b}	4.75±0.10^{a}	68.45±1.39^{b}	17.40±0.52 ns	17.35±0.76^{a}	3.85±0.18^{a}	4.64±0.23^{a}	1.03±0.05^{a}	0.24±0.01^{bc}
Growing media for *Sesbania sesban*									
4:1:0	16.25±0.8^{d}	3.9±0.19^{bc}	48.75±1.48^{c}	16.95±0.73ns	9.09±0.72^{c}	5.16±0.45^{c}	2.46±0.21^{bc}	1.71±0.12^{bc}	0.72±0.05^{bc}
2:1:0	20.35±0.8^{ab}	4.45±0.19^{ab}	59.1±1.48^{a}	18.50±0.73 ns	13.68±0.72^{a}	6.84±0.45^{a}	3.59±0.21^{a}	2.29±0.12^{a}	0.68±0.05^{bc}
3:2:0	22.3±0.8^{a}	4.8±0.19^{a}	52±1.48^{c}	18.25±0.73 ns	13.3±0.72^{a}	7.07±0.45^{a}	3.66±0.21^{a}	2.03±0.12^{ab}	0.63±0.05^{bc}
1:3:0	19.15±0.8^{bc}	3.9±0.19^{bc}	49.65±1.48^{c}	17.5±0.73 ns	9.48±0.72^{c}	5.41±0.45^{c}	2.34±0.21^{c}	1.37±0.12^{c}	0.76±0.05^{a}
1:5:0	17.3±0.8^{cd}	3.5±0.19^{c}	56.4±1.48^{ab}	18.7±0.73 ns	10.34±0.72^{bc}	4.38±0.45^{c}	2.62±0.21^{bc}	1.52±0.12^{c}	0.56±0.05^{c}
1:1:1	20.6±0.8^{ab}	4.2±0.19^{b}	52.8±1.48^{bc}	18.3±0.73 ns	12.35±0.72^{ab}	5.62±0.45^{bc}	3±0.21^{b}	1.68±0.12^{bc}	0.58±0.05^{bc}

Note CRD= root collar diameter, DM= Dry matter

Interaction effect of pot size and growing media on Cajanus cajan and Sesbania sesban plant species;

The current study showed a significant interaction effect among the dependent variables except root length in both species. In smaller pot size of both Cajanus cajan and Sesbania sesban higher seedling morphology were recorded at the mixing ratio of 2:1:0 and at a ratio of 2:1:0 and 3:2:0 respectively. However, in larger pot sizes a mixing ratio of 1:1:1 and 1:5:0 gave the highest growth parameters in Cajanus cajan and Sesbania sesban respectively (Table 5).

Similarly Yadessa& Bekere (2001) found higher shoot and root dry weight in larger pots of 10cm than in

smaller pot of 8cm for Leucaena pallida. Besides pot size, Mulugeta (2014) found higher growth performance of the seedlings when the 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. The application of animal manure or organic manure in a substrate might provide nutrient and also improve the physicochemical properties of the substrate. Mustafa et al. in 2016 also recorded the highest germination in treatments containing composts. Similarly, Gebre (2007) observed the best shoot size in lowland nurseries with the highest content (30%) of animal manure. The highest growth parameters in 10cm pot size could be due to the presence of high forest soil in the growing medium

Table 5. Mean growth values of interaction effect between pot size and growing media on Cajanus cajan and Sesbania sesban seedlings at the end of three months nursery life span

category	No. leaves	CRD (mm)	Height (cm)	Root length (cm)	Fresh shoot weight(g)	Fresh root weight (g)	shoot DM (g)	Root DM (g)	Root / Shoot ratio
Pot size and growing medium for *Cajanus cajan*									
8cm									
4:1:0	14.70±0.83^{ab}	4.23±0.15^{a}	66.30±1.96^{a}	18.30±0.73^{a}	17.81±1.08^{ab}	3.36±0.26^{ab}	4.39±0.32^{a}	0.69±0.07^{bc}	0.16±0.02^{b}
2:1:0	17.50±0.83^{a}	4.50±0.15^{a}	73.30±1.96^{a}	17.40±0.73^{a}	20.25±1.08^{a}	3.25±0.26^{ab}	4.83±0.32^{a}	1.02±0.07^{a}	0.24±0.02^{a}
3:2:0	15.40±0.83^{a}	4.42±0.15^{a}	56.30±1.96^{b}	18.50±0.73^{a}	14.99±1.08^{b}	4.01±0.26^{a}	4.11±0.32^{a}	1.05±0.07^{a}	0.27±0.02^{a}
1:3:0	11.80±0.83^{b}	3.30±0.15^{b}	53.80±1.96^{b}	16.50±0.73^{a}	9.19±1.08^{c}	2.12±0.26^{b}	2.28±0.32^{b}	0.47±0.07^{c}	0.22±0.02^{ab}
1:5:0	16.80±0.83^{a}	4.51±0.15^{a}	73.60±1.96^{a}	16.40±0.73^{a}	18.68±1.08^{ab}	3.19±0.26^{ab}	4.21±0.32^{a}	0.82±0.07^{ab}	0.22±0.02^{ab}
1:1:1	14.40±0.83^{ab}	4.77±0.15^{a}	59.10±1.96^{b}	16.60±0.73^{a}	16.01±1.08^{ab}	3.49±0.26^{a}	3.68±0.32^{a}	0.9±0.07^{ab}	0.25±0.02^{a}
10cm									
4:1:0	13.20±0.83^{b}	4.00±0.15^{c}	57.00±1.96^{b}	16.7±0.73ns	10.84±1.08^{c}	2.78±0.26^{b}	2.74±0.32^{d}	0.75±0.07^{b}	0.29±0.02^{a}
2:1:0	18.80±0.83^{a}	4.40±0.15^{ab}	73.80±1.96^{a}	17.1±0.73ns	18.72±1.08^{a}	2.9±0.26^{b}	4.82±0.32^{ab}	0.78±0.07^{b}	0.16±0.02^{b}
3:2:0	12.70±0.83^{b}	4.06±0.15^{bc}	59.10±1.96^{b}	16.3±0.73ns	12.27±1.08^{bc}	2.9±0.26^{b}	2.83±0.32^{d}	0.96±0.07^{ab}	0.35±0.02^{a}
1:3:0	14.80±0.83^{ab}	4.29±0.15^{b}	54.50±1.96^{b}	16.1±0.73ns	11.45±1.08^{c}	3.17±0.26^{b}	2.99±0.32^{cd}	0.77±0.07^{b}	0.28±0.02^{a}
1:5:0	14.60±0.83^{ab}	4.89±0.15^{a}	72.10±1.96^{a}	16.5±0.73ns	16.46±1.08^{ab}	2.79±0.26^{b}	4.14±0.32^{bc}	0.75±0.07^{b}	0.2±0.02^{b}
1:1:1	17.60±0.83^{a}	4.72±0.15^{a}	77.80±1.96^{a}	18.2±0.73ns	18.69±1.08^{a}	4.2±0.26^{a}	5.59±0.32^{a}	1.16±0.07^{a}	0.23±0.02^{b}
Pot size and growing medium for *Sesbania sesban*									
8cm									
4:1:0	16±1.14^{bc}	3.9±0.27^{bc}	47.2±2.1^{bc}	15.9±1.04^{a}	8.19±1.01^{b}	4.24±0.64^{b}	2.37±0.29^{bc}	1.42±0.17^{b}	0.61±0.07^{b}
2:1:0	21.8±1.14^{a}	5.4±0.27^{a}	64.2±2.1^{a}	17.4±1.04^{a}	18.32±1.01^{a}	8.56±0.64^{a}	4.66±0.29^{a}	2.72±0.17^{a}	0.6±0.07^{b}
3:2:0	24.2±1.14^{a}	5.8±0.27^{a}	58.4±2.1^{ab}	19.6±1.04^{a}	17.55±1.01^{a}	7.45±0.64^{a}	4.59±0.29^{a}	2.15±0.17^{a}	0.49±0.07^{b}
1:3:0	15.2±1.14^{c}	2.9±0.27^{c}	41.9±2.1^{c}	15.3±1.04^{a}	6.25±1.01^{c}	4.64±0.64^{b}	1.49±0.29^{c}	1.36±0.17^{bc}	1.05±0.07^{a}
1:5:0	15.8±1.14^{c}	3±0.27^{c}	52.5±2.1^{b}	16.4±1.04^{a}	7.79±1.01^{c}	2.61±0.64^{c}	1.85±0.29^{c}	0.9±0.17^{c}	0.47±0.07^{b}
1:1:1	20.3±1.14^{ab}	4.2±0.27^{b}	51.8±2.1^{bc}	19±1.04s^{a}	11.67±1.01^{b}	4.38±0.64^{b}	3.01±0.29^{b}	1.31±0.17^{bc}	0.44±0.07^{b}
10cm									
4:1:0	16.5±1.14^{b}	3.9±0.27^{ab}	50.3±2.1^{b}	18±1.04^{a}	9.99±1.01^{a}	6.08±0.64^{a}	2.54±0.29^{a}	2±0.17^{ab}	0.83±0.07^{a}
2:1:0	18.9±1.14^{ab}	3.5±0.27^{b}	54±2.10^{b}	19.6±1.04^{a}	9.04±1.01^{a}	5.11±0.64^{a}	2.51±0.29^{a}	1.85±0.17^{ab}	0.76±0.07^{a}
3:2:0	20.4±1.14^{ab}	3.8±0.27^{ab}	45.6±2.1^{b}	16.9±1.04^{a}	9.05±1.01^{a}	6.68±0.64^{a}	2.72±0.29^{a}	1.91±0.17^{ab}	0.76±0.07^{a}
1:3:0	23.1±1.14^{a}	4.9±0.27^{a}	57.4±2.1^{a}	19.7±1.04^{a}	12.71±1.01^{a}	6.17±0.64^{a}	3.19±0.29^{a}	1.38±0.17^{b}	0.46±0.07^{b}
1:5:0	18.8±1.14^{ab}	4±0.27^{ab}	60.3±2.1^{a}	21±1.04^{a}	12.89±1.01^{a}	6.14±0.64^{a}	3.39±0.29^{a}	2.14±0.17^{a}	0.66±0.07^{ab}
1:1:1	20.9±1.14^{ab}	4.2±0.27^{ab}	53.8±2.1^{b}	17.6±1.04^{a}	13.02±1.01^{a}	6.86±0.64^{a}	2.98±0.29^{a}	2.04±0.17^{a}	0.72±0.07^{ab}

Conclusion and Recommendation

From the above results it can be concluded that both pot size and growing media had a significant effect on morphological parameters of Cajanus cajan and Sesbania sesban seedling. Besides, the result depicted a significant interaction effect between pot size and growing media. In the case of Cajanus cajan seedlings grown in the smaller pot size and large pot size were comparable with respect to many parameters. However since the study area has shortage of rainfall using 10cm pot size would be advantageous. In the case of Sesbania sesban the larger pot size had significantly higher root length, fresh root weight root dry matter and root to shoot ratio. Therefore, using larger pot size is preferable compared to the smaller one.

With respect to mixing ratio for both Cajanus cajan and Sesbania sesban, using 2:1:0 ratio gave better results. However, the mixing ratios of 2:1:0 followed by 3:2:0 for pot size of 8 cm and a ratio of 1:1:1 for pot size 10cm are found to be appropriate to grow seedling of Sesbania sesban. The study results also showed that there were a significant interaction effect between pot size and mixing ratio. Thus, the growth parameters in smaller pot size were enhanced when the mixing ratio was 2:1:0 for both Cajanus cajan and Sesbania sesban. However, in larger pot size for Cajanus cajan , the growing medium of 1:1:1 gave the highest growth parameters. In the same larger pot, the growing medium of 1:5:0 might be appropriate to raise seedlings specie of Sesbania sesban in the nursery in the case of Yabello district.

Since seedling growths and development parameters of Cajanus cajan and Sesbania sesban were affected by growing medium and pot size therefore further researches should be directed towards assessing the effect of different substrates of high nutrients on pot size along with a study on seedling survival after transplanting. This has to do with the fact that the nutrients found in forest soil of Yabello district were very small.

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