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Evaluating the Growth Response of *Cassia abbreviata* oliv. Seedlings to Growing Mediain Botswana

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Abstract

A pot experiment was conducted at the Botswana College of Agriculture nursery to investigate effects of growing media on the growth of Cassia abbreviata. A completely randomized design (CRD) with four treatments: top garden soil, top forest soil, commercial compost and a mixture of top garden soil, top forest soil, commercial compost at a 1:1:1 (v/v) ratio replicated four times was used. The results showed that top garden soil significantly ($p<0.01$) increases plant growth in terms of plant height. Moreover, no significant ($p>0.05$) effects were observed for leaf number, leaf area, collar girth, green and dry weight as influenced by growth media. The results show that top garden soil is a good medium for raising C. abbreviata seedlings.

Keywords: Cassia abbreviate, completely randomized design, top garden soil, top forest soil, commercial compost.

Introduction

Cassia abbreviata is leguminous tree which belongs to Caesalpinioideae[1,2,3]. It is a small tree that grows to a height of 3−10 m in height[2,3] and may rarely reach a height of 15 metres[2]. *Cassia abbreviata* is widespread from Somalia to South Africa at altitude 220−1520 m above sea level[2,4]. The tree grows well in open woodland and wooded grassland, sometimes on river banks[1,3], hillsides and frequently on termite mounds[2,3]. *Cassia abbreviata* has a straight trunk with rough grey brown, fissured flaking bark[5,6]. Leaves are evenly compound with a pair of 5−12 leaflets per leaf[7]. Flowers are pea-like, yellow in colour and appear at the same time with leaves[6]. Fruits are up to 80cm long, thin and cylindrical in shape[7]. Pods ripen nearly a year after flower development[2,5,8]. They release seeds once they are mature but remain on the tree for a long time[7]. The wood is fairly heavy, hard and course in texture[9, 10].

They are numerous economic benefits derived from this plant tree species. The wood is used for firewood and timber[2], while the bark and roots are used in traditional medicine to treat different ailments[2-4,8,11-13]. Young branches and leaves provide fodder to wildlife[14], while pods are eaten by baboons and monkey[3]. Seeds are eaten by birds[7]. Reports on the cultivation of this important multipurpose indigenous tree species are scarce. The digging of roots and the cutting of the bark for medicinal purposes has reduced the population of *C. abbreviata* in the wild such that the sustainability of this resource cannot be guaranteed[7]. If the benefits derive from the plant are to continue, there is need to stimulate farmer's interest in the cultivation and domestication of *C. abbreviata* as a way of reducing pressure on trees growing in the wild. Therefore, there is need to acquit farmers with the most successful growing media or potting soil that could enhance the growth of *C. abbreviata* seedlings. The composition of potting mixtures is among factors affecting the growth seedlings in the nursery[15]. This study was conducted to investigate the growth response of *C. abbreviata* to different growing media in order to recommend the best growing media to tree growers in Botswana, especially at the nursery stage.

Material and Methods

Study area: The study was carried out from December 2012 to March 2013 at the Botswana College of Agriculture (BCA) tree nursery, which is located at Sebele Content Farm (24° 33'S and 25° 54'E). Sebele is located10 km north of centre of Gaborone, the capital City of Botswana, along the A1 highway and lies at altitude of 994 m above sea level. The study area is characterized by sandy loam soil. Seeds for propagating seedlings were obtained from Botswana National Tree Seed Centre, Department of Forestry and Range Resources, Ministry of Environment, Wildlife and Tourism, Gaborone.

Seedling germination: Seeds were germinated in a seedbed measuring 2m×5 m filled with a layer of sand and compost (leaf mold). Seeds were soaked in warm water overnight before drill sowing one seed per hole. The seedbed was watered twice a day when required. After germination and development of true leaves, seedlings were transplanted into black polyethylene pots containing different soil mixtures (inside diameter 25, height 15cm).

Experimental design: The experiment was laid out in a completely randomized design (CRD) with four treatments (growing media) replicated four times. The four treatments were as follows: i. top garden soil (TGS), ii. commercial compost (CC), iii. top forest soil (TFS), and iv. mixture of TGS+CC+TFS (1:1:1). There were 10 polythene pots per

replicate which were randomly located in the nursery (figure 1), giving a total of one hundred and sixty (160) pots. The experiment was conducted under a 60% green net-shade to minimize loss of water due to heat. 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. Cypermethrin Sipermetrin was sprayed once at 5mL/5L to control an identified insect which was observed feeding on the leaves of *Cassia abbreviata* seedlings. No fertilizer was supplied to the seedlings.

Growth parameters: Growth parameters measured included plant height (cm), number of leaves, leaf area (cm^2), collar diameter (cm), fresh and dry weights. The parameters were monitored for 12 weeks after transplanting (WAT). Measurements were taken forth nightly after transplanting except for fresh and dry weights which were taken at the end of the study. Plant height was measured using a meter ruler from the soil level to the terminal bud. The number of leaves was measured quantitatively by counting. For leaf area, the terminal leaf was measured by tracing the leaf on a grid paper with squares each measuring 1 cm by 1 cm. The collar girth 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 fresh and dry weights at week 12, 5 seedlings per replicate were used. The average was 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 to measure the fresh weight using an electric balance (PGW 4502e). The same samples were oven dried to constant weight at 80^{o}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 $p \leq 0.05$ to separate treatment means.

Results and Discussion

Plant Height: Table 1 shows that *Cassia abbreviata* seedlings grown in top garden soil recorded plant height values significantly ($p<0.01$) higher than other potting mixtures throughout the duration of the study. Seedlings grown in top garden soil attained a mean height of 14.4 cm, 12 weeks after transplanting. This result is supported by findings of studies conducted elsewhere using different tree species which reported significantly higher plant height in seedlings grown in top garden soil compared to other soil mixtures[16,17]. Although physical and chemical analysis of the soil mixtures were not carried out in the present study, the results probably suggest that top garden soil contained both macro and micro nutrients required by plants for their normal growth and developmental activities. No significant ($p>0.05$) differences were observed in plant height between seedlings grown in top forest soils, commercial compost and a mixture of TGS+CC+TFS, respectively.

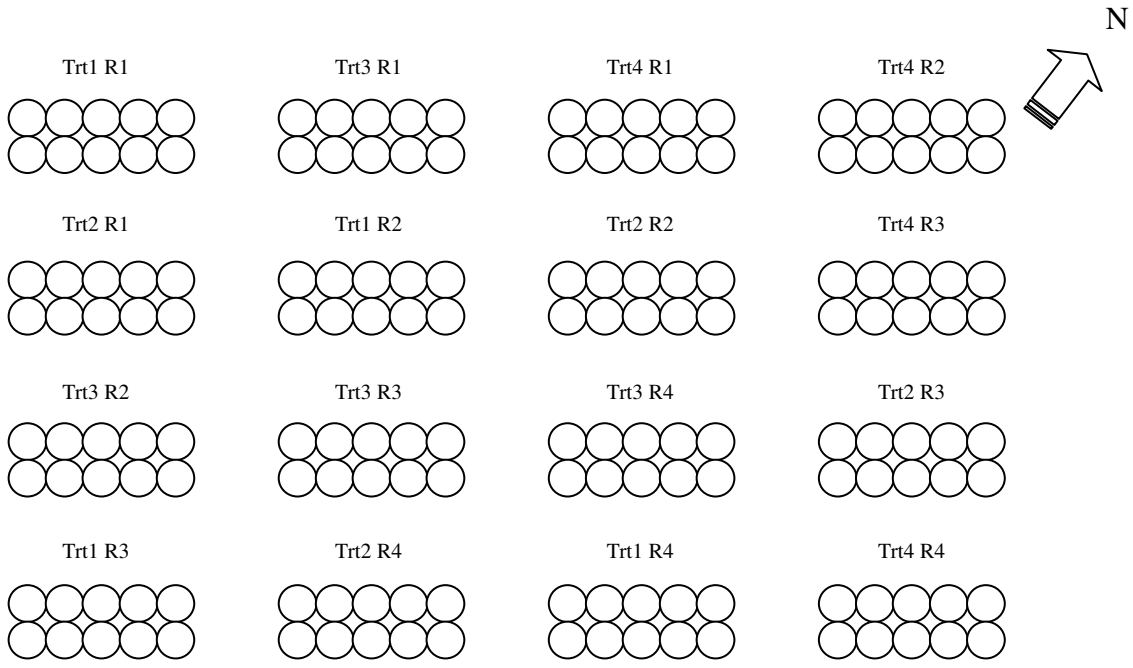

Figure-1
The experimental design

Leaf number and areas: Table 2 shows that there was no significant ($p>0.05$) effect of growing media on the number of leaves across the treatments for the entire study period. However, the number of leaves were significantly ($p<0.05$) increased by top garden soil and commercial compost 8 weeks after transplanting. Low numbers of leaves (but not statistical different across the treatments) were recorded in the mixture of TGS+CC+TFS throughout the study. Leaf area is an important parameter in many agronomical and ecological processes, including photosynthesis, transpiration and field energy balance[18]. It is also an important parameter for modeling tree growth and physiological processes of trees[19]. Results of the present study show that none of the growth media significantly ($p>0.05$) influenced the leaf area in *C. abbreviata* seedlings (table 3). However, seedlings in the top forest soil were slightly superior in terms of leaf area when compared to other soil types. The observed non-significant effect of treatment on leaf number and leaf area in the present study probably suggests that the two growth parameters are not influenced by growth media at seedling stage.

Collar girth and fresh and dry weight: There was no significant ($p>0.05$) difference on the effect of soil type on the collar girth/diameter 2 to 10th weeks after transplanting (table 4). However, TGS and TFS produced seedlings which had as lightly higher collar girth than other treatments**.** This is in agreement with[20] who observed no significant difference on the effect of soil type on the collar girth/diameter within 6 to 10th weeks after planting. Moreover, the fresh and dry weight of C. *abbreviate* determined 12weeks after transplanting were not influenced by growing media (table 5).

Table-1
Mean plant height of *C. abbreviata* as influenced by growing media

Treatments	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12
Top garden soil (TGS)	13.3^{a}	13.7^{a}	13.9^{a}	14.1^{a}	14.3^{a}	14.4^{a}
Compost (CC)	11.1^{b}	11.4^{b}	11.7^{b}	11.9^{b}	11.9^{b}	11.9^{b}
Top forest soil (TFS)	10.9^{b}	11.3^{b}	11.5^{b}	11.6^{b}	11.7^{b}	11.7^{b}
Mixture (TGS+CC+TFS)	10.2^{b}	10.7^{b}	11.0^{b}	11.3^{b}	11.3^{b}	11.4^{b}
Significance	**	**	**	**	**	**
LSD 0.05	1.52	1.10	1.10	1.13	1.15	1.09
CV (%)	8.68	6.05	5.95	6.03	6.12	5.80

** Highly significant at $p<0.01$. Means separated by Least Significance Difference (LSD) Test at $p\leq0.05$, means within columns followed by the same letters are not significantly different.

Table-2
Mean leaf number of *C. abbreviata* as influenced by growing media

Treatments	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12
Top garden soil(TGS)	6.3	7.1	7.2	7.4^{a}	7.6	7.6
Compost(CC)	6.3	7.2	7.5	7.7^{a}	8.0	8.1
Top forest soil(TFS)	6.0	6.3	6.5	6.7^{ab}	6.8	6.8
Mixture (TGS+CC+TFS)	5.4	6.0	6.3	6.2^{b}	6.5	6.5
Significance	ns	ns	ns	*	ns	ns
LSD 0.05	ns	ns	ns	1.14	ns	ns
CV (%)	10.53	9.79	11.38	10.65	12.91	12.71

* Significant at $p<0.05$, ^{ns} non-significant at $p>0.05$. Means separated by Least Significance Difference (LSD) Test at $p\leq0.05$, means within columns followed by the same letters are not significantly different.

Table-3
Mean leaf area of *C. abbreviata* as influenced by growing media

Treatments	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12
Top garden soil(TGS)	13.3	13.4	13.6	13.7	13.8	13.9
Compost(CC)	15.9	16.0	16.2	16.3	16.4	16.5
Top forest soil(TFS)	18.8	19.0	19.1	19.2	19.3	19.4
Mixture (TGS+CC+TFS)	15.3	15.4	15.5	15.6	15.8	15.8
Significance	ns	ns	ns	ns	ns	ns
LSD 0.05	ns	ns	ns	ns	ns	ns
CV (%)	22.65	22.25	34.89	22.17	21.80	21.89

^{ns} non-significant at $p>0.05$.

Table-4
Mean collar girth (mm) of*C. abbreviata* as influenced by the growing media

Treatments	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12
Top garden soil(TGS)	1.6	1.6	1.7	1.8	1.8	1.9
Compost(CC)	1.4	1.5	1.6	1.7	1.7	1.8
Top forest soil(TFS)	1.5	1.6	1.7	1.8	1.8	1.9
Mixture (TGS+CC+TFS)	1.5	1.6	1.6	1.7	1.7	1.8
Significance	ns	ns	ns	ns	ns	ns
LSD 0.05	ns	ns	ns	ns	ns	ns
CV (%)	13.93	13.68	13.58	13.72	12.70	12.17

[ns] non-significant at p>0.05.

Table 5 Mean fresh and dry weightof *C. abbreviata* as influenced by growing the media

Treatments	**Fresh weight (g)**	**Dry weight (g)**
Top garden soil (TGS)	19.7	11.7
Compost(CC)	22.8	11.0
Top forest soil(TFS)	15.6	8.9
Mixture (TGS+CC+TFS)	20.2	10.7
Significance	ns	ns
LSD 0.05	ns	ns
CV (%)	37.17	40.45

[ns] non-significant at p>0.05.

Conclusion

The results of this study showed that most of *C. abbreviata*growth parameters were not influenced by growth media. Plant height was the only parameter which was significantly increased by top garden soil. Since selection of seedlings for planting programmes is normally based on their height and robustness one can suggest that tree growers use top garden soil for propagating *C. abbreviata*.

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