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Effect of Different Growing Media on Germination and Growth of Avocado (*Persea americana* Mill.) Nursery Plants

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ABSTRACT

Avocado (*Persea americana* Mill.) is one of the popular fruit crops grown in Sri Lanka which is mainly propagated through seeds. Growing medium plays a major role in producing quality seedlings that are essential to produce grafted plants. It was noted that growth of the grafted avocado plants was retarded in the nursery due to poor drainage in the growing medium. Therefore, this study was conducted to find out suitable growing media to produce avocado nursery plants. Five different growing media that contain top soil, sand, compost, burnt paddy husk and coir dust in different proportions, were evaluated by considering number of days for seed germination, seed germination rate and growth parameters of seedlings and grafted plants. The experiment was arranged as Randomized Complete Block Design (RCBD) with four replicates. Data were analyzed using SAS Statistical package (version 9.2). According to the results, T_5 (Sand: Compost: Burnt paddy husk 1:1:1) and T_3 (Top soil: Sand: Compost 1:2:3) took significantly less number of days to germinate seeds compared to other media. Both of these media recorded significantly higher root distribution in seedlings, and number of leaves and shoot length in grafted plants compared to others. Further, T_3 and T_5 recorded higher shoot and tap root length in seedlings. Therefore, T_5 and T_3 media could be used to produce avocado nursery plants.

KEYWORDS: Avocado, Growing media, Growth parameters, Nursery plants

INTRODUCTION

Avocado (*Persea americana* Mill.) which belongs to family Lauraceae, is one of the popular fruit crops grown and consumed in Sri Lanka. It is a native plant to Central America (Human, 1987). Avocado has healthy fatty acid composition together with antioxidants, vitamins, proteins and dietary fiber. Further, it has positive effect on lowering blood cholesterol and controlling body weight (Bergh, 1992).

At present, the total extend of avocado is around 826 ha and produce around 11,000 mt. annually. Pollock, Simmond, Booth 7, Fuerte, Tower II and Peradeniya purple selection are the recommended avocado varieties in Sri Lanka. Many natural hybrids occurred as a result of escapes from cultivation in government nurseries and today a large population of non-descript varieties thrive in village home gardens of the mid-country and up-country wet zones (Dionysius, 2000).

The use of suitable growing media or substrates is essential for production of quality planting materials of fruit crops. Potting medium is important for healthy and uniform seedling production (Parasana *et al.*, 2013). A good growing medium provides sufficient anchorage to the plant, serves as reservoir for nutrients and water, and allows oxygen diffusion to the roots and permit gaseous exchange between the roots and atmosphere outside the root substrate (Abad *et al.*, 2002). Further, it directly affects to the growth and development of root system during nursery period. In heavy soil with poor drainage condition, the development of root system is suppressed and plants are more susceptible to soil borne diseases (Beattie and White, 1992). Not only potting media influence the quality of seedlings produced (Agbo and Omaliko, 2006) but also plays an important role in seed germination (Wilson *et al.*, 2001).

Use of improved nursery practices in avocado is required for the production of healthy and vigorous grafted seedlings, thus searching for improved media from locally available material is essential. Sowing media used in avocado vary greatly from country to country (Gaillard and Godefroy, 1995). It has been observed that three to four months after grafting growth of the plants are retarded and higher percentages of grafted plants are died in current medium used. It is mainly due to root rot caused by poor drainage condition of the pots. Improving the texture of the medium will help to increase the growth of grafted plants. Therefore, this study was initiated to study the different growth media to improve the growth of the avocado nursery plants.

MATERIALS AND METHODS

Experimental Site

This study was conducted at the Fruit Crop Research and Development Station, Gannoruwa, Peradeniya from December 2015 to May 2016 situated in the WM_{2b} Agro ecological zone with 1800-2200 mm of average annual rainfall, 30 °C of maximum temperature and 21.1 °C of minimum temperature.

Treatments and Layout of the Experiment

Five different media (Table 1) were prepared from locally available ingredients; top soil, compost, sand, coir dust and burnt paddy husk for this study. Treatments were arranged in Randomized Complete Block Design (RCBD) with four replicates.

Table 1. Different media used in the experiment

Treatment	Media
T_1	Sand 1: Top soil 1: Compost 1
T_2	Sand 2: Coir dust 2: Compost 1
T_3	Top soil 1: Sand 2: Compost 3
T_4	Top soil 1: Sand 1: Compost 1: Burnt paddy husk 1
T_5	Sand 1: Compost 1: Burnt paddy husk 1

Seed Sowing and Maintenance Practices

Black polythene bags of 10×7 cm were prepared and filled with above growing media (Table 1). Seeds were obtained from ripen fruits from avocado plants in the research station. Immediately after extraction, seeds were sown in the polythene bags. Fungicide treatment was done to the seeds before sowing as recommended by the Department of Agriculture, Sri Lanka. Daily watering was done. Two months after seed sowing, cleft grafting was practiced and variety Booth 7 was used as scion woods.

Data Recording

Before Grafting

Number of days for seed germination, seed germination percentage, shoot diameter and length, root distribution and tap root length were recorded. Seed germination percentage was calculated using following equation.

$$\text{Seed germination\%} = \frac{\text{No. of germinated seeds}}{\text{Total no. of sown seeds}} \text{X } 100$$

Shoot length (from base of the plant to tip) and shoot diameter (at the middle of the plant stem) was measured at five, six and seven weeks after sowing. Shoot length was measured using a vernier caliper. Root distribution and tap root length (from base of the seed to end of the root tip) were measured from randomly selected four plants from each treatment in each replicate after 50 days. Root distribution was measured using grid method.

After Grafting

Total number of leaves of plants, root distribution and tap root length were measured at ten weeks after grafting and shoot length was measured at six, eight and ten weeks after grafting by using above described methods.

Percentage of Successful Grafts

Percentage of successful grafts was calculated six weeks after grafting using following equation.

$$\textit{Successful grafts\%} = \frac{\textit{No. of success grafts}}{\textit{Total no. of grafted plants}} \text{X100}$$

Statistical Analysis

The data were analyzed using Statistical Analysis System (SAS version 9.2) software.

RESULTS AND DISCUSSION

Before Grafting

Number of Days for Seed Germination

Number of days for seed germination was significantly different ($p<0.05$) among all the treatments (Table 2). Treatment one, three and five recorded significantly less number of days to germinate seeds. Even though, the lowest number of days was recorded by T_1 and T_5, it was not significantly different from T_3. The highest number of days was recorded in T_4 followed by T_2.

Seed Germination Percentage

Neither of the treatments showed any significant difference for the seed germination percentage (Table 2). However, T_5 recorded the highest germination percentage (91.62%) followed by T_1 and T_3. Both T_2 and T_4 recorded the lowest germination percentage of 79.12%.

Root Distribution

Horizontal root distribution was significantly different ($p<0.05$) among treatments. Treatment five recorded the highest root distribution (10.40 cm) followed by T_3 and T_4. The lowest distribution of 5.73 cm was recorded in T_2 (Table 2).

Tap Root Length

Even though there was no significant difference observed in tap root length among treatments, the highest length (21.97 cm) was recorded in T_3 followed by T_5 and the lowest (18.95 cm) was recorded in T_4 (Table 2).

Table 2. Effect of different media on the development of avocado seedlings used for root stocks

Treatments	No. of days taken for germination	Germination (%)	Root distribution (cm)	Tap root length (cm)
T_1	25 ± 0^{b}	87.47 ± 10.8^{a}	7.09 ± 1.1^{bc}	20.22 ± 5.0^{a}
T_2	27 ± 1^{a}	79.12 ± 10.8^{a}	5.73 ± 1.9^{c}	19.67 ± 6.2^{a}
T_3	26 ± 1^{b}	83.30 ± 6.8^{a}	9.25 ± 0.9^{a}	21.97 ± 2.2^{a}
T_4	28 ± 1^{a}	79.12 ± 10.8^{a}	8.28 ± 1.7^{ab}	18.95 ± 5.1^{a}
T_5	25 ± 1^{b}	91.62 ± 6.8^{a}	10.40 ± 0.8^{a}	21.50 ± 3.9^{a}
CV	*3.35*	*10.99*	*16.25*	*17.87*

Means in a column with same letter are not significantly different at $P<0.05$. T_1-Sand 1:Top soil 1:Compost 1, T_2-Sand 2: Coir dust 2: Compost 1, T_3-Top soil 1: Sand 2: Compost 3, T_4-Top soil 1: Sand 1: Compost 1: Burnt paddy husk 1, T_5-Sand 1: Compost 1: Burnt paddy husk 1

Shoot Length

Shoot length of seedlings was significantly different ($p<0.05$) among treatments (Figure 1) in all three weeks. When consider the shoot length, the highest shoot length was recorded in T_5 followed by T_3 in every week. The lowest shoot length in all three weeks was recorded in T_1. In five, six and seven weeks after sowing, T_5 recorded significantly higher shoot length compared to all others.

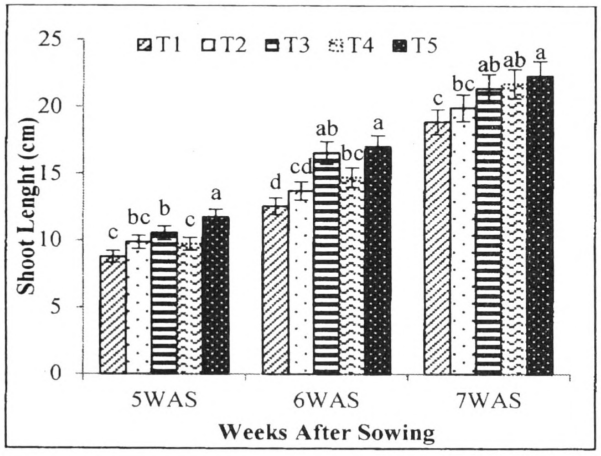

Figure 1. Variation of mean shoot length of avocado seedlings in three different weeks

*Means in a column with same letter are not significantly different at $P<0.05$. *WAS-Weeks After Sowing. T_1-Sand 1:Top soil 1:Compost 1,T_2-Sand 2: Coir dust 2: Compost 1, T_3-Top soil 1: Sand 2: Compost 3, T_4-Top soil 1: Sand 1: Compost 1: Burnt paddy husk 1, T_5-Sand 1: Compost 1: Burnt paddy husk 1*

Shoot Diameter

Shoot diameter was significantly different ($p<0.05$) among the treatments only in six and seven weeks after sowing (Table 3). Treatment one recorded the highest shoot diameter in both six and seven weeks after sowing (0.40 cm and 0.44 cm respectively) and those were not significantly different from T_3.

After Grafting

Number of Leaves of Plants

Number of leaves of grafted plants was significantly different ($p<0.05$) among treatments 10 weeks after grafting. Treatment three and five recorded significantly higher number of leaves of grafted plants compared to other treatments (Figure 2).

Root Distribution and Tap Root Length

Neither of the treatments showed any significant difference for the root distribution and tap root length after 10^{th} weeks of grafting (Table 4). However, the highest length of tap root was recorded in T_5.

Table 3. Effect of treatments on shoot diameter of seedlings

Treatments	Shoot diameter (cm)		
	5 WAS	6 WAS	7 WAS
T_1	0.360^{a}	0.405^{a}	0.44^{a}
T_2	0.315^{a}	0.362^{c}	0.39^{c}
T_3	0.370^{a}	0.402^{ab}	0.43^{ab}
T_4	0.337^{a}	0.367^{bc}	0.40^{bc}
T_5	0.317^{a}	0.362^{c}	0.39^{c}
CV	*10.17*	*6.17*	*4.87*

*Means in a column with same letter are not significantly different at $P<0.05$*WAS- Weeks After Sowing. T_1- Sand 1: Top soil 1: Compost 1, T2- Sand 2: Coir dust 2: Compost 1, T_3- Top soil 1: Sand 2: Compost 3, T_4- Top soil 1: Sand 1: Compost 1: Burnt paddy husk 1, T_5- Sand 1: Compost 1: Burnt paddy husk 1*

Shoot Length

Shoot length was significantly different ($p<0.05$) among treatments in all three weeks (Figure 3). It was interesting to note that, both T_5 and T_3 recorded significantly higher shoot length in 6^{th}, 8^{th} and 10^{th} weeks compared to others. However, T_4 recorded the lowest shoot length compared to others in all three weeks.

Percentage of Successful Grafts

Neither of the treatments showed any significant difference for percentage of successful grafts (Table 5). However, the highest percentage (95%) was recorded in T_4 followed by T_1.

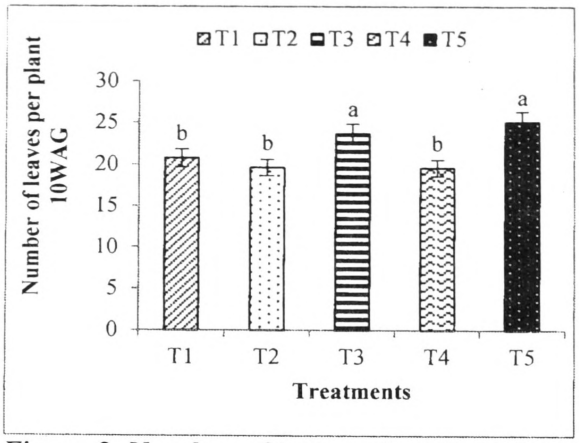

Figure 2. Number of leaves of grafted plants after 10th week of grafting. *Means in a column with same letter are not significantly different at P<0.05. T1-Sand 1: Top soil 1: Compost 1, T2-Sand 2: Coir dust 2: Compost 1, T3-Top soil 1: Sand 2: Compost 3, T4-Top soil 1: Sand 1: Compost 1: Burnt paddy husk 1, T5-Sand 1: Compost 1: Burnt paddy husk 1*

Table 4. Root distribution and tap root length of grafted plants after 10th week

Treatments	Root distribution (cm)	Tap root length (cm)
T_1	15.48[a]	23.26[a]
T_2	15.71[a]	28.25[a]
T_3	15.05[a]	24.56[a]
T_4	16.40[a]	27.85[a]
T_5	14.10[a]	29.25[a]
CV	*23.37*	*29.22*

Means in a column with same letter are not significantly different at P<0.05. T1-Sand 1: Top soil 1: Compost 1,T2-Sand 2: Coir dust 2: Compost 1, T3-Top soil 1: Sand 2: Compost 3, T4-Top soil 1: Sand 1: Compost 1: Burnt paddy husk 1, T5-Sand 1: Compost 1: Burnt paddy husk 1

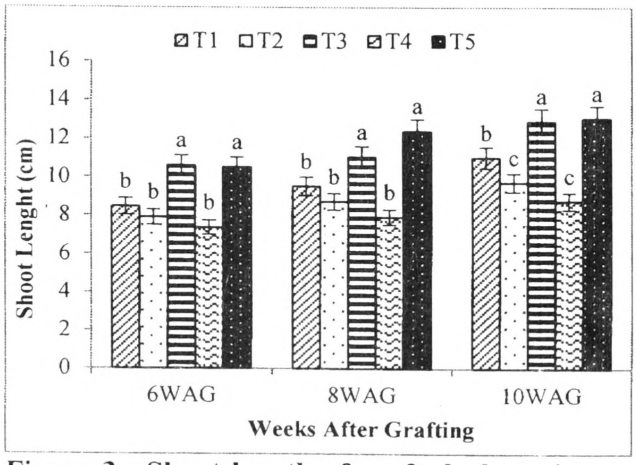

Figure 3. Shoot length of grafted plants in three different weeks. *Means in a column with same letter are not significantly different at P<0.05. *WAG-Weeks After Grafting.T1-Sand 1: Top soil 1: Compost 1, T2-Sand 2: Coir dust 2: Compost 1, T3-Top soil 1: Sand 2: Compost 3, T4-Top soil 1: Sand 1: Compost 1: Burnt paddy husk 1, T5-Sand 1: Compost 1: Burnt paddy husk 1*

Table 5. Percentage of successful grafts after 6th week

Treatments	Percentage (%) of successful grafts
T_1	92.73±9.51[a]
T_2	89.43±12.25[a]
T_3	89.70±8.19[a]
T_4	95.00±10.00[a]
T_5	86.05±12.69[a]
CV	*11.53*

Means in a column with same letter are not significantly different at P<0.05. T1-Sand 1: Top soil 1: Compost 1, T2-Sand 2: Coir dust 2: Compost 1, T3-Top soil 1: Sand 2: Compost 3, T4-Top soil 1: Sand 1: Compost 1: Burnt paddy husk 1, T5-Sand 1: Compost 1: Burnt paddy husk 1

Growing medium plays an important role in seed germination and quality of the nursery plants (Baiyeri and Mbah, 2006). According to the results, T_5 (Sand: Compost: Burnt paddy husk 1:1:1), T_3 (Top soil: Sand: Compost 1:2:3) and T_1 (Sand: Top soil: Compost 1:1:1) took significantly low number of days for seed germination compared to other treatments. Further, both T_5 and T_3 recorded higher shoot length, root distribution, tap root length in seedlings, and number of leaves and shoot length in grafted plants compared to other treatments. Treatment three contains higher amount of compost (three parts) together with two sand parts. High amount of compost in the medium retains moisture which requires for the seed germination (Bisla *et al.*, 1984) and the presence of sand would help to create an open soil structure which improves the drainage condition in the medium (Tisdale *et al.*, 1985). Further, organic matter acts as glue for soil aggregates improving permeability and airflow in the polybags and it provides adequate nutrient to plants (Bhardwaj, 2014). Therefore, T_3 recorded less number of days for seed germination together with better growth performances.

Apart from the compost and sand, T_5 contains burnt paddy husks which could provide reasonable quantities of Ca, Mg, K, Na and P to the medium (Anon, 2001), thus it recorded better growth performances and low number of days for seed germination (paddy husk provide good aeration). Further, paddy husk and compost are locally available and inexpensive ingredients which have potential to be used in nursery plant production. Even though, T_1 took low number of days for seed germination it had significantly lower root distribution in seedling, less number of leaves and shoot length in grafted plants compared to T_3 and T_5. Treatment two and T_4 recorded low germination percentages and took more time to germinate seeds together with poor growth performances. This could be attributed to

presence of top soil in the medium that leads to increase the compactness of media. Even though T_2 contains sand and compost, it had more coir dust which could retain excess moisture that might adversely affect for seed germination and root growth. Further, excess coir dust may promote nursery diseases. Therefore, out of tested media, T_3 and T_5 were the best media to produce avocado nursery plants.

CONCLUSIONS

Treatment five (Sand: Compost: Burnt paddy husk 1:1:1) and T_3 (Top soil: Sand: Compost 1:2:3) recorded better growth performances in nursery plants compared to all other treatments. Further, it was noted that both of the treatments took less number of days for seed germination. Therefore, these two media could be promoted to produce nursery plants of avocado. Further studies should be carried out to achieve fast and uniform growth of avocado seedlings.

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