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Growth of Teak Seedlings in Some Biodegradable Containers

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Abstract: The growth of teak seedlings was studied in different biodegradable containers at College of Forestry, Kerala Agricultural University, Thrissur, Kerala, India in 2020. Teak seedlings were grown in some biodegradeable containers such as nonwoven bag, bamboo split pot coco pot, CNSL treated cardboard pot, mud pot and coir root trainer in nursery. Each container had capacity of 12cm x 15cm filled with soil mixture of soil: coir pith: vermicompost @ 2:1:1 by volume. The teak seedlings were evaluated monthly for five months. It was observed that considerable variability existed in seedling growth characters such as height, collar diameter, root dry weight, shoot dry weight and total dry weight. Among all container types studied Nonwoven bag grown seedlings showed better growth performance followed by seedlings grown in bamboo split containers, while mud pot raised seedlings showed the lowest performance during all the stages of seedling growth. At 5-month age, the seedling height varied from 17.4 to 31.5cm and the total dry weight of seedling varied from 2.73 to 5.63g under different containers.

Keywords: Biodegradable container, seedling, teak

Oneliner: Teak seedlings performed better in Nonwoven bag and Bamboo split pot.

INTRODUCTION

Nursery and afforestation activities are very important in the present scenario to meet ecological and economic needs throughout the world. The plastic based materials are widely used in the nursery production sector both in agriculture and forestry primarily as seedling containers. The conservative estimates suggest that roughly 0.35 million tons of plastic is used in agricultural sector annually[18]. The economic feasibility, durability, easiness of handling, irrigation and application of plant protection measures makes it most popular among the nursery containers. However, such massive use of plastic for plant container production causes serious environmental degradation such as longer periods of non-degradability and consequent soil degradation, block sewerage systems, breeding areas for mosquitoes and other vectors, etc. [19][1]. It is necessary to find out substitute for plastic containers.

There are advantages and disadvantages of using biodegradable containers in nursery. Some of the potential advantages include: planting of seedlings with entire container, provision of better drainage and aeration promoting root growth, minimization of transplanting shock, little disruption to the vigour of the seedlings as the roots grow through the side wall of the pot into the soil thereby reducing the problem of root congestion caused by plastic pots, etc. The main disadvantages include: biodegradable containers are fragile and require careful handling during transportation of seedlings. They also lack a solid wall which prevent in training the roots to the lower part of the container. Being bio-materials,

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chances of the container being infested with algae and fungi are more which may affect the growth of seedlings and overall hygiene. Yet another factor of concern is the high cost of biodegradable containers. The quality biodegradable containers available in the market are costly and hence may not be economical for mass production of seedlings. However, consumer demand for environmentally conscious products and practices is on the rise and consumers are willing to pay more for eco-friendly products, such as plants grown in biodegradable containers [3]. In the present investigation, the performance of teak seedlings was studied in terms of growth and quality for five months.

MATERIALS AND METHODS

The growth and quality of teak seedlings were studied using different biodegradable containers at College of Forestry, Kerala Agricultural University, Thrissur, Kerala, India during 2020. The experiment site is located at $10^0$32' N latitude and $76^0$26'E longitude with an altitude of 40 m above mean sea level which comes under the humid tropical zone. The area receives an annual rainfall ranging from 2650 to 3200mm with almost bulk share of the rain during June-August. The mean maximum temperature during the study period was 36^0C (March) and mean minimum temperature 23 ^{0}C (January).

Six containers were taken in the trial such as nonwoven cloth bag (T_1), coco pot (T_2), mud pot (T_3), bamboo splits pot (T_4), CNSL treated cardboard (T_5) and coir root trainer (T_6) as 6 treatments. The experiment was done in Complete Randomized Design with 4 replications. Each treatment included 30 plants per replication. The data were compared under DMRT. For this pre-treated teak seeds of single source (Nilambur) were sown in raised nursery bed at a spacing of 10cm x 10cm in first week of March. After germination, 15-day old uniform sized seedlings were transplanted in different containers. Each container had capacity of 12cm x 15cm filled with soil mixture of soil: coir pith: vermicompost @ 2:1:1 by volume. The evaluation of performance was done when seedlings became 1, 2, 3, 4 and 5-month old. After each month, five representative seedlings from each treatment per replication were subjected to destructive test.The growth performance was assessed in terms of height, diameter, shoot dry weight, root dry weight and total dry weight following standard procedure.

RESULTS AND DISCUSSION

The growth performance of plants remarkably varied under different container types.

Height

The height of teak seedling varied significantly in different containers in different months (Table 1). At the age of 5-month, it varied from 17.4 to 31.5 cm. The seedlings in nonwoven bag registered significantly higher height over others followed by bamboo split pot (29.5 cm). Mudpot witnessed significantly lower height. Seedling height in the containers often strongly influenced by the container type especially the shape and cubic [20][2][15] [17][21][7]. Such factors again influence the root development especially root elongation and spread [21][10][4]. Ideally tree seedling containers with reasonably larger size (height) and moderate diameter are preferred which ensure deep root production and training of roots by the side walls. Nonwoven bags are similar to polythene bags in terms of durability and physical sturdiness to hold soil. The possible reason is that the nonwoven container is permeable and allows water and soluble nutrients to move laterally, which could affect the water and nutrient availability for each seedling and thus impact the seedling growth. [20] The container walls are strong enough to train the roots to the deeper soil. Bamboo splits also had high durability and better length to diameter ratio which permit the faster growth of the root system. This could be reason for the better height growth of teak seedlings in these two types of containers. Furthermore, better soil aeration, ability to hold water and minerals may also have contributed to the better height growth. Interestingly height growth of teak seedlings in the mud pot was the lowest despite its physical soundness. Probably, the short stature and broad base of the mud pots may have adversely affected the root and shoot growth. Many studies illustrate such differences in seedling height growth consequent to size and shape of the containers.

Table 1: Height of teak seedlings in different biodegradable containers

Type of containers (T)	*Seedling height of teak seedling (cm)*				
	1-month old	*2-month old*	*3-month old*	*4-month old*	*5-month old*
Nonwoven bag (T_1)	7.0^{a}	14.1^{a}	17.6^{a}	24.9^{a}	31.5^{a}
Coco pot (T_2)	6.0^{abc}	11.1^{b}	13.6^{bc}	20.1^{c}	24.9^{c}
Mud pot (T_3)	4.6^{d}	7.2^{c}	9.0^{e}	14.1^{f}	17.4^{f}
Bamboo split pot (T_4)	6.7^{ab}	12.2^{b}	15.2^{ab}	21.5^{b}	29.5^{b}
CSNL treated cardboard pot (T_5)	5.6^{bcd}	9.1^{c}	12.2^{cd}	18.4^{d}	22.1^{d}
Coir rot trainer (T_6)	5.0^{cd}	8.8^{c}	10.6^{de}	16.5^{e}	20.0^{e}
$SE_{(m)}$	0.3	0.3	0.9	0.7	1.6
CV	14.6	7.3	14.2	7.7	13.8

Collar diameter

The collar diameter of seedlings differed significantly among containers (Table 2) in different ages. At 5-month age it ranged from 5.2 to 10.6 mm. Nonwoven bag (T_1) recorded highest value while mud pot (T_3) recorded the lowest diameter. Optimal collar diameter is inevitable for healthy growth of the plants which should be proportional to the height growth. [16][13] A larger collar diameter also indicates a larger root system and a larger stem volume[9] . The poor collar diameter and faster height growth often lead to weaker seedlings which may eventually topple with increase in biomass. The better radial growth of teak seedlings in the non-woven bag followed by bamboo splits pot suggest their ability to maintain better soil biophysical conditions especially for optimal root growth in addition to their enhanced physical suitability and durability. Most of the remaining container types exhibited varying levels of degradation due to infestation by fungi and termites. This might has further influenced the general health of the seedlings.

Table 2: Collar diameter of teak seedlings in different biodegradable containers

Type of containers (T)	*Collar diameter of teak seedlings (mm)*				
	1-month old	*2-month old*	*3-month old*	*4-month old*	*5-month old*
Nonwoven bag (T_1)	2.2^{a}	4.2^{a}	6.2^{a}	8.4^{a}	10.6^{a}
Coco pot (T_2)	1.8^{bc}	3.1^{bc}	4.5^{bc}	6.2^{c}	7.9^{c}
Mud pot (T_3)	1.4^{c}	2.0^{e}	2.8^{d}	3.8^{e}	5.2^{e}
Bamboo split pot (T_4)	2.1^{ab}	3.6^{b}	5.2^{b}	7.6^{b}	9.7^{b}
CSNL treated cardboard pot(T_5)	1.7^{c}	2.6^{cd}	4.1^{c}	5.6^{cd}	7.3^{cd}
Coir root trainer (T_6)	1.6^{c}	2.2^{de}	3.2^{d}	5.2^{d}	6.8^{d}
$SE_{(m)}$	0.1	0.1	0.2	0.3	0.3
CV	12.5	11.6	11.3	8.2	7.6

Shoot dry Weight

The data in Table 3 indicate a clear-cut difference in shoot dry weight under different containers in each month of evaluation. At the age of 5-month, it differed from 1.95 to 4.00 g per seedling. In consistent with the general trends observed so far, the non-woven bag and bamboo split pot grown seedlings had higher shoot weight while the mud potted seedlings had the lowest value. Shoot weight often reflects the total aboveground biomass allocation potential by plants with progressive time. The rate of shoot weight accumulation may vary with advancement in time for variable container types consequent to the changes in biophysical conditions. The variation in shoot dry weight under different container types may be attributed to difference in shoot growth in terms of height, diameter, number of leaves and leaf area.

Table 3: Shoot dry weight of teak seedlings in different biodegradable containers

Type of containers (T)	*Shoot dry weight of teak seedlings (g)*				
	1-month old	*2-month old*	*3-month old*	*4-month old*	*5-month old*
Nonwoven bag (T_1)	0.72^{a}	1.85^{a}	2.34^{a}	3.25^{a}	4.00^{a}
Coco pot (T_2)	0.49^{bc}	1.27^{c}	1.70^{c}	2.25^{c}	3.15^{b}
Mud pot (T_3)	0.28^{e}	0.68^{d}	0.90^{e}	1.4^{d}	1.95^{c}
Bamboo split pot (T_4)	0.54^{b}	1.53^{b}	2.00^{b}	2.75^{b}	3.65^{a}
CSNL treated cardboard pot (T_5)	0.41^{cd}	1.07^{c}	1.40^{d}	2.15^{c}	2.85^{b}
Coir root trainer (T_6)	0.33^{de}	0.82^{d}	1.10^{e}	1.65^{d}	2.35^{c}
$SE_{(m)}$	0.01	0.04	0.08	0.12	0.12
CV	11.2	10.7	9.99	10.45	8.10

Root dry weight

Root dry weight of teak seedlings varied appreciably under different containers in all months (Table 4). At 5-month age, it ranged from 0.78 to 1.63 g and nonwoven bag registered maximum which was at par with bamboo split pot (1.49 g). Mud pot demonstrated the minimum root growth. The seedlings with larger root dry weight tend to grow more and survive better than those with smaller root mass. The higher root biomass associated with seedlings grown in non-woven bag and bamboo split pot suggest physical suitability of the container material to facilitate root growth. The variations in root biomass with container types have also been reported before [12][6]. The faster root production is often a continuation of the better aboveground biomass accumulation. However, the size, shape and wall flexibility of the containers may limit the root growth considerably despite the better soil properties and moisture regimes [14][8].

Table 4: Root dry weight of teak seedlings in different biodegradable containers

Type of containers (T)	*Root dry weight of teak seedlings (g)*				
	1-month old	*2-month old*	*3-month old*	*4-month old*	*5-month old*
Nonwoven bag (T_1)	0.14^{a}	0.52^{a}	1.00^{a}	1.30^{a}	1.63^{a}
Coco pot (T_2)	0.11^{bc}	0.35^{bc}	0.72^{bc}	1.00^{b}	1.25^{b}
Mud pot (T_3)	0.09^{c}	0.18^{e}	0.34^{d}	0.54^{c}	0.78^{d}
Bamboo split pot (T_4)	0.12^{ab}	0.41^{b}	0.89^{ab}	1.17^{a}	1.49^{a}
CSNL treated cardboard pot (T_5)	0.11^{bc}	0.29^{cd}	0.61^{c}	0.87^{b}	1.09^{bc}
Coir root trainer (T_6)	0.10^{bc}	0.24^{de}	0.46^{c}	0.68^{c}	0.95^{cd}
$SE_{(m)}$	0.01	0.01	0.02	0.05	0.08
CV	11.1	7.9	6.2	10.82	12.77

Table 5: Total dry weight of teak seedlings in different biodegradable containers

Type of containers (T)	*Total dry weight of teak seedlings (g)*				
	1-month old	*2-month old*	*3-month old*	*4-month old*	*5-month old*
Nonwoven bag (T_1)	0.34^{a}	1.78^{a}	3.34^{a}	4.55^{a}	5.63^{a}
Coco pot (T_2)	0.29^{abc}	1.19^{bc}	2.42^{c}	3.25^{c}	4.40^{c}
Mud pot (T_3)	0.22^{d}	0.64^{d}	1.24^{e}	1.94^{e}	2.73^{f}
Bamboo split pot (T_4)	0.31^{ab}	1.40^{b}	2.89^{b}	3.92^{b}	5.14^{b}
CSNL treated cardboard pot (T_5)	0.27^{bcd}	1.01^{c}	2.01^{d}	3.02^{c}	3.94^{d}
Coir root trainer (T_6)	0.25^{cd}	0.79^{d}	1.56^{e}	2.33^{d}	3.30^{e}
$SE_{(m)}$	0.01	0.06	0.06	0.10	0.15
CV	8.7	10.45	5.29	6.10	6.97

Total dry weight

The total dry weight of teak seedlings remarkably varied under different containers tested (Table 5). It varied from 2.73 to 5.63 g at 5-month age and nonwoven bag recorded highest total weight followed by bamboo splits pot whereas mud pot registered the minimum. The highest total biomass production in the nonwoven bagged seedlings is on account of the cumulative higher shoot and root biomass production. Similarly mud pot positioned last because of its minimum shoot and root weight. The variation of dry weight under different container types have also been reported [21][12][11][6][5].

CONCLUSION

The performance of different biodegradable containers tested for raising teak seedlings varied remarkably with respect to height, diameter, shoot dry weight, root dry weight and total dry weight of planting stock. Nonwoven bag closely followed by bamboo split pot performed appreciably better over others.

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