# Comparative growth performance of four multipurpose tree species (MPTs) in different containers under nursery condition

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**Abstract:** Seedling growth of four multipurpose tree species (MPTs) were evaluated in four different types of container up to six months in nursery condition at Department of Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh. The MPTs were *Gliricidia sepium, Delonix regia, Terminalia arjuna and Swietenia mahagoni* and containers were gunny bag, poly bag, earthen pot and bare rooted. The first two species were leguminous and the rest two were non-leguminous. Seedling height (cm), collar diameter (mm), leaf number and fresh and dry weight (gm) of root, stem and leaf was measured to compare the growth performance of the tree species. Leguminous species showed better growth performance than the non-legume species. *G. sepium* performed better than the other three species in terms of plant height, collar diameter, and biomass production. Statistically significant and maximum leaf number was recorded in *T. arjuna* followed by *G. sepium*, *D. regia* and *S. mahagoni*. Gunny bag produced maximum biomass in all the studied tree species.
**Key words:** Multipurpose tree species (MPTs), growth performance, fresh weight, dry weight, gunny bag.

## Introduction

Multipurpose tree species (MPTs) refer to all woody perennials that are purposely grown so as to provide more than one significant contributions to the production and /or service function. Those functions may be food, animal feed, medicine, fuel, timber, shade, shelter, ornamental, soil conservation etc. Generally, MPTs are fast growing and capable of growing successfully in a wide range of environment. Legumes are found to get popularity because of its fast growth, nitrogen-fixing, reducing fertilizer needs and coppicing behavior and ability to adapt in wide range of environments (Mahmud *et al*. 2005). Growth and biomass production potential of multipurpose tree species including leguminous trees vary from site to site (Radoglou and Teskey, 1997). Among the different MPTs, *Gliricidia sepium, Delonix regia, Swietenia mahagoni and Terminalia arjuna* are widely grown in different plantation programs. *G. sepium* is famous for its green manuring properties, for fodder and for ornamental purpose. In alley cropping its performance is better with different food crops, grass or legumes (Nitis *et al.,* 1989, 1991). *D. regia* is well known for its bright red flowers. It is an important avenue tree all over the world and also important for bees (Usman, 2011). *S. mahagoni* timber is famous all over the world including Bangladesh. It is also important for reforestation and afforestation programs. *T. arjuna* is an important medicinal tree mainly for cardiac disease. All these four tree species are widely planted in Bangladesh due to their multipurpose use though the first three species are exotic but now successfully grown all over the country. The demands of the fast growing multipurpose trees in plantation programs are immense all over the world. So, interest in producing quality seedlings by application of improved and modern nursery technique has increased in recent years (Gera and Ginwal, 2002). The success of a plantation program largely depends on prompt germination, enhanced growth and even on the containers in which seeds are sown. Bare rooted seedlings are not generally produced in large quantities in the tropics because of greater heat, moisture and transpiration stresses that may cause high mortality (Evans, 1993). Various containers i.e. earthen pots and tubes, *Palmyra* and bamboo baskets, seed boxes, leaf, cups or 'doras', tin trays, manure bricks and even cylindrical rolls of moss were used in the past (Dhiman and Sood, 1994). Most of them are gradually replaced by lightweight, durable, easy to transport, cheap and resistant polythene bags. Until recently, maximum tree seedlings in the tropics were grown in polybags. Different types and sized saplings are sold from nurseries and in the open market also. All types of saplings are not suitable for maximum survival, optimum growth and commercial production. Siddiqui and Ali (1994) suggested six months aged saplings for plantation. Sapkata (1987) also work with six months aged Goraneem saplings established well in Nepal. No proper information is available as to what type of container should be used for which MPTs to obtain optimum growth of the seedlings in Bangladesh context. In this regard, the present study was initiated to compare the growth performance of aforementioned four Multi-purpose tree species (MPTs) in different containers under nursery conditions.

## Materials and Methods

The experiment was carried out over a period of six months from May to October, 2012 in the nursery of the Department of Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh. The experiment was laid out in two factors Randomized Complete Block Design (RCBD) with three replications.

Factor 1: Four different types of container i.e. poly bag, gunny bag, earthen pot and bare rooted.

Factor 2: Four Multipurpose tree species i.e. *Gliricidia sepium, Delonix regia, Terminalia arjuna and Swietenia mahagoni.*

Potting soils were prepared as Cowdung : Soil = 1: 2 ratio and the size of different containers were 23 cm × 15 cm or 9 inch × 6 inch for each (Suitable container size suggested by Jabber *et al*., 2010 and Ferdouse *et al*., 2010). The soil was sieved by 2 mm to remove stones, roots and other debris. In total 120 poly bags, 120 gunny bags, 120 earthen pots and 120 pit for bare rooted were prepared and placed in a RCBD. Healthy seeds for each tree species were collected from plus trees of BSMRAU farm. The seeds were treated with hot water for 3 minute followed by soaking in cold water for 12 hrs to enhance germination.

After treatment three seeds were sown per container. After germination one healthy seedling was kept. Adequate watering and care was taken regularly.

Data for seedling height, collar diameter and leaf number was recorded at the age of 1.5 months, 3 months and 6 months. Height was measured with a steel scale (1.5 m) marked in meters and centimeters. In case of multi-stemmed and shrubby seedling, only the height of the tallest shoot was recorded. And collar diameter was measured by taking the mean of two readings with calipers. At 6 months three seedlings of each type of container and each tree species were harvested randomly for recording the biomass productivity (both fresh weight and dry weight of root, shoot and leaf including the above mentioned parameters. After uprooting the root was washed with tap water to remove soil particles and dried by soaking with tissue paper. Fresh weight for root, stem and leaf was measured immediately after harvest and kept in desiccators for 72 hrs and then dry weight data was recorded. Plant height, collar diameter and biomass weight was measured in centimeter (cm), millimeter (mm) and gram (gm), respectively.

The data were subjected to analysis of variance to test for significant difference in different parameters among the species studied. The means were compared using the Duncan's Multiple Range Test (DMRT).

## Results

**Seedling height (ht):** Seedling height (ht) of MPTs was significantly influenced by different containers and tree species irrespective of sampling dates. *G. sepium* seedling growth was found superior to the other three species at all the sampling dates. Bare rooted condition always produced tallest *G. sepium* seedling (Table 1).

**Table 1.** Seedling height, collar diameter and leaf number of four MPTs as influenced by growth containers

| Treatment combination | Seedling height (cm) | | | Collar diameter | | | Leaf number | | |
|---|---|---|---|---|---|---|---|---|---|
| | 45 DAS | 90 DAS | 180 DAS | 45 DAS | 90 DAS | 180 DAS | 45 DAS | 90 DAS | 180 DAS |
| Container | | | | | | | | | |
| $C_1$ | 23.65 a | 84.63 a | 155.6 a | 5.46 a | 11.93 b | 20.59 a | 12.55 a | 46.63 a | 114.7 b |
| $C_2$ | 20.94 b | 70.46 b | 141.7 b | 5.13 ab | 12.79 a | 18.30 b | 11.73 b | 41.11 b | 129.4 a |
| $C_3$ | 17.34 c | 66.62 c | 136.3 c | 4.68 b | 12.24ab | 21.52 a | 11.10 b | 37.88 c | 116.7 b |
| $C_4$ | 13.20 d | 37.48 d | 82.17 d | 3.66 c | 9.59 c | 10.55 c | 7.593 c | 16.85 d | 39.35 c |
| Tree species | | | | | | | | | |
| $T_1$ | 31.32 a | 124.6 a | 252.0 a | 7.793 a | 17.21 a | 28.07 a | 13.80 a | 37.08 b | 104.1 b |
| $T_2$ | 17.42 b | 68.08 b | 133.2 b | 6.503 b | 15.48 b | 21.15 b | 11.69 b | 17.50 c | 19.78 c |
| $T_3$ | 17.05 b | 46.53 c | 93.50 c | 3.053 c | 10.10 c | 16.00 c | 13.29 a | 78.30 a | 255.6 a |
| $T_4$ | 9.347 c | 19.99 d | 37.00 d | 1.568 d | 3.752 d | 5.742 d | 4.202 c | 9.591 d | 20.76 c |
| Interaction effect | | | | | | | | | |
| $T_1 \times C_1$ | 36.20 a | 145.7 a | 263.0 a | 8.05 b | 16.91 b | 36.18 a | 12.55 e | 38.13 d | 100.5 e |
| $T_1 \times C_2$ | 31.07 b | 119.3 c | 240.7 b | 7.52 b | 17.07 b | 24.80cd | 11.73fg | 37.73 d | 92.33 f |
| $T_1 \times C_3$ | 31.93 b | 130.0 b | 261.0 a | 8.70 a | 19.36 a | 27.90 b | 11.10 g | 39.27 d | 127.2 d |
| $T_1 \times C_4$ | 26.07 c | 103.3 d | 187.5 b | 6.90 c | 15.50 c | 23.40de | 7.593 i | 33.20 e | 96.20 f |
| $T_2 \times C_1$ | 22.47 d | 103.3 d | 187.3 c | 7.56 b | 17.01 b | 22.13 e | 0.1090k | 15.77 g | 21.67 j |
| $T_2 \times C_2$ | 23.39 d | 85.33 e | 167.7 d | 7.92 b | 19.21 a | 27.00bc | 13.73 c | 21.08 f | 22.08 ij |
| $T_2 \times C_3$ | 13.84 f | 70.33 f | 151.0 e | 6.00 d | 17.15 b | 25.47cd | 15.13ab | 23.82 f | 26.06 i |
| $T_2 \times C_4$ | 10.0gh | 13.33 l | 26.67 k | 4.53 e | 8.56 f | 10.00 h | 12.27 ef | 9.333 h | 9.33 l |
| $T_3 \times C_1$ | 22.27 d | 59.53 g | 117.0 f | 3.75 f | 9.71 e | 16.73 f | 14.73 b | 118.2 a | 320.0 b |
| $T_3 \times C_2$ | 19.73 f | 57.00 g | 115.0 f | 3.47 f | 9.34 e | 14.07 g | 13.25cd | 94.47 b | 362.7 a |
| $T_3 \times C_3$ | 14.77 f | 46.67 h | 96.67 g | 2.74 g | 8.23 f | 26.73bc | 12.42 e | 78.67 c | 293.5 c |
| $T_3 \times C_4$ | 11.42 g | 22.93 j | 45.33 i | 2.25 g | 13.12 d | 6.47 i | 6.333 j | 21.87 f | 46.00 g |
| $T_4 \times C_1$ | 13.67 f | 30.00 i | 57.00 h | 2.47 g | 4.07 h | 7.33 i | 15.00 b | 14.42 g | 16.67 k |
| $T_4 \times C_2$ | 9.583 h | 20.17jk | 43.33 i | 1.62 h | 5.53 g | 7.33 i | 15.67 a | 11.17 h | 40.56 h |
| $T_4 \times C_3$ | 8.807 h | 19.47 k | 34.33 j | 1.26 hi | 4.23 h | 5.97 i | 12.72de | 9.780 h | 19.93 jk |
| $T_4 \times C_4$ | 5.333 i | 10.33 m | 13.33 l | 0.93 i | 1.17 i | 2.33 j | 9.773 h | 3.000 i | 5.87 l |
| CV% | 5.28 | 2.58 | 2.08 | 6.98% | 3.14% | 7.56% | 3.52% | 5.10% | 2.41% |
| LSD | 1.655 | 2.785 | 4.468 | 0.551 | 0.6081 | 2.235 | 0.6306 | 3.031 | 4.024 |

In a column, Figure having the similar letter (s) or without letter (s) do not differ significantly as per DMRT. T1= Gliricidia sepium, 2=Delonix regia, T3=Terminalia arjuna, T4=Swietenia mahagoni, C1=Bare-rooted (uncontrolled), C2=Gunny bag, C3=Poly bag and C4=Earthen pot. DAS= Days after sowing

At 45 DAS gunny bag and poly bag produced significantly similar plant ht but at 90 and 180 DAS, seedling ht of poly bag was significantly superior to gunny bag. For *D. regia* tallest seedling (187.3cm) was recorded at 180 DAS in bare rooted condition. Gunny bag and poly bag produced significantly different plant ht at all the sampling dates and gunny bag always shown better performance than the poly bag. However, earthen pot always produced significantly

shortest plant. Significantly tallest and smallest *T arjuna* seedling was recorded at bare rooted condition in 45 DAS and earthen pot condition in 90 DAS, respectively. At 90 and 180 DAS, gunny bag produced identical seedling ht with bare rooted condition. Seedling ht in gunny bag and poly bag was identical at 45 DAS, although at 90 and 180 DAS gunny bag produced significantly taller seedlings. For *S. mahagoni,* bare rooted condition had shown better performance while earthen pot showed poorer performance. Gunny bag and poly bag produced identical seedling ht at 45, 90 and 180 DAS.

**Collar diameter:** *G. sepium* attained maximum collar diameter followed by *D. regia, T. arjuna and S. mahagoni*. Earthen pot produced significantly lowest collar diameter than the other three growth conditions. At 45 DAS and 90 DAS significantly maximum *G sepium* collar diameter was recorded at poly bag condition while bare rooted condition and gunny bag produced statistically identical collar diameter (Table 1). Whereas, at 180 DAS, maximum collar diameter was recorded at bare rooted condition followed by poly bag, gunny bag and earthen pot containers. For *D. regia*, At 45 DAS statistically identical collar diameter was produced by bare rooted and gunny bag condition however the other sampling dates gunny bag condition produced maximum collar diameter followed by poly bag, bare rooted and earthen pot condition. *T arjuna* attained highest collar diameter at 180 DAS in poly bag condition. Both gunny bag and bare rooted condition produced statistically identical collar diameter at 45 and 90 DAS. Significantly highest and lowest *S mahagoni* collar diameter was recorded in bare rooted condition at 45 DAS and earthen pot condition at 180 DAS, respectively.

**Leaf number:** Significantly lowest leaf number was recorded at earthen pot condition and *S. mahagoni* for all the sampling dates. At 45 DAS significantly maximum *G. sepium* leaf was recorded for bare rooted condition followed by gunny bag, poly bag and earthen pot condition whereas, at 180 DAS poly bag produced maximum leaf followed by bare rooted, gunny bag and earthen pot condition (Table 1). Nevertheless at 90 DAS leaf number was identical in bare rooted, gunny bag and poly bag condition. For *D. regia*, poly bag produced statistically maximum leaf number at all the sampling dates followed by gunny bag, bare rooted and earthen pot. At 45 and 90 DAS *T. arjuna* leaf number was recorded significantly highest in bare rooted condition followed by gunny bag, polybag and earthen pot. Although gunny bag produced maximum leaf number at 180 DAS. For *S. mahagoni* significantly highest leaf number was recorded in gunny bag condition for all the sampling dates followed by bare rooted, poly bag and earthen pot.

**Biomass production:** Maximum biomass (508.56 gm) was recorded in $T_1C_2$ (*G sepium*-gunny bag) treatment followed by 505.22 gm in $T_2C_2$ *(D regia*-gunny bag) and minimum biomass (9.96 gm) was recorded in $T_4C_4$ (*S. mahagoni*- earthen pot) treatment followed by 15.33 gm in $T_4C_2$ (*S mahagoni*-gunny bag). Gunny bag produced maximum biomass for *G. sepium* and *D. regia* whereas poly bag produced maximum biomass for *T. arjuna and S mahagoni*. Except earthen pot, *G. sepium* and *D. regia* shown similar trend for biomass partitioning where major contribution was from shoot weight followed by leaf weight and root weight. However, in earthen pot container, *D. regia* root contributed maximum weight than shoot and leaf and for *G sepium* root weight was higher than leaf weight. On the other hand *T. arjuna* and *S. mahagoni* shown similar trend for biomass partitioning for all the containers (Table 2).

**Table 2.** Biomass productivity of four MPTs after 6 months

| Treatment | Root (fresh wt) (gm) | Shoot (fresh wt) (gm) | Leaf (fresh wt) (gm) | Total fresh wt (gm) | Root (dry wt) (gm) | Shoot (dry wt) (gm) | Leaf (dry wt) (gm) | Total dry wt (gm) |
|---|---|---|---|---|---|---|---|---|
| $T_1 \times C_1$ | 282.83 | 598.78 | 345.31 | 1226.92 | 99.16 | 194.37 | 99.84 | 393.37 |
| $T_1 \times C_2$ | 319.38 | 785.99 | 511.21 | 1616.58 | 113.45 | 265.66 | 129.45 | 508.56 |
| $T_1 \times C_3$ | 313.31 | 594.95 | 400.7 | 1308.96 | 106.11 | 196.65 | 120.31 | 423.07 |
| $T_1 \times C_4$ | 266.18 | 362.95 | 204.28 | 833.41 | 87.54 | 104.91 | 45.26 | 237.71 |
| $T_2 \times C_1$ | 131.59 | 479.33 | 263.62 | 874.54 | 50.39 | 158.97 | 82.77 | 292.13 |
| $T_2 \times C_2$ | 280.55 | 783.02 | 515.25 | 1578.82 | 106.64 | 241.24 | 157.34 | 505.22 |
| $T_2 \times C_3$ | 168.46 | 546.99 | 363.87 | 1079.32 | 63.51 | 173.81 | 141.69 | 379.01 |
| $T_2 \times C_4$ | 19.99 | 16.11 | 14.55 | 50.65 | 6.5 | 7.46 | 6.83 | 20.79 |
| $T_3 \times C_1$ | 46.59 | 128.49 | 147.61 | 322.69 | 16.23 | 45.19 | 50.16 | 111.58 |
| $T_3 \times C_2$ | 57.19 | 115.84 | 173.27 | 346.3 | 17.8 | 39.06 | 53.28 | 110.14 |
| $T_3 \times C_3$ | 81.99 | 182.75 | 192.75 | 457.49 | 24.3 | 66.06 | 68.66 | 159.02 |
| $T_3 \times C_4$ | 12.89 | 12.18 | 18.36 | 43.43 | 5.85 | 10.8 | 5.17 | 21.82 |
| $T_4 \times C_1$ | 5.56 | 15.8 | 23.14 | 44.5 | 2.55 | 6.09 | 9.61 | 18.25 |
| $T_4 \times C_2$ | 7.75 | 12.54 | 20.79 | 41.08 | 2.89 | 4.68 | 7.76 | 15.33 |
| $T_4 \times C_3$ | 13.78 | 30.76 | 38.35 | 82.89 | 4.15 | 8.76 | 14.77 | 27.68 |
| $T_4 \times C_4$ | 7.51 | 4.26 | 14.55 | 26.32 | 2.54 | 1.67 | 5.75 | 9.96 |

$T_1$= *G. sepium*, $T_2$=*Delonix regia*, $T_3$=*Terminalia arjuna*, $T_4$=*Swietenia mahagoni*, $C_1$=Bare-rooted, $C_2$=Gunny bag, $C_3$=Poly bag and $C_4$=Earthen pot.

## Discussion

For any MPTs initial growth performance is very important as it gives an idea or reflects about the performance in field. In the study *G. sepium* was found superior MPTs for all the studied parameters accept leaf number and gunny bag shown better result.

In terms of plant height performance the four studied MPTs can be ranked as *G. sepium* > *D. regia* > *T. arjuna* >*S. mahagoni* and growth containers as bare rooted > gunny bag > poly bag > earthen pot.

Khan *et al.* (2004) observed three months old seedlings of *Gliricidia sepium* attained highest shoot growth among the eleven multipurpose tree legume seedlings; while Milks *et*

*al*. (1989) reported that plants growing in small containers have growth problems due to poor aeration or low water holding capacity of the growing medium. Hence the shortest seedling height of earthen pot might be due to poor aeration and limited space available to the root system in the earthen pots. For collar diameter the MPTs showed the same trend as plant height. Gunny bag found better up to 3 months but after 6 months both bare rooted and poly bag produced maximum collar diameter than the gunny bag. And as usual the earthen pot produced lowest collar diameter for all the species. Generally leaf number may vary from species to species. *T. arjuna* shown maximum leaf number for all the sampling dates followed by *G. sepium, D. regia* and *S mahagoni*. Up to three months, bare rooted seedling produced maximum leaf number but the six months data showed that gunny bag produced maximum and statistically different leaf number than the others. After 6 months gunny bags were rotten and added more nutrients and organic matter to the root area which increased the leaf number in gunny bag containers than the other three containers.

Among the studied MPTs, *G. sepium* produced maximum biomass followed by *D. regia, T. arjuna and S. mahagoni.* Gunny bag was found suitable for biomass production among the containers followed by bare rooted, poly bag and earthen pot. *G. sepium* and *D. regia* performed similarly in terms of biomass production and partitioning in different growth containers. On the contrary *T. arjuna* and *S. mahagoni* perform similarly for biomass production and partitioning in different growth containers.

In any plantation program, during uprooting from nursery, bare rooted seedlings are always injured in root which reduces the survival rate in field condition. In the study except bare rooted, gunny bag performed better over poly bag and earthen pot as it is easily decomposable and adds nutrients, organic matters to the soil. Moreover gunny bag is environmentally friendly and completely organic while comparing with poly bag.

**Conclusion:** The initial growth performance is very important for any MPTs as it gives an idea or reflects about the performance in field. In the study *G. sepium* performed better all the studied parameters accept leaf number. In terms of plant height performance the four studied MPTs can be ranked as *G. sepium* > *D. regia* > *T. arjuna* >*S. mahagoni* and growth containers as bare rooted > gunny bag > poly bag > earthen pot. For collar diameter the same trend was followed. *T. arjuna* showed maximum leaf number for all the sampling dates followed by *G. sepium, D. regia* and *S. mahagoni*. Gunny bag found better up to 3 months but after 6 months both bare rooted and poly bag performed better. However earthen pots performance was poor for all the species. Up to three months, bare rooted seedling produced maximum leaf number but the six months data showed that gunny bag produced maximum and statistically different leaf number than the others. *G. sepium* produced maximum biomass followed by *D. regia, T. arjuna and S. mahagoni.* In the study after bare rooted, gunny bag performed better over poly bag and earthen pot as it is easily decomposable and adds nutrients, organic matters to the soil. Moreover gunny bag is environmentally friendly and completely organic while comparing with poly bag. So for local plantation program seedling can be grown in gunny bag.

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