Australian Journal of Basic and Applied Sciences, 4(8): 3038-3042, 2010
ISSN 1991-8178

Comparative Growth Performance of *Albizia procera* Seedlings Raised in Nursery Bed, Polybag and Root Trainers

[1]Farhana Jabbar, [1]Nure Ferdousee, [1]Mohammed Kamal Hossain and [1,2]A.T.M. Rafiqul Hoque

[1]Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong-4331, Bangladesh
[2]Laboratory of Ecology and Systematics (Plant Ecophysiology Section), Biology Division, University of the Ryukyus, Okinawa 903-0213, Japan,

Abstract: Comparative growth of *Albizia procera* seedlings grown in polybag, nursery bed and root trainers was investigated with an aim to select suitable container for quality seedlings for large scale plantation programs. Seed germination and seedling growth were assessed for shoot length, root length, collar diameter, fresh weight, dry matter production, leaf number and number of nodules of the seedlings. Vigor index, quality index, imbibition period, energy period and root shoot ratio were also calculated for each treatment. Germination percentage was found better in nursery bed. Seedlings raised in polybags of 23 x 15 cm size revealed best performance in respect to germination and other growth parameters. However, root-shoot ratio was higher in root trainer in comparison to other treatments. Polybag size of 23 x 15 cm was found suitable in the nursery for quality seedling production of *Albizia procera*.

Key words: Plantations, polybag, nursery bed, root trainers, nursery, *Albizia procera*

INTRODUCTION

Albizia procera is a large, fast-growing tree that occurs and found in natural forest and homesteads of Bangladesh. This species provides wood for a variety of purposes, nutritious fodder for livestock and shade for tea plantations. It is an important reforestation and agroforestry species (Parrotta and Roshetko, 1997). Due to its multipurpose use and nitrogen fixing ability it is considered as one of the priority species in plantation programs. Opportunities exist in the improvement of seedling production system to provide quality seedlings without increasing costs. Survival and improved growth of plants lead to better financial and ecological output and can generate sustained production for organizations involved in tree planting activities (Davidson, 1995). 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, palmyrah 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. But, root trainer is increasingly being used to deal with the problems of root coiling and distortion. Root trainers are the containers, usually made of high density polythene, designed with 4 - 6 vertical ribs and have open bottoms (Davidson, 1995). The most common type is the Hiko pots with 20-25 cavities each having 150 cm^3 volumes. The root trainers are placed on a root trainer stand in such a way that the drainage hole is exposed above the ground, which facilitates free flow of air. The present study was initiated to compare *A. procera* seedlings grown in different containers.

MATERIALS AND METHODS

The study was conducted in the nursery of the Institute of Forestry and Environmental Sciences, Chittagong University Campus during the month of April-September. Forest top soil was mixed with

Corresponding Author: Nure Ferdousee, Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong-4331, Bangladesh
E-mail: nure300679@gmail.com

decomposed cow dung in a ratio of 3:1. A total of 600 polybags and root-trainers were filled with the sieved potting media. Three types of containers with the same potting media, were used to compare the *Albizia procera* seedling growth. These are:

T_0 : Root-trainer;
T_1 : Poly bag of size 23×15 cm (9×6 inch);
T_2 : Poly bag of size 12×15 cm (5×6 inch) and
T_3 : Traditional nursery bed.

(Note: The specific type of spencer-Lamaire Root-Trainer was used. The root-trainer was Fleet 'B' block of four cells each 350 cc pot space with 20 cm depth. Ten blocks (40 cells) fit into a plastic fleet holder (also called basket or tray), size 40 cm long × 26 cm wide × 13 cm height. 0.06 mm thick, white and transparent polybags and Nursery bed of 5 m length and 1.25 m. wide was used)

A randomized complete block design with four replicates was used in the study. *A. procera* seeds were sown in the subplots of the nursery bed directly and covered with thin layer of sand and soil. Adequate care and maintenance were taken from the time of seed sowing up to the harvesting of seedlings.

The effects of seed sowing in different containers were assessed periodically through counting germination and initial growth performance of the seedlings. At the age of four months, five dominant seedlings from each treatment were randomly selected and uprooted very carefully to estimate the seedling biomass. The seedlings were measured for shoot length, collar diameter, root length and total oven dry weight (leaf, shoot and root components). Leaf, shoot, root and nodules were oven dried at $70^{O}C$ for 48 hours until the constant weight is obtained. The germination and growth data were analyzed statistically by using computer software package SPSS for determining the morphological growth variation. Germination energy was calculated using the formula of Djavanshir and Pourbeik (1976). Vigor Index was calculated according to Abdul-Baki and Anderson (1973). The Quality Index (QI) of the seedlings was computed as developed by Dickson *et al.* (1960).

RESULTS AND DISCUSSION

Seed Germination:

Albizia procera attained 95% germination within 14 days energy period in T_3 treatment followed by T_0 treatment. T_3 treatment (root trainers) took longer time (energy period 9 days) and showed highest germination percent (95%) was high in comparison to other treatments (Table 1). The effect of different containers on mean daily germination percent was highest (Figure 1) at the 8^{th} day after sowing in T_2 treatment. The cumulative germination percent for treatment T_3 rises sharply from the 8^{th} to 16^{th} days and remains constant upto 24^{th} day. The cumulative germination percent remains highest for T_3 treatment followed by T_0, T_2 and T_1 treatments (Figure. 2).

Growth Performance of the Seedlings:

Table 2 presents the comparative morphological information recorded in different treatments. The mean total length of the seedlings was highest in T_1 (109.0 cm) followed by T_2, T_3 and T_0 treatments. Considering the collar diameter of the seedlings, T_2 has highest collar diameter (6.6 mm) followed by T_1 and is significantly different from T_3 and T_0 treatments. Similarly, the mean number of leaves was highest in T_1 (15) and significantly different from T_3 (12), T_1(11) and T_0(8) treatments.

Table 3. presents comparative weights (dry and fresh) of different parts including total plants. The oven dry weight of seedling components (shoot, leaf, and root) of different treatments were statistically analyzed. Mean shoot dry weight (g) was highest in T_1 but not significantly different from T_2. Besides it was significantly different from T_3 and T_0. Root dry weight (g) of the seedlings was highest for T_1 followed by T_2 and those were significantly higher than T3 and T0 treatments. Similarly and Leaf dry weight (g) of the seedlings was highest for T_2 followed by T_1 and those were significantly higher than T_3 and T_0 treatments. Considering the seedling dry weight, T_2 attained the highest biomass followed by T_1, $T_3$and T_0. Considering the vigor index, T_3 attained the highest value followed by T_2, T_1, and the lowest value for T_0. But, T_2 attained the maximum seedlings quality index followed by T_1 and significantly different from T_0 and T_3 treatments. The high root/shoot ratio was observed in T_0 followed by T_3, T_1 and T_2 treatments.

Comparative nodulation behavior is shown in table 4. Maximum 70 nodules were recorded in T_2 followed by T_1. But the number of nodules recorded in T_3 and T_0 were significantly lower than T_1 nad T_2. Highest fresh and dry weight of nodules was recorded T_1 followed by T_2. Nodule dry weight was significantly higher in T_1 and T_2 compared to T_3 and T_0. In the present study, the seedling morphometric parameters were superior in 23×15 cm (9×6 inch) polybags (Table 4).

Table 1: Effect of different containers on germination, imbibition and germination period of *Albizia procera* seeds.

Treatments	Germination %	Imbibition (days)	Germination Period	Energy period (days)
T0	55.0 b*	4	10	6
T1	34.0 c	5	9	4
T2	49.0 b	4	8	4
T3	95.0 a	6	15	9

* Means followed by the same letter (s) are not significantly different at p<0.05, Duncan's Multiple Range Test (DMRT).

Table 2: Comparative morphological study of 4 months old *Albizia procera* seedlings grown in different containers in nursery conditions

Treatment	Shoot height (cm)	Root Length (cm)	Total length (cm)	Collar dia. (mm)	Vigor Index	Leaf no.
T0	43.7b*	28.0b	71.7b	2.1b	3938.0c	8.0c
T1	76.3a	41.3a	117.7a	6.1a	3998.4c	15.0a
T2	72.0a	37.0ab	109.0ab	6.6a	5341.0b	11.0b
T3	633ab	30.7a	93.0ab	3.3b	8825.5a	12.0b*

Means followed by the same letter (s) are not significantly different at p<0.05, Duncan's Multiple Range Test (DMRT).

Table 3: Comparative study of fresh and dry weight, quality index, root/shoot ratio of 4 month old *Albizia procera* seedlings grown in different containers at nursery conditions

Treatment	Shoot fresh weight (gm)	Root fresh weight (gm)	Leaf fresh weight (gm)	Total fresh weight (gm)	Shoot oven-dry weight (gm)	Root oven-dry weight (gm)	Leaf oven-dry weight (gm)	Total oven-dry weight (gm)	Quality Index (QI)	Root/Shoot ratio
T0	2.55b*	4.19b	4.30c	11.04c	2.09b	3.14c	3.51c	8.74c	0.41	1.50 ns
T1	17.2a	20.16a	21.63a	58.99a	12.88a	17.25a	12.89ab	43.02a	3.25	1.34 ns
T2	16.34a	22.25	19.63a	58.22a	13.06a	16.36a	14.22a	43.64a	3.73	1.25 ns
T3	6.86b	9.04b	12.0b	27.9b	7.54b	9.95bc	22.79b	40.28b	1.15	1.42 ns

* Means followed by the same letter (s) are not significantly different at p<0.05, Duncan's Multiple Range Test (DMRT).

Table 4: Nodule number and mass of 4 month old *A. procera* seedlings grown in different containers

Treatment	Nodule no.	Nodule fresh weight (gm)	Nodule oven dry weight (gm)
T0	17.0b*	0.21b	0.06b
T1	65.0a	1.76a	0.57a
T2	70.0a	1.41a	0.45a
T3	20.0b	0.75ab	0.23ab

* Means followed by the same letter (s) are not significantly different at p<0.05, Duncan's Multiple Range Test (DMRT).

Significant differences were observed for all the growth parameters among seedlings grown in containers, root-trainers and nursery bed. It is revealed that the size of the container has influence on all the characters, e. g. size, root length, shoot height, shoot collar diameter, number of leaves, number of nodules, root and shoot fresh weights, root and shoot dry weights, and quality index, vigor index, root/shoot ratios throughout the growth period of the seedlings. The increased root lengths of container grown seedlings perform better on adverse sites than do bare root seedlings (Goodwin, 1976) and they survive better under drought conditions (Amidon *et al.*, 1982). 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. Aeration porosity is considered to be the most important physical property of any growing medium (Brag and Chambers, 1988). The container of 9 x 6 inch size recorded superiority over 5 x 6 inch size polythene containers and then nursery bed and the seedlings grown in the root trainer for the above growth parameters of the seedlings. The seedlings raised in root trainers have shown poor performance for height, collar diameter, number of nodules and the biomass parameters for *A. procera* in comparison to other treatments. This may be due to the limited space available to the root system in root trainers (Gera and Ginwal, 2002). Seedlings can better be compared on the basis of quality parameters, rather than on actual values on height or collar diameter. Seedling quality specifications have traditionally been based on certain morphological characters such as root/shoot ratio and some other root features (Aldhous, 1967; Cleary *et. al.,* 1978; Lavender and Cleary, 1974; Schmitt-Vogt, 1974). The root /shoot ratio indicates the higher amount of root production which is also a pre-requisite for seedling establishment through anchorage and more absorption of nutrients (Hossain *et. al.,* 1998). Poor nodulation was observed in seedlings raised in root trainers. However, root trainer raised seedlings registered the maximum values on root/shoot ratio among the treatments. Higher values on root/shoot ratio were observed in seedlings raised on polybags in comparison to seedlings raised on nursery beds. Several Researchers found suitable container size for particular species such as 30 × 20 cm for *Cocoa* (Keshavachandran and Nair, 1985), 30 × 15 cm for *Santalum albam* (Karivaradharaaju, 1999), 26 × 12.6 cm for *Azadirachta indica* (Bharathi, 1999) and 25 × 15 cm for *Albizia lebbeck* (Natarajan, 1999). However, the treatments when compared on the basis of seedling quality parameters in different containers, 23 × 15 cm size (9 × 6 inch) container is the best in order to obtain vigorous seedlings capable of surviving under stress in nursery condition.

Growth performance of seedlings increased with the increase of polybag sizes in comparison to nursery bed and root trainers. Longer containers have significant influence on the survival, height and nodule formation under nursery conditions. The present study has provided information that differences in seedlings growth were significant throughout the treatments. The seedlings raised in root trainers showed poor performance in comparison to other treatments.

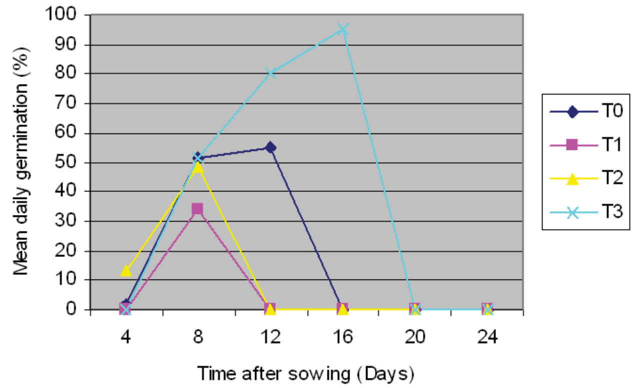

Fig. 1: Effect of different containers on mean daily germination percent of *Albizia procera* seeds

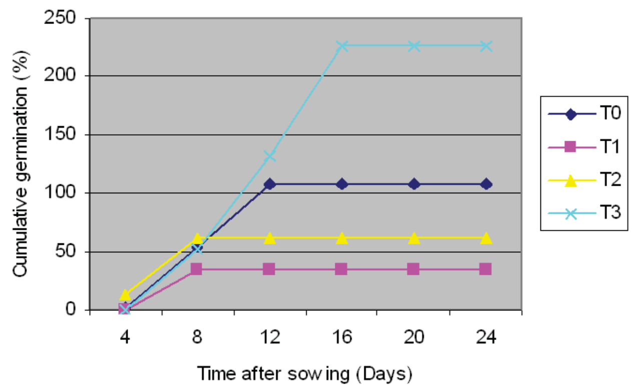

Fig. 2: Effect of different containers on cumulative germination percent of *Albizia procera* seeds

For quality seedlings, polybags of T_1 treatment (23 × 15 cm size, or 9 × 6 inch) produce the best seedlings followed by T_2 (12 × 15 cm or 5 × 6 inch), T_3 (nursery bed) and T_0 (root trainer) treatment. T_1 treatment may be recommended to raise the quality seedlings for large scale plantations in short time due to its lower cost involvement. However, for successful afforestation and reforestation programs and maximum survival of seedlings in the field, the bigger size poly bags as well as the quality seedlings are essential in field planting. So, after keeping cost factors in consideration polybags of bigger sizes (23 × 15 cm size = 9 × 6 inch) may be preferred for raising large and vigor seedlings.

Conclusion:

Based on the results of the present experiment, it may be recommended that seedlings should be grown in 23 × 15 cm size containers, in order to obtain vigorous seedlings capable of surviving in plantation area. But, recently Government is discouraging the use of polybags in raising seedlings because of environmental hazards. Root trainers are becoming popular as they can be reused for several years and very light to transport. However selection of suitable media for trainer is also essential for the growth and development of quality seedlings. But before that polybags of 23 x 15 cm in size may be used for quality seedling production programs.

ACKNOWLEDGEMENT

The authors are highly grateful to two anonymous reviewers and editorial teams especially to Dr. Muhammad Atif, Managing Editor, Australian Journal of Basic and Applied Sciences in improving the quality of this manuscript.

REFERENCES

Abdul-Baki, A.A. and J.D. Anderson, 1973. Vigour determination in soybean seed by multiple criteria. Crop Sci., 13: 630-633.

Aldhous, J.R., 1967. Review Research and Development in forest nursery techniques in Great Britain 1949-1966. Paper for FAO Symposium on Man-made Forests, 1967. For, comm., Res. and Development Paper, 46: 11.

Amidon, T.E., J.P. Barnett, J.P. Gallagher and J. Mcgilyray, 1982. A field test of containerised seedlings under draught conditions. *Proc Southern containerized Forest tree seedlings Conference.* [R.W. Guldin and J.P. Barnett (Eds.)]. Gen. Tech. Rep. No. 37. USDA Forest Service, Southern Forest Experiment Station. New Orleans, pp: 139-144.

Bharathi, A., 1999. *Studies on handling, management and storage of Neem Seed* (*Azadirachta indica* A. Jnss.). Ph. D. Thesis, Seed Science and Technology. Tamil Nadu Agricultural University, Coimbatore.

Bragg, N.C. and B.J. Chambers, 1988. Interpretation and advisory applications of air filled porosity (AFP) measurements. Acta Hort., 129: 35-44.

Cleary, B.D., R.D. Greaves and P.W. Owston, 1978. *Seedlings, Rgenerating Oregon's Foresters* (Cleary, B.D.; Greaves R.B. and R.K. Hermann, eds.) Oregon University Extension Service, Corvallis, Oregon, pp: 63-67.

Davidson, J., 1995. Root trainers in seedling production system for Forestry and Agroforestry in Bangladesh. Technical Training Manual, Forest Resources Management Project, Government of Bangladesh and The World Bank.

Dhiman, R.C. and S.D. Sood, 1994. Trials with different root trainers and potting medial. In: *Proc Seminar on root trainer seedling production system* (K. Subramanian and M. Tha, eds.). Pune, 6: 35-39.

Dickson, A., A.L. Leaf, J.F. Hosner, 1960. Quality appraisal of white spruce and white pine seedling stock in nurseries. For. Chronicle., 36: 10-13.

Djavanshir, K. and H. Pourbeik, 1976. Germination value - a new formula, *Silvae Genetica* 25: 79-83.

Evans, J., 1993. *Plantation silviculture in the tropics*. Clarendron Press, Oxford.

Gera, M. and H.S. Ginwal, 2002. Preliminary observations on field trial of root trainer raised seedlings. The Ind. Forester, 128(1): 19-26.

Goodwin, O.C., 1976. Summer-planted loblolly and longleaf pine tubehngs outgrow 1-0 nursery seedlings in North Carolina. J. For., 74: 515-516.

Hossain, M.K., S. Akhter and S.M. Riadh, 1998. Effect of polybag size on initial growth of *Casuarina equisetifolia* seedlings in the nursery. The Chittagong University Journal of Science. The Chittagong Univ. J. of Sci., 22(2): 43-46.

Karivaradharaaju, T.V., K. Vanangamudi, R. Umarini, A. Bharathi, C. Surendren and S. Balaji, 1999. *A treatise on tree seed technology.* Sowmiya Communications, Coimbatore, pp: 90.

Keshavachandran, R. and P.C.S. Nair, 1985. Standardisation of seed propagation in cocoa. Indian cocoa, Arecanut & spices J., 9(1): 1-4.

Lavender, D.P. and B.D. Cleary, 1974. Coniferous seedling production techniques to improve seedling establishment. *Proc, North American Containersed Forest Tree Seedling Symposium* [Tinus, R.W.; Stein, W.I. and W.E. Balmer, (eds.)] Denver, Colorado, August 26-29. Great Plains Ag. Council Pub.

Milks, R.R., W.C. Fonteno and R.A. Larson, 1989. Hydrology of horticultural substrates: III. Predicting air and water content of limited. Volume plug cells. J. Amer. Soc. Hort. Sci., 114(1): 57-61.

Natarajan, S., 1999. Investigations on seed source variations, standardization of seed testing procedures and nursery techniques in *Albizia lebbeck* (L) Benth. Ph. D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Parrotta, A. and J.M. Roshetko, 1997. A quick guide to multipurpose trees from around the world. FACT Sheet. FACT 97-01, Forest, Farm, and Community Tree Network (FACT Net), Winrock International, 38 Winrock Drive, Morrilton, Arkansas 72110-9370, USA

Schmitt-Vogt, H., 1974. Planting Material. *Proc. Symp. Stand Establishment*, IUFRO Joint Meeting Divs. 1 and 3 Wageningen, The Netherlands, October, pp: 69-107.