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Growth Performance of Ipil Ipil (*Leocaena leococephala* (Lam.) de wit.) Under Different Conditions at Nursery Stage in Bangladesh

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Abstract: In the present investigation the growth performance of Ipil-Ipil (*Leucaena leucocephala* (Lam.) de wit.) seedling was studied under different conditions in the nursery. In dry season, the growth is poor, but starting the wet season, there was sharp rise in growth. In height and diameter growth, Seedbed under peat with cowdung mixture showed the best result, then polybag and plastic tray in all the media. In all types of containers, peat with cowdung mixture showed the best result. Similarly seedling growth performances showed good relation with seasonal variations. Leaf production also showed the same trend with seasonal variations as well as growth performance.

Key words: Ipil-Ipil, Bangladesh, growth performance, nursery

INTRODUCTION

The forest cover of Bangladesh is about 14.85% of the land area of the country[1]. Its a densely populated country (834 persons km^{-2}) with an area of about 14.4 million ha and a population of 123.1 million[1], is one of the poorest countries in the world. Natural Forests of Bangladesh (which are state owned) are controlled by the Forest Department and fall under three classes: Hill forest (84%), Inland Sal forest (9%) and Mangrove forest (43%)[2]. Besides, Village forests covers about one-seventh of the country. Village forest contribute 89% and 80% of the countries total fuel wood and saw or ply logs supply, respectively[3]. These forests that are unevenly distributed are the sources of various forest products and the reported productivity of these forests are extremely low (0.5-2.5 $m^3ha^{-1}yr^{-1}$)[4]. Despite a very low per capita consumption of wood (fuelwood 0.06 m^3 and timber 0.018 m^3)[5] the supply from the forest is inadequate and far beyond the demand. There remains a wide gap between the supply and demand of forest products (5 million m^3)[4]. On the other hand the demand for good quality wood is very high in Bangladesh and insufficient availability of fuelwood and good quality wood species have been the main cause of damage to forest in many areas and threat to environment and energy[4]. The present forest system of Bangladesh is unable to meet the present demand of forest products for its people due to over exploitation of resources, destruction of forests by different agents, shortage of quality seed supply and planting stocks, increased cost of raising plantation and shortage of sufficient research and technology know how. The northern part of the country is going to turn into desert due to shortage of water level. Beside these, Plantation of Bangladesh is generally done by traditional method by seeds and seedlings. For this program, seeds are generally collected from existing plantations and natural stands. As a result, problems like non-uniformity of timber, slow growth, average low quality and quantity. Pests and diseases often damage these seeds. To get rid of such worse situation Bangladesh Forest Department introduce *Leucaena leucocephala* in August 1977 from the Philippines[6]. Peoples widely prefer fast growing multipurpose trees for their plantation programs. From that aspect it was found that Leguminosae is the best because of its fast growing, nitrogen-fixing, coppicing ability to adapt in wide range of environment.

Of all tropical legumes, *Leucaena* probably offers the widest assortment of uses. Through its many varieties, *Leucaena* can produce nutritious forage, firewood, timber and rich organic fertilizer. Side by side seeds of Ipil after softening are strung as beans into various items of jewelry for tourists in Puerto Rico and the Virgin Islands[7]. The wood, leaves, Twigs have a medicinal value as well as tannin[8]. It's diverse uses in regenerating tropical hillslopes and providing windbreaks, firebreaks, shade and ornamentation. Individual *Leucaena* trees have yielded extraordinary amounts of wood-in-deed, among the highest annual total yields ever recorded[9]. This species has aesthetic value to plant ornamentally in

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school, college, Madrasha and Island of road in town area. Medicinally, the bark is eaten for internal pain. A decoction of the root and bark is taken as a contraceptive, ecbolic, depilatory, or emmenagogue in Latin America. However, in experiments with cattle, *Leucaena* had no effect on conception[7]. *Leucaena* is relatively resistant to the pests and diseases. More over in mixed cropping it is reported that Bananas may do better in the shade of *Leucaena* than in full sunlight due to reduced damage by Sigatoka disease[7].Wood specific gravity of *Leucaena leucocephala* is about 0.50-0.70[10]. Leucaena wood has the potential to become a major source for pulp and paper, roundwood and construction materials[9]. In some cases, the wood of *Leucaena leucocephala* is used for light furniture, handles of agricultural tools[11]. The cylindrical type of bole is also used for Posts, poles, rafts[8]. The sapwood light yellow, the heartwood yellow-brown to dark brown used for fuel or charcoal. Plants are used in some countries for shade for black pepper, coffee, cocoa, quinine and vanilla and for hedges[7]. Leucaena wood makes excellent firewood and charcoal, source of electricity (dendroplants in Philippines powered by Ipil-Ipil wood)[8,9]. Fuel wood calorific value of this species is about 4200-4600[10]. Cattle and goats browse this species[10]. The wood has uncommonly high density and calorific value for a fast-growing tree and because the stumps readily coppice, the plant could become a renewable fuel resource in areas suited to its agronomic requirements. In the Philippines, dense *Leucaena* plantations have yielded higher annual quantities of wood than any species yet measured. In pure plantation, Volume production is about 20-40 cubic meters per hectare per year[8].

In Bangladesh it was reported that the leaves, twigs and fruits are excellent fodder for domestic animals[8,11-13]. The powdered form of seeds is used as poultry feed[12]. Young pods and seeds are cooked and eaten with rice[14]. In recent, British-American Tobacco Company Ltd. utilizes the wood chips of Ipil-Ipil for the substitute of Tobacco. So it is more economic as well as to conserve human health. Due to its multipurpose utility and wide range of ecological amplitudes (specially suitable to Bangladesh Environment) the species is recommended road side as well as khat land other than forest land[13]. The species has potentiality in newly formed islands and coastal areas of the country where need immediate plantations for stability of soils and protect the country from unexpected flood and other natural calamities. Systematic site-specific growth information is scarce in Bangladesh. So it was felt necessary to generate information based on initial growth performance of this species seedling in different rooting media.

MATERIALS AND METHODS

Seed source and collection: Seeds of *Leucaena leucocephala* were collected from different region of Khulna districts during October in Bangladesh. The ripe fruits were collected directly from the matured trees and dried for a week in the open sun. The seeds were then separated from the pods by hand and dried again in the sun for another week. The collected seeds were checked to remove the discolored damaged seeds.

Site and environmental condition

Physical environments: Khulna district is situated between the latitudes of 22°12' and 23°59' N and between 89°14' to 89°45' E. The total area of the district is 4394.46 km^2 of which 59.79 km^2 is riverine[15]. The study area is under Batiaghata thana of this district.

Climatic conditions: Like other parts of Bangladesh, the climate of Khulna is sub-tropical in nature and there are three main reasons such as winter, summer and monsoon. The winter begins in November and ends in February. Here winter is relatively mind and the temperature fluctuation is low. The temperature ranges from a minimum of 7.22-12.77°C in winter to a maximum of 23.88-31.11°C in summer. Occasionally the temperature might be as high as 36.66°C or more and the mean monthly temperature is 28°C (Fig. 1). The summer is from March to June and the monsoon starts in July and continues until October[16]. This Monsoon period (June-October) is characterized by heavy rainfall under the influence of southwest monsoon wind. During the experiment, the average temperature, rainfall and humidity were 24.77°C, 64.31 mm and 78.1%, respectively.

A number of rivers are flown through this thana. All the rivers are subjected to ebb and tide all the year round. The salinity in these rivers is extreme in the irrigation season. During the rainy season the salinity is almost nil. But with the start of dry season, the salinity gradually increases and reaches to maximum during April to May.

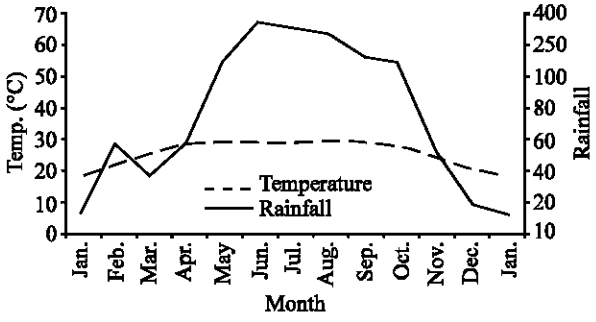

Fig. 1: Climatic map of Khulna district[31]

As the dams protect the areas, saline water cannot invade into the agricultural fields and homesteads[17]. There are four soil series identified in the Batiaghata thana. A brief description of the different series is given Table 1.

Peat soil: In Bangladesh, peat soil covers an area of about 0.22 million ha, which is 1.6% of the total area of the country. Peat soil occupies a number of basin areas lying between the Ganges River floods plains of Gopalganj, Bagerhat and adjoining parts of Khulna, Barisal and Jessore districts. Peat soil is also found in the Sylhet basin[18]. Peat soil of Bangladesh is seasonally flooded, poorly drained, very dark grayish brown to black organic soil. In peat soils organic matter content is very high. Due to the presence of highly decomposed and partially decomposed organic matter, there is a possibility of root injury by H_2S gas. A lump of soil is lighter in weight than mineral soil when dried. Very late draining, low bearing capacity, irreversible shrinking property after drying, deep flooding the wet season are the main limitations of peat soil. It may be mentioned that the drying of peat soil is hazardous due the irreversible subsidence of the ground level[18]. The soil reaction is generally slightly acidic (pH 5.9-6.4). Soil salinity ranges from non-saline to slightly saline (ECe: 0.9-5.5 dSm^{-1}). It is revealed that organic matter content is very high. Organic matter content increases with depth in both the soils that vary from 18.2-45.5%. Total nitrogen and sulfur contents show the same trend as organic matter. Total N varies from 0.78-1.7% and sulfur from 135.5-499 $\mu g\ g^{-1}$ of soils. Almost all the macro and micronutrients are very high throughout the profile. Pungent smell of H_2S gas was evolved during excavation of the profile.

From the above configuration, soil means the soils other than peat soil that is available in Khulna region. Peat, soil and cowdung should finely grin after drying the sun.

Experimental design: Randomized Complete Block Design, was used for measuring the effect of media and containers on growth performance of the species *Leucaena leucocephala*. In the experiment, three types of containers and media were used. Transparent Polybag (10×15 cm^2), Plastic seed-tray (24.5 cm dia.) and Open seedbed (They are indicated as C_1, C_2 and C_3, respectively). In every container, three types of media were used. These were Peat Soil + Cowdung (3:1), Soil + Cowdung (3: 1) and Soil + Peat Soil(1:1) (They are indicated as m_1, m_2 and m_3, respectively).

In the experiment, untreated seeds were used. To test the interaction between media and container, in each container all types of media were used to prepare the germination bed. For each media, 4 replications were used to assess the internal variability of the species. For each replication 25 seeds were considered. In germination, one seed was dibbled in each poly bag and 25 bags were separated as a replication. Similarly, 25 seeds were sown in each seedbed (18"×18") and plastic tray as replications. After two months of seed sowing six seedlings of same ages from each replication were selected randomly. Stem diameter, height and leaf numbers of the seedlings were measured. Wooden scale, slide caliper were used for the measurement. The measurements were taken after one month interval from December to May. During the experiment, only the last month's data were used for analysis of variance and the graphical presentation was made by the data of 6 months. During the experiment, the potted seedlings were individually rotated to avoid roots penetration into the ground. Watering was made every day with regular interval. An equal amount (on volume basis) of water was given to each replication. Weeding was done once per week.

Data analysis: The analysis of variance (ANOVA) was carried out to test the effect of media and containers on germination and growth performance. For significant treatments, Least significant difference (LSD) was made.

RESULTS AND DISCUSSION

For assessing the effect of containers and media, three parameters of growth (Height, diameter and leaf number) were studied.

Height growth: The height growths of *Leucaena leucocephala* in different conditions are shown in the (Fig. 2-4). For all types of containers, highest height growth was observed in m1 media. For polybag, plastic tray and seedbed, the rates were found 97.96, 70.29 and 133.91 cm, respectively and the lowest height growth was observed in m_2 media. For poly bag and plastic tray the rates were 81.65 and 61.88 cm, respectively. Similarly in seedbed the lowest height growth 118.75 cm was found in m_3 media (Table 3). Similar results also recorded in Matin and Rashid[19] where the height growth of *L. leucocephala* ranges from 80 to 100 cm. In comparison to the fast growing *Albizia* species, similar observations among the species were also found during height growth[20]. Similar fast growing tendency in height growth of *A. procera* (52.7 cm), *A. falcateria* (64.2 cm) and *A. chinensis* (73.11 cm) were also reported by Nandy[21]. According to Ruiz and Febles[22] study of seeds of *L. leucocephala,*

Table 1: Physical and chemical properties of the soil series of Batiaghata Thana[17]

Soil series	Land class	Soil texture	pH value	Organic content (%)	Drainage condition
Gopalpur	High	Clay loam	7.3	2.5	Slightly poorly drained
Isshardi	Medium High-High	Clay	6.5	2.1	Poorly drained
Bazoa	Medium High-High	Clay loam	5.4-7.3	2.41	Poorly drained
Barisal	Medium High	Clay	4.9-7.6	2.35	Poorly drained

Table 2: LSD for height growth, diameter growth and leaf number

Height growth				Diameter growth				Leaf no.			
Container		Media		Container		Media		Container		Media	
Treat	Remark	Treat	Remark	Treat	Remark	Treat	Remark	Treat	Remark	Treat	Remark
C_3	a	m_1	a	C_3	a	m_1	a	C_3	a	m_1	a
C_1	b	m_3	b	C_1	b	m_3	b	C_1	b	m_2	b
C_2	c	m_2	b	C_2	c	m_2	b	C_2	c	m_3	b

Values in the remark columns forwarded by the same letter(s) are not significantly different at 0.05 level

Table 3: Growth data of *Leucaena leucocephala* seedling (December-May)

	Polybag			Plastic tray			Seedbed		
Height growth	m_1	m_2	m_3	m_1	m_2	m_3	m_1	m_2	m_3
Dec.	11.65±4.240	9.81±1.700	10.60±0.69	9.95±2.670	7.54±1.060	6.67±0.430	12.73±4.600	11.24±1.840	11.51±0.73
Jan.	16.00±4.880	13.52±1.900	12.19±0.78	13.96±3.370	9.29±1.350	8.42±0.540	17.42±5.870	16.81±2.350	14.66±0.94
Feb.	23.56±9.170	19.80±3.670	22.92±1.47	19.41±4.610	14.33±1.850	11.53±0.740	24.19±8.270	22.29±3.310	20.67±1.32
Mar.	53.50±17.52	38.00±7.000	43.79±2.80	31.29±9.650	20.25±3.860	24.13±1.540	52.25±18.15	40.25±7.260	45.36±2.90
Apr.	70.50±26.34	55.50±10.54	65.83±4.21	52.25±18.15	42.25±7.260	45.36±2.900	92.34±29.37	82.92±11.75	73.42±4.70
May	97.96±35.52	81.65±14.21	88.79±5.69	70.29±26.19	61.88±10.48	65.64±4.190	133.91±47.51	121.89±19100	18.75±7.60
Diameter growth									
Dec.	0.16±0.060	0.14±0.020	0.15±0.009	0.15±0.060	0.15±0.020	0.15±0.009	0.24±0.090	0.22±0.030	0.23±0.01
Jan.	0.20±0.070	0.18±0.030	0.19±0.010	0.20±0.070	0.18±0.030	0.19±0.010	0.31±0.110	0.29±0.040	0.28±0.01
Feb.	0.25±0.010	0.25±0.004	0.23±0.001	0.26±0.090	0.22±0.038	0.24±0.010	0.36±0.130	0.35±0.050	0.33±0.02
Mar.	0.49±0.160	0.33±0.060	0.41±0.020	0.49±0.140	0.31±0.057	0.36±0.020	0.52±0.160	0.49±0.060	0.42±0.02
Apr.	0.65±0.240	0.51±0.090	0.60±0.030	0.60±0.210	0.46±0.080	0.53±0.030	0.76±0.250	0.69±0.090	0.62±0.03
May	0.84±0.290	0.71±0.110	0.75±0.040	0.70±0.250	0.58±0.100	0.63±0.040	0.95±0.340	0.89±0.140	0.85±0.05
Leaf no.									
Dec.	11.87±4.550	10.04±1.800	11.38±0.730	10.17±3.380	7.42±1.350	8.46±0.540	16.71±5.770	12.96±2.300	14.42±0.92
Jan.	19.00±5.770	15.67±2.300	14.42±0.920	15.70±4.200	10.38±1.680	10.50±0.670	23.04±7.140	20.08±2.860	17.86±1.14
Feb.	30.58±9.650	25.33±3.860	24.13±1.540	23.92±9.010	18.92±3.600	22.54±1.440	30.67±12.15	26.21±4.860	30.38±1.94
Mar.	59.29±18.60	40.25±7.440	46.50±2.900	50.25±16.90	45.33±6.800	42.25±2.700	70.29±24.75	45.36±9.900	61.88±3.96
Apr.	93.92±35.57	80.50±14.23	88.92±5.690	75.25±26.27	70.16±10.51	65.67±4.200	118.75±36.03	97.96±14.42	90.08±5.76
May	154.36±53.56	118.75±21.43	133.92±8.580	109.75±38.32	102.20±15.33	95.79±6.130	174.83±61.76	165.88±24.71	154.38±9.88

Where m_1, m_2 and m_3 shows the average data of 24 seedlings (4 replication). ± shows 95% confidence limit

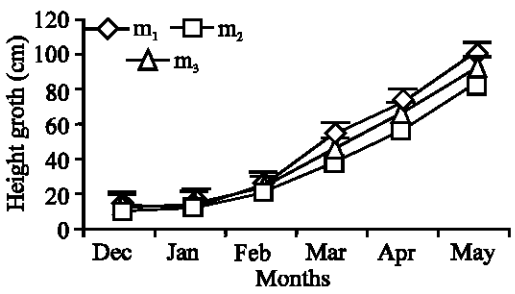

Fig. 2: Effect of media on height on growth in polybag. Bars show 95% confidence limit

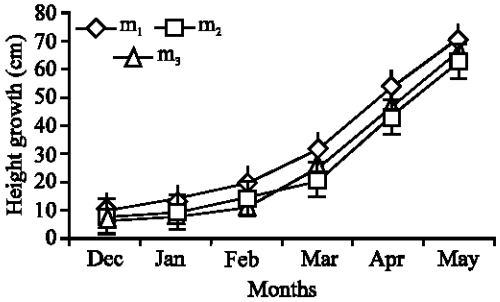

Fig. 3: Effect of media on height growth in plastic tray. Bars show 95% confidence limit

sown in April, May and June had the best heights (125, 137, 120 cm), number of stems/plant (6.8, 6.3, 8.5) and weight/ plant (132, 127 and 102 DM) 6 months after sowing. Sowing in October had the poorest development. Analysis of variance showed treatment effects of container and media are highly significant. The interaction effect is not significant (Table 1). So, LSD test was carried out for containers and media (Table 2). Container C_3 showed significantly higher and C_2 showed lower result compared to all other container and all the containers are significantly different from each other. The highest height growth of seedbed may be due

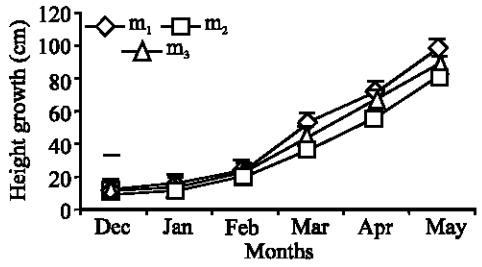

Fig. 4: Effect of media on height growth in seedbed. Bars show 95% confidence limit

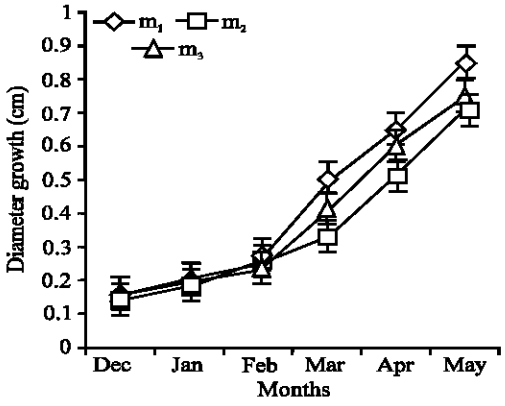

Fig. 5: Effect of media on diameter growth in polybag. Bars show 95% confidence limit

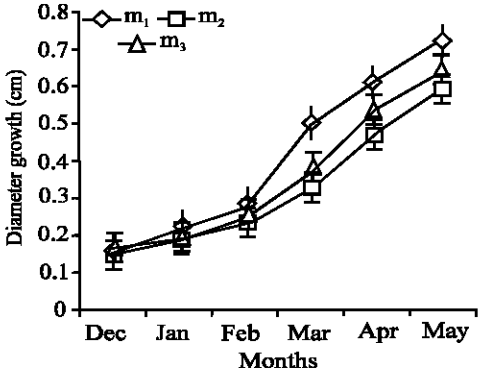

Fig. 6: Effect of media on diameter growth in plastic tray. Bars show 95% confidence limit

to the content of higher volume of rooting media. Similarly, in plastic tray, the cause of poor growth is for competition among the seedling in small quantity of rooting media. m_1 showed significantly higher result compared to all other media. m_2 and m_3 are on par (Table 3). The causes of differences in height growth among media may be the difference of water holding capacity, differences of nutrient status in media and the presence of soil bacteria and fungi, which play a lot of role in the formation of humus and in general cycling of nutrient materials. Agboola *et al.*[23] observed similar results for *Tectona grandis*. The species showed relation in height growth with seasonal variation. During the dry period, there was practically no increase in diameter. According to Loomis[24], Matin and Banik[25] the causes of this tendency of poor growth during dry periods might be due to water stress. It also might be the cause that water stress reduced photosynthesis and decreased translocation of carbohydrates and growth regulators, all these add to reduce growth[26]. But at the beginning of wet season, there was a sharp rise in diameter growth among all the conditions. This increase in the growth during wet season might be due to adequate rainfall in this period that increased soil moisture for the seedling. Similar investigation was also found during the growth study of some forest tree seedlings (*Artocarpus chaplasha, Michelia champaca, Techtona grandis Gmelima arborea* and *Albizia procerao*) of Bangladesh[25]. Reports are also available that there is positive correlation between the size of root system and net photosynthesis[27]. Formation of root help to absorb water to maintain a healthy water balance and replenish water lost in transpiration[28].

Diameter growth: The diameter growth of *Leucaena leucocephala* in different conditions is shown in Fig. 5-7. For all types of containers highest diameter was observed in m1 media. For poly bag, plastic tray and seed bed the rates were 0.84, 0.70 and 0.95 cm, respectively and the lowest diameter was observed in m_2 media. For poly bag and plastic tray, the rates were 0.71 and 0.58 cm, respectively (Table 3). Similarly in seedbed the lowest diameter growth was found 0.85 cm in m_3 media. Matin and Rashid[19] observed similar result. They found after 6 months the diameter growth of *Leucaena leucocephala* was greater than 0.8 cm. In comparison to some fast growing *Albizia* species, the diameter growth after 6 months ranges from .4 to 1 cm[20]. According to Nandy[21] the higher diameter growth in *A. chinensis* were found 1.05 cm after 3 months. Analysis of variance showed treatment effects of container and media are highly significant. T he interaction effect is not significant (Table 2,3). Container C_3 showed significantly higher and C_2 showed lower result compared to all other container; all the containers were significantly different from each other. The causes of the variation of diameter growth in container may be the as same as height growth. m_1 showed significantly higher result compared to all other media and m_3 and m_2 are on par (Table 3). The causes of the variation of diameter growth in media may be the as same as height growth. The species also showed relation in diameter growth with seasonal variations. In the dry season, there was found minimum growth. The causes of this growth are also similar to height growth. But starting wet season, the diameter growth began to rise up. The

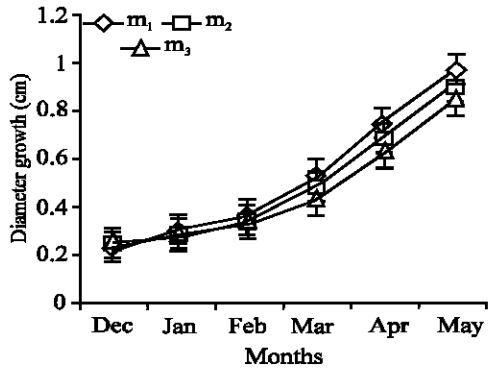

Fig. 7: Effect of media on growth diameter in seedbed. Bars show 95% confidence limit

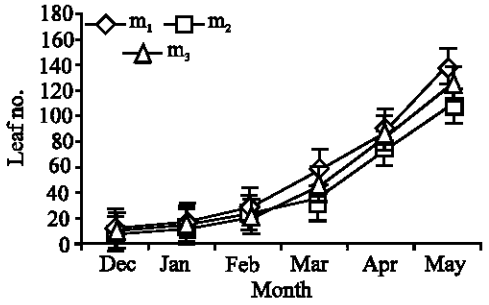

Fig. 8: Effect of media on leaf no. in polybay. Bars show 95% confidence limit

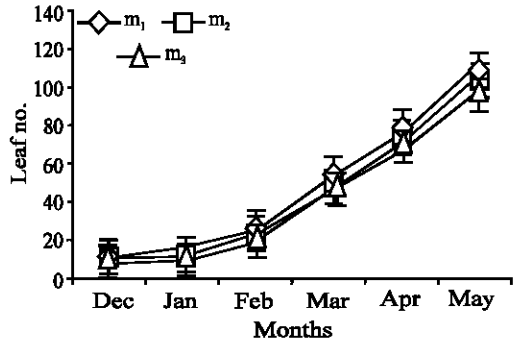

Fig. 9: Effect of media on leaf no. in plastic tray. Bars show 95% confidence limit

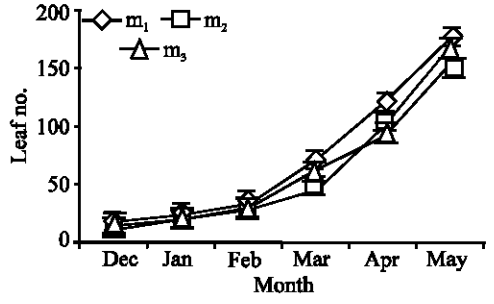

Fig. 10: Effect of media on leaf no. in seedbed. Bars show 95% confidence limit

causes of this increase might be due to formation of new leaves and roots after few weeks in *Nauclea diderrichii* cuttings increased the total carbohydrate concentrations to the cuttings[29] and reports are available that carbohydrate reserves and water has positive role on growth of plants[30].

Leaf number: The leaf number of *Leucaena leucocephala* in different conditions are shown in the Fig. 8-10. For all types of containers, highest numbers of leaf were observed in m_1 media. For polybag, plastic tray and seedbed, the no. of leaves were 154.36, 109.75 and 174.83, respectively and the lowest number of leaf was observed in m_3 media. For plastic tray and seedbed, the rates were 95.79 and 154.38, respectively. Similarly in polybag the lowest number of leaf was found in m_2 media (118.75) (Table 3). Analysis of variance showed treatment effects of container and media are highly significant. The interaction effect is not significant. So, LSD test was carried out for containers and media (Table 2). Container C_3 showed significantly higher and C_2 showed lower results compared to all other containers and all the containers were significantly different from each other. The causes of the variation of leaf formation in container may be the as same as height growth. m_1 showed significantly higher and m_3 and m_2 are on par (Table 3). The causes of the variation of leaf formation in media may be the same as height growth. Seasonal variation has positive effects on leaf formation. The species also showed increased in leaf number during starting wet season whereas the number decreased in dry season. It might be the fact that leaf shedding was influenced by water stress. Similar result was also found in seedling growth of different *Albizia* species in different seasons of the year[20].

Initial growth performance of any species in the nursery stage is very much important as it leads to the better growth performance in the field. This finally results in the best yield. The experiment result suggest that polybag with the peat with cowdung mixture is better for germination but from the analysis of growth performance (Diameter, height and leaf number), the results suggest that seedbed showed the best performance followed by polybag and plastic tray. In all types of containers, peat with cowdung mixture also showed the best performance than others. The results suggest that seasonal variations, in respect of environmental factors showed good relation with the growth and development of the species in all conditions. So for better growth performance of seedlings, media prepared with peat and cowdung at 3:1 ratio can be used for large-scale plantation. Due to some

practical constraints, full investigation into the effect of different factors on growth performance could not be done. So, the result of this study should be taken with caution. Further long-term study including different parameters is recommended.

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