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SEED GERMINATION AND SEEDLING GROWTH PERFORMANCE AT NURSERY STAGE OF THREE MULTIPURPOSE TREE SPECIES IN BANGLADESH

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Abstract: External morphology of fruits and seeds, seed germination and seedling growth performances of rain tree (*Albizia saman* (Jacq.) Merr, ipil ipil (*Leucaena leucocephala* (Lam.) deWit.) and mandar (*Erythrina indica* Linn.), were studied in a nursery. The length, breadth and number of seed per fruit were found the highest in ipil ipil and the lowest in mandar. The length, breadth, thickness and dry weight per seed were the highest in rain tree. Germination percentage was found the highest both rain tree and mandar in polybags and for ipil ipil in seed tray condition. Seedling growth performances showed good relation with seasonal variations. Height and diameter growth showed sharp rise during wet season and continue to rise up to semi-dry period. During dry period, there was very less growth in height and diameter. Leaf production also showed the same trend with seasonal variations.

Key words: Germination; Growth; Multipurpose tree; Nursery stage; Seedling

Introduction

Quality seed and seedlings are the important factors to increase yield and quality of tree products for any land use system related to tree plantings. In Bangladesh, Forest Department, government agencies and NGOs are mainly associated with nursery raising and planting through the execution of agroforestry, social forestry and homestead forestry programmes. But still seed and seedlings are the main planting materials in most of the tree planting programmes. Quality certified tree seeds are not available in the market other than the seeds collected from locally available trees without considering the genetic potential of seeds (Kamaluddin, 1997). The seed collectors do not always collect seeds at the best time to achieve optimal maturation state. In addition, un-predictability of seeding of most species, heavy or gregarious flowering every few years, insects and fungi attacking both flower and seed, formation of poor percentage of flowers into fruits, etc, are very common in tropical natural forests (Ibrahim, 1977). As a result of the above problems, such as shortage of seed supply, poor germination percentage, retention of

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variability resulting in heterogenous products, non-uniformities in timber, slow-growth and average low productivity in stands are most common in tropical forests.

In this study, three important multipurpose tree species were selected to observe their seed germination behaviours in three different germinating conditions and seedling growth performances in different seasons of the year. The species were rain tree (*Albizia saman* (Jacq., Merr.), ipil ipil (*Leucaena leucocephala* Lam., de Wit.) and mandar (*Erythrina indica* Linn.).

Rain tree is a large evergreen tree with a very broad crown and generally planted around the margins of the homesteads as multipurpose tree species in Bangladesh. The tree is mainly used as timber, fuel wood, fodder, plywood, shade and sometimes as an ornamental tree. The plant has nitrogen fixing abilities, fairly coppices and pollarding well (Davidson, 1985).

Ipil Ipil is a small tree that can fix nitrogen from the atmosphere. It is also a multipurpose tree species and used as fuelwood, posts, fodder, green manure, shade, pulpwood, ornamental etc.(Davidson,1985). The plant has excellent coppicing ability. Generally it is planted in cropland and roadside as strip plantation.

Mandar is a leguminous tree, mainly grown along the fence lines or along the water canals all over the country (Pradhan, 1992). It is propagated mainly from seeds. It is also a multipurpose tree species and generally used as fuel-wood, fodder, fence and others.

Material and Methods

Seeds of ipil ipil were collected from Bangladesh Forest Research Institute campus, Chittagong and that of rain tree and mandar from Chittagong forest areas during February - March in Bangladesh. The matured ripe fruits (pods) were dried for a week in the sun after collection directly from the trees. Measurements of the fruits and seeds were taken in unopened condition and before putting them into the germination test respectively. Germination was made in three conditions: plastic seed-tray (24.5cm dia.), transparent polybag (10cmx15cm) and in open nursery seedbed. In all the cases, the media was soil mixed with cow-dung in 3:1 ratio. The air temperature and relative humidity were from 28-35°C and 52-69% respectively during the experiment. Watering was done to the seedlings at regular interval other than wet season.

In seed-tray and seedbed, 100 seeds were directly sown without any pretreatment having 3 replications and in polybag condition, 100 seeds were given in 100 polybags having 3 replications. The number of seeds germinated was recorded everyday in each condition by counting the number of seedlings germinated. The germinated seedlings from the seed trays and seedbed were transplanted into the transparent polybags (10cmx15cm) at the age of 2 weeks. To study their growth performances in each month, the poly bag-raised seedlings were used and the randomised block design was followed with 4 replications (10 seedlings in each replication) for each species.

Results and Discussion

Fruits: The fruits (pods) of the species were flat dehiscent legumes. The colour, size and number of seeds per fruit were different in each species. The average length, breath and number of seed per fruit were highest in ipil ipil and lowest in mandar. The average thickness and weight per fruit were found highest in rain tree and lowest in ipil ipil. The colour of the fruits of ipil ipil and mandar were chocolate and reddish respectively whereas the colour of the rain tree fruits was blackish (Table 1).

Table 1. Morphological characteristics of the fruits of rain tree (*Albizia saman*), ipil ipil (*Leucaena leucocephala*) and mandar (*Erythrina indica*) (mean of 30 fruits).

| Species | Colour | Average length (cm) | Average breath (cm) | Average thickness (cm) | Seeds /fruit | Weight /fruit (g) |
|-----------|-----------|---------------------|---------------------|------------------------|--------------|-------------------|
| Rain tree | blackish | 15.9 ± 0.9 | 1.8 ± 0.05 | 0.65 ± 0.1 | 16.6 ± 0.9 | 9.5 ± 0.9 |
| Ipil ipil | chocolate | 20.0 ± 0.7 | 2.2 ± 0.05 | 0.16 ± 0.06 | 20.2 ± 1.6 | 2.0 ± 0.05 |
| Mandar | reddish | 10.0 ± 0.2 | 1.0 ± 0.01 | 0.49 ± 0.01 | 8.0 ± 0.05 | 6.0 ± 0.1 |

± showed 95% confidence limit

Seeds: The seeds were dark brown in both rain tree and mandar whereas reddish brown in ipil ipil. Average length, breath, thickness and dry weight per seed were highest and the total number of seeds per kg was lowest in rain tree. The total number of seeds per kg was found highest in ipil ipil as the seed size was smaller than other species (Table 2).

Table 2. Morphological characteristics of the seeds of rain tree (*Albizia saman*), ipil ipil (*Leucaena leucocephala*) and mandar (*Erythrina indica*) (mean of 30 seeds).

| Species | Fruit colour | Average length (cm) | Average breath (cm) | Average thickness (cm) | Av. Dry wt. (g) | Seeds/Kg |
|-----------|---------------|---------------------|---------------------|------------------------|-----------------|----------|
| Rain tree | dark brown | 0.89 ± 0.04 | 0.58 ± 0.04 | 0.38 ± 0.02 | 0.15 ± 0.09 | 7000 |
| Ipil ipil | reddish brown | 0.84 ± 0.02 | 0.54 ± 0.02 | 0.16 ± 0.01 | 0.06 ± 0.008 | 17000 |
| Mandar | dark brown | 0.68 ± 0.05 | 0.50 ± 0.05 | 0.27 ± 0.02 | 0.1 ± 0.02 | 9500 |

± showed 95% confidence limit.

Seed germination: In case of rain tree, seed germination started within 3 days both in seed tray and seed bed condition whereas in polybag it started within 4 days. Ipil ipil seed germination started within 4 days in seed tray but within 6 days both in polybags and seedbed. On the otherhand, mandar seed germination started in seed tray within 5 days, in polybags within 3 days and in seed bed within 7 days (Table 3). The germination percentage was found the highest in case of rain tree (79%) and in mandar (68%) both in polybag condition and in ipil ipil (87%) in seed tray condition (Table-3). The higher germination in seed tray may be due to the fact that the seeds in tray were not washed out at the time of watering during germination because water was given to the perforated tray as and when necessary to maintain optimum moisture condition by dipping perforated portion of the tray in water trough. Similar technique of watering was also followed by Beniwal and Singh (1989) and Matin and Rashid (1992) during seed germination of some forest species. In the same way, the better germination percentage in polybags might be due to the fact that each poly bag had 1 seed during the germination test. The poly bags were duly perforated to drain out excess water in time and perforation helped proper

aeration which is also very important for germination. Moreover, each polybag contained higher volume of rooting medium which is favourable for seed germination. On the other hand, germination percentage of all the species were very poor in open seed bed condition. It is possible that some seeds might be washed away or buried deep in soil due to heavy rain fall in May- June of the year (Banik, 1987; Beniwal *et al.*, 1989; Matin and Rashid, 1992).

Table 3. Seed germination (%) as mean of 100 seeds of rain tree, ipil ipil and mandar under seed tray, polybag and seed bed conditions.

| Species | Seed tray | | | | Polybag | | | | Seed bed | | | |
|-----------|--------------------------|-------|-------|----------|--------------------------|-------|-------|----------|--------------------------|-------|-------|----------|
| | Germination period (day) | | | Ger. (%) | Germination period (day) | | | Ger. (%) | Germination period (day) | | | Ger. (%) |
| | Start | Cease | Total | | Start | Cease | Total | | Start | Cease | Total | |
| Rain tree | 3 | 42 | 39 | 50 | 4 | 52 | 48 | 79 | 3 | 38 | 35 | 52 |
| Ipil ipil | 4 | 53 | 49 | 87 | 6 | 35 | 29 | 74 | 6 | 36 | 30 | 42 |
| Mandar | 5 | 24 | 19 | 49 | 3 | 24 | 21 | 68 | 7 | 13 | 6 | 36 |

Height Growth of Seedlings: At the end of 12 months, the height growth of mandar, ipil ipil and rain tree showed 1st, 2nd and 3^d positions respectively (Fig. 1). Analysis of variance showed significant differences in height growth among the species at the end of 12 months (Table 4). The cause of the differences might be due to the fact that each species has its own genotypic characteristics. Simillar observations among the species were also found in case of *Albizia* species during their height growth (Matin and Khan 2000). The species showed relation in height growth with seasonal variations (Fig. 1). During the wet season, there was a sharp rise in height growth among all the species. This increase in the height growth during wet season might be due to adequate rain fall in this period that increased soil moisture in the polybags of the seedlings. Similiar observations were also found during the growth study of some forest tree seedlings by Matin and Banik (1993). But during semi-dry and dry seasons, gradual increase was found in mandar and ipil ipil but practically no increase in rain tree (Fig. 1). The cause of this tendency of poor height growth during semi-dry and dry periods might be due to water stress (Loomis, 1934; Matin and Banik, 1993). Leaf formation was found to increase throughout the wet and semi-dry periods (Fig. 3). This reduction of photosynthetic surface decreased the relative amount of carbohydrates available for growth, as compared with unstressed plants (Kramer, 1969; Matin and Khan, 2000).

Table 4. ANOVA for height growth.

| Source of variation | Sum of square | df | MS | Cal. F- ratio | Tab. F-at 1% | F-ratio at 5% |
|---------------------|---------------|----|---------|---------------|--------------|---------------|
| Species | 4478.96 | 2 | 2239.48 | 7.13* | 10.92 | 5.14 |
| Blocks | 252.23 | 3 | 84.08 | 0.27 | 9.78 | 4.76 |
| Errors | 1883.92 | 6 | 313.99 | | | |
| Total | 6615.11 | 11 | | | | |

* significant at p= 0.05

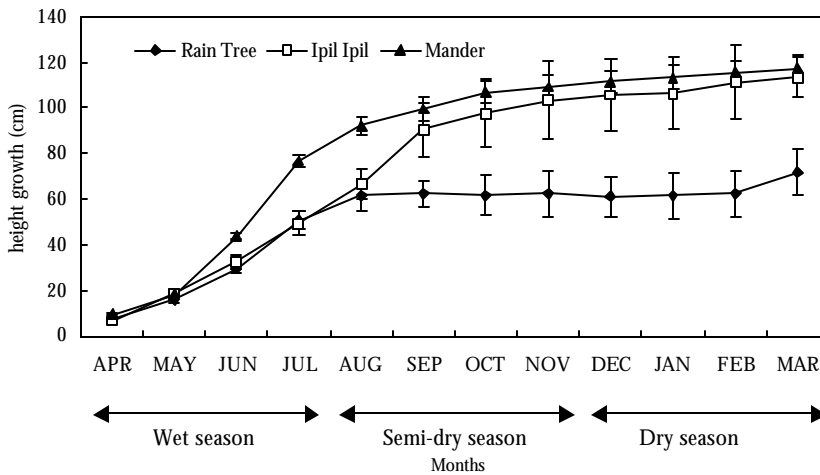


Fig. 1. Effect of age and season on the height growth of the seedling of 3-multipurpose tree species at nursery stage. Bars show 95% confidence limit.

Diameter Growth of Seedlings: The diameter growth of the tree species are shown in Fig. 2. Among the three species, highest diameter growth was observed in mandar and leaf diameter growth in ipil ipil (Fig. 2). At the end of 12 months, analysis of variance showed significant differences in diameter growth among the 3 species. The cause of this variation in diameter growth might be the same as height growth. Like height growth, diameter growth also showed seasonal variations. In the wet season, diameter growth began to rise up and continued upto semi-dry season in all the 3 species. The cause of increase might be due to formation of new leaves and roots which ultimately increased the total carbohydrate concentrations to the seedlings. Similiar instances were mentioned by Matin (1989) in *Nauclea diderrichii* cuttings. During dry periods, there was practically no increase in diameter. It might be the cause that water stress reduced photosynthesis and decreased translocation of carbohydrates and growth regulators, all these add to reduce turgor in reducing growth (Kramer, 1969).

Table 5. ANOVA for diameter growth.

| Source of variation | Sum of square | df | MS | Cal. F- ratio | Tab. F-at 1% | F-ratio at 5% |
|---------------------|---------------|----|------|---------------|--------------|---------------|
| Species | 0.85 | 2 | 0.43 | 6.14* | 10.92 | 5.14 |
| Blocks | 0.12 | 3 | 0.04 | 0.57 | 9.78 | 4.76 |
| Errors | 0.43 | 6 | 0.07 | | | |
| Total | 1.40 | 11 | | | | |

* Significant at p=0.05.

Leaf Formation of Seedlings: Average leaf number of the above species were shown in Fig. 3. At the end of 12 months, the average leaf numbers were 29,17.8 and 10.6 in mandar, ipil ipil and rain tree respectively. All the species showed increased leaf number

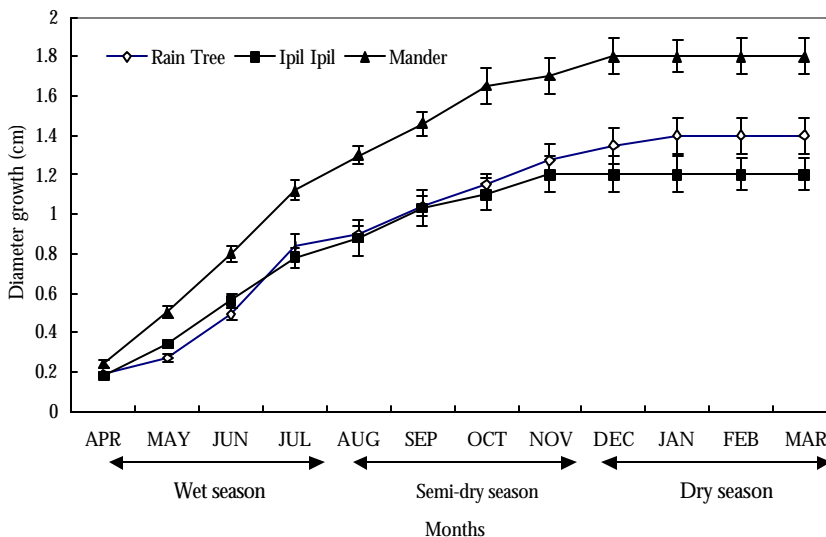


Fig. 2. Effect of age and seasons on the diameter growth of the seedlings of 3-multipurpose tree species at nursery stage. Bars show 95% confidence limit.

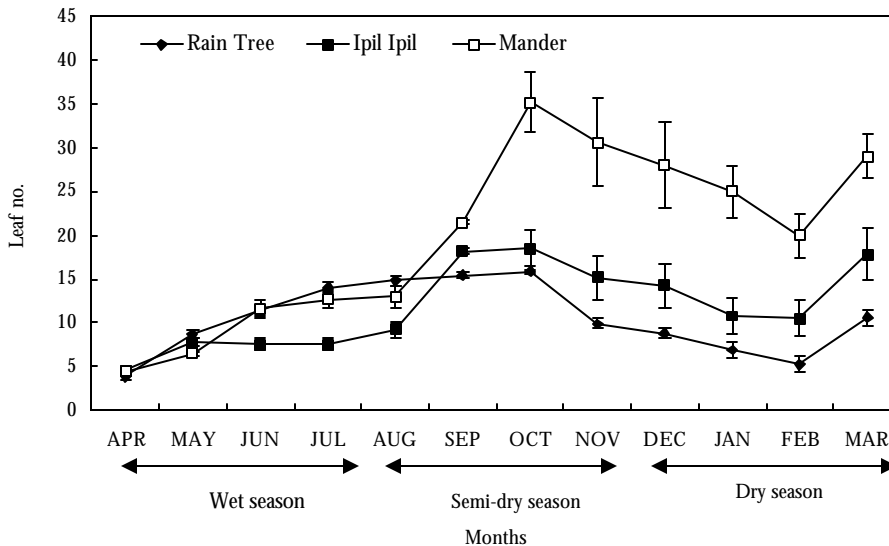


Fig. 3. Effect of age and seasons on leaf production of the seedlings of 3-multipurpose tree species at nursery stage. Bars show 95% confidence limit.

Table 6. ANOVA for leaf production.

| Source of variation | Sum of square | df | MS | Cal. F- ratio | Tab. F-at 1% | F-ratio at 5% |
|---------------------|---------------|----|--------|---------------|--------------|---------------|
| Species | 618.91 | 2 | 309.46 | 1.22 | 10.92 | 5.14 |
| Blocks | 622.91 | 3 | 207.64 | 0.82 | 9.78 | 4.76 |
| Errors | 1519.55 | 6 | 253.26 | | | |
| Total | 2761.37 | 11 | | | | |

during wet and semi-dry periods whereas the number decreased in dry season. It might be the fact that leaf shedding was influenced by water stress. Similar results were also found in seedling growth study of different *albizia* species in different seasons of the year (Matin and Khan, 2000). In mandar, increased leaf area showed increased height and growth but in rain tree and ipil ipil, increased leaf area showed better growth in height but not in diameter (Fig. 3).

Conclusion

Among the 3 multipurpose tree species, mandar showed the best performances in growth (height, diameter and leaf production). In case of seed germination, ipil ipil showed the best performance in seed tray condition but rain tree and mandar performed better in polybag condition. Seasonal variations, in respect of environmental/climatic factors showed good relation with the growth and development of all the seedlings of the 3 species. Increase of leaf surface might promote more carbohydrate production but did not show more height and diameter growth in all the species. Moreover, increased leaf surface showed less diameter growth to ipil ipil and rain tree. Therefore, growth in these types of fast growing species is not only controlled by environmental factors but also by genetic factors.

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