*Journal of Tropical Plant Physiology 2 (2008): 11-19*

# LIGHT INTENSITY PREFERENCES OF SOME COMMERCIAL PEAT SWAMP FOREST SPECIES

**Ismail, P. * and Abdul Razak, O.**
Forest Research Institute Malaysia, Kepong 52109 Selangor, Malaysia
**Email: ismailp@frim.gov.my*

## ABSTRACT

A light intensity study was conducted in nursery for seedlings of six peat swamp forests species. Main objective was to determine preferences of the plants to the light intensity suitable for field planting. The species studied were *Anisoptera marginata*, Callophyllum *ferrugineum, Durio carinatus, Gonystylus bancanus, Madhuca motleyana* and *Shorea platycarpa.* The experiments were carried out in nursery for two years by using three different light intensities: 100, 70 and 30% of relative light intensity. Parameters recorded and observed throughout the periods were plant survival, total height, basal diameter and plant vigorousity. Results of seedlings performances obtained from the experiment indicating that there were differences in light preferences needed by these species for survival and better growth. In general, survival results of the species in two years ranged from 85 to 100%. Growth of the seedlings, in term of basal area and total height varied amonf the species based on different light intensities. Outputs of these studies are useful in selecting suitable species for field planting in different types of degradation in peat swamp areas.

*Keywords*: Peninsular Malaysia, nursery experiment, survival, growth increments, wetland

## INTRODUCTION

Light is the most important factor for the survival and development of seedlings in the tropical moist forests (Jeyarai 1987; Lee et al. 1994). In fact, according to Nicholson (1958), apart from planting and weeding the most critical factor that influences the composition of a regenerating dipterocarps forest is the conditions of light within the stand that can be manipulated to favour the growth of certain species according to their light requirements. The observation was supported by Sasaki and Mori (1981) who reported that growth of dipterocarps seedlings depend on the conditions of light in the forest and different species required different light intensities. They also reported that usually after heavy fruiting most dipterocarps seeds will germinate on the forest floor but seedlings often disappear within one year after germination due to high mortality. This high mortality of young seedlings is very much related to the conditions of the light under the dense canopy of dipterocarps forests.

There is no report on peat swamp forest (PSF) species related to light intensity study except one by David et al. (1997) who studied in detail on seedling development of *Gonystylus bancanus* (ramin melawis) in response to light intensity and spectral quality. From the study, they concluded that seedlings of *G. bancanus* are intolerant of extreme shade and direct sunlight, growing most rapidly in partial shade, with daily percentages of 40% and more of full sunlight. There are about ten commercial timber species of PSF, and the *G. bancanus* is the most valuable species (Chong & Latifi 2003).

Nonetheless, only some of the species have been used in rehabilitation works as only their planting materials are available (Ismail et al. 2006). However, their light preferences suitable for field planting are yet to be determined, with an excepttion for *G. bancanus*. Therefore, this study was conducted to gather some information on the light preferences of some commercial PSF species. The *G. bancanus* was also included in this study as it is the most important timber species in PSF (Soerianegara & Lemmens 1994; Chong & Latifi 2003), and also their planting materials are readily available. Others PSF species used in this study were *Anisoptera marginata* (mersawa paya), *Calophyllum ferrugineum* (bintangor gambut), *Durio carinatus* (durian paya), *G. bancanus, Madhuca motleyana* (Nyatoh ketiau) and *Shorea platycarpa* (meranti paya). Degradation of PSF was found to be varied depending on the causal factors (Ismail et al. 2005; 2006), therefore, findings from this study could be employed as a guide in selecting species to be used for the rehabilitation work.

## MATERIALS AND METHODS

The experiment was conducted at the nursery of Forest Research Institute Malaysia (FRIM). Three different relative light intensities (RLI) of 30%, 70% and 100% from the full sunlight were used in this study. The selection of the amount of RLI was based on the following criteria: the 30% RLI is to represent common condition in natural undisturbed PSF, 70% RLI for condition of logged-over and secondary PSF, while the 100% RLI is to represent condition of open areas in PSF such as highly degraded or grass-occupied areas. Two shade chambers of 3 m height, 4 m wide and 12 m long were constructed and the chambers were fully covered with sarlon net of 30 and 70% RLI, respectively (Plates 1 and 2), while an entirely open area was used for the 100% RLI site (Plate 3).

Twenty seedlings of each species aged about one-year old were placed in the shade chambers as well as in the open area. The seedlings were germinated from seeds collected from Pekan Forest Reserve in Pahang. All the seedlings, either in the shade chambers or open area was given similar treatment with respect to watering, fertilizer applications and weeding. The watering was carried out twice by using automatic sprinkler, and the plants were fertilized with about a gram of compound fertilizer Nitrophoska Blue every month, while the weeding was carried out when necessary. Data on plant survival, basal diameter (measured at 5 cm above the soil surface) and total height was collected in three months interval for duration

of two years. Additional information on vigorosity and formation of new shoots were also observed.

Plate 1. Shade chamber with 30% RLI.

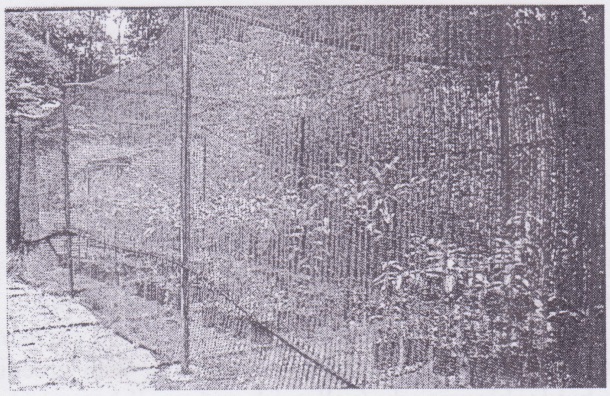

Plate 2. Shade chamber with 70% RLI.

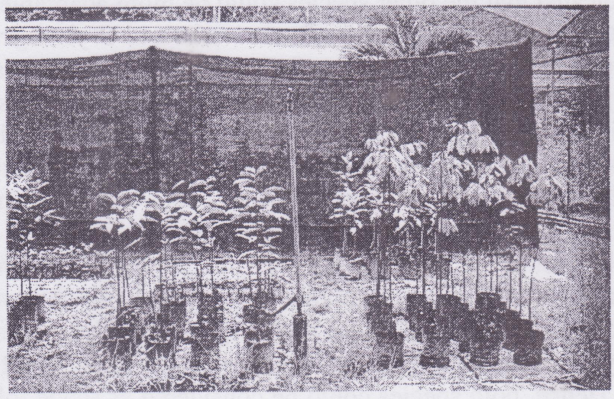

Plate 3. Study site with 100% RLI

## RESULTS AND DISCUSSIONS

### Survival and vigorosity

Results on plant survival of all seedlings in the nursery after two years are shown in Table 1. The survival ranged from 85 to 100% indicating that in general all the species are able to survive in all different light condition, provided water and nutrients are enough. There were three species having 100% survival after two years of treatment and they were *A. marginata*, *D. carinatus* and *G. bancanus,* while *C. ferrugineum* produced the lowest survival with 85% in the 100% RLI.

Table 1. Plants survival after two years of treatments.

| Species | 100% RLI | 70% RLI | 30% RLI |
|---|---|---|---|
| *A. marginata* | 100 | 100 | 100 |
| *C. ferrugineum* | 85 | 95 | 100 |
| *D. carinatus* | 100 | 100 | 100 |
| *G. bancanus* | 100 | 100 | 100 |
| *M. motleyana* | 100 | 95 | 100 |
| *S. platycarpa* | 100 | 100 | 95 |

Based on the additional observation, it was found that the different light intensities affected the seedlings physically especially in term of plants vigorosity, shoot development and leaf sizes (Plate 4). Obviously, *D. carinatus* and *C. ferrugenium* have good plant condition (look very healthy with greenish and big leaves) at 30% RLI; but looking poorly (yellowish and small leaves) at 100% RLI. The other species, however, showed moderate physical differences in all the lights intensities. This indicated that the other species could be more adaptable or tolerant to different light intensities compared to the *D. carinatus* and *C. ferrugenium*. The observation also found that shoot production for all species were generally similar except for *M. motleyana*, which was most active in producing new shoots in all light conditions. Light intensities also imposed obvious effect on leaf sizes as was found that seedlings raised in the open area (full sunlight) generally had smaller leaf sizes compared with the seedlings raised under shade (inside the shade chambers).

Based on the results of the plant survival, *D. carinatus* was found to be adaptable to various light conditions, although the species was observed to have better physical condition when raised under lower light intensities. Meanwhile, *C. ferrugineum* clearly exhibited its preference from low to moderate light conditions of 30 to 70% RLI. Hence, both species could be considered as shade tolerant. This indicated that *D. carinatus* and *C. ferrugineum* are not suitable for field planting in

open areas such as the highly degraded PSF. Other species had relatively high survival and vigorosity in all light conditions, and they are suitable to be used for field planting in different condition of the PSF, including in an open area. Nonetheless, Otsamo et al. (1996) reported that *A. marginata* was the best dipterocarps with 80% survival after two years of field planting. This is a clear indication for *A. marginata* that the species is suitable for the field planting in the open areas.

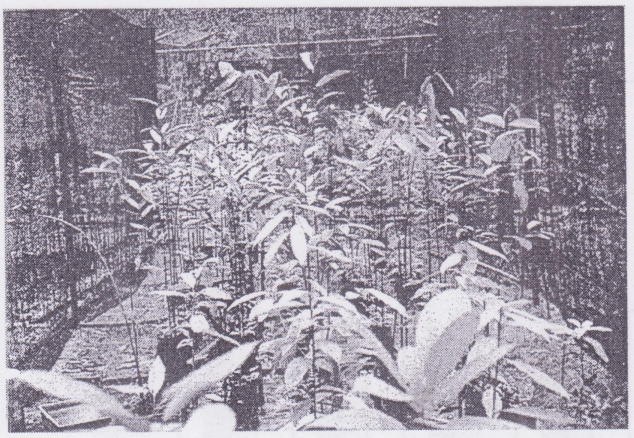

Plate 4. Generally bigger leaves were produced by seedlings in shade chambers compared to open area (note: seedlings inside the shade chamber of 70% RLI).

**Average basal diameter increment**

Results of the average of basal diameter increment (BDI) during two years of experiment are shown in Table 2 and Figure 1. In term of BDI, *A. marginata, G. bancanus* and *M. motleyana* had shown wide ranges of adaptability to the light conditions. Meanwhile, *C. ferrugineum, D. carinatus* and *S. platycarpa* seemed to prefer low light intensities. *Madhuca motleyana* has big BDI in all RLIs compared to the other species. However, *D. carinatus* has biggest BDI with 8.1 at 30% RLI, while *S. platycarpa* has the smallest BDI with 2.6 mm at 100% RLI.

Ismail et al. (2006) reported average BDI increments of 2.5 mm and 0.5 mm at nine months after planting using line planting method (RLI at about 70%) for *A. marginata* and *G. bancanus*, respectively. Comparably, results of this study showed relatively higher BDI for both species in the nursery study due to longer period of nursery time (two years) where supply of water and nutrients in the nursery had been optimum.

Table 2. Average of basal diameter increment (BDI) in two years.

| Species | 100% RLI | 70% RLI | 30% RLI |
|---|---|---|---|
| *A. marginata* | 6.0 ± 0.3 mm | 5.0 ± 0.3 mm | 6.0 ± 0.6 mm |
| *C. ferrugineum* | 4.7 ± 0.5 mm | 6.0 ± 0.6 mm | 6.0 ± 0.4 mm |
| *D. carinatus* | 6.0 ± 0.6 mm | 5.3 ± 0.3 mm | 8.1 ± 0.5 mm |
| *G. bancanus* | 4.9 ± 0.5 mm | 5.0 ± 0.5 mm | 4.7 ± 0.4 mm |
| *M. motleyana* | 7.2 ± 0.8 mm | 7.7 ± 0.8 mm | 6.8 ± 0.7 mm |
| *S. platycarpa* | 2.6 ± 0.2 mm | 4.7 ± 0.3 mm | 4.2 ± 0.3 mm |

± = standard error

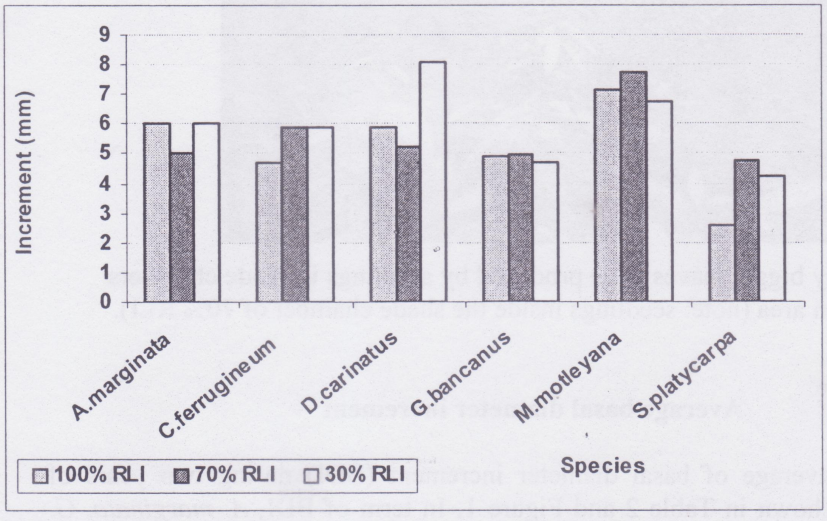


Figure 1. Average basal diameter increment (BDI) in two years

**Average total height increment**

Results on the average of total height increment (THI) in two years are shown in Table 3 and Figure 2. The figure showed that in general all species had an increased pattern of THI from 100% to 30% RLI, except for *A. marginata*, which had lower THI in 70% RLI. Nevertheless, all species in this study grew taller in 30% RLI. Novertheless, it was observed that higher THI produced low BDI as shown in Table 2. Therefore, moderate light condition of 70% RLI was found to have moderate THI and BDI.

*Madhuca motleyana* has high THI as compared to the others species, particularly in RLI of 30% where it is has the highest THI of 86.2 cm. While, among the lowest THI found in the 30% RLI were *G. bancanus* and *D. carinatus*

with 42.8 and 46.4 cm, respectively. In fact, compared to other species, both *G. bancanus* and *D. carinatus* recorded low THI in the all light conditions. Based on earlier study by Ismail et al. (2006), *A. marginata* and *G. bancanus* planted in the logged-over PSF have an average of 17.9 and 8.9 cm of THI, respectively, at nine months after planting. Apparently, results of this nursery study also reflected the performances of both species in the field.

Table 3. Total height increment (THI) in two years.

| Species | 100% RLI | 70% RLI | 30% RLI |
|---|---|---|---|
| *A. marginata* | 56.5 ± 4.6 cm | 44.3 ± 4.4cm | 57.6 ± 5.7 cm |
| *C. ferrugineum* | 42.5 ± 3.6 cm | 58.6 ± 7.0 cm | 75.2 ± 6.5 cm |
| *D. carinatus* | 22.5 ± 3.3 cm | 26.4 ± 3.6 cm | 46.4 ± 4.2 cm |
| *G. bancanus* | 20.3 ± 1.7 cm | 32.6 ± 3.8 cm | 42.8 ± 5.2 cm |
| *M. motleyana* | 56.3 ± 6.0 cm | 63.7 ± 7.5 cm | 86.2 ± 10.3 cm |
| *S. platycarpa* | 23.2 ± 1.4 cm | 48.0 ± 3.7 cm | 50.2 ± 3.4 cm |

± = standard error

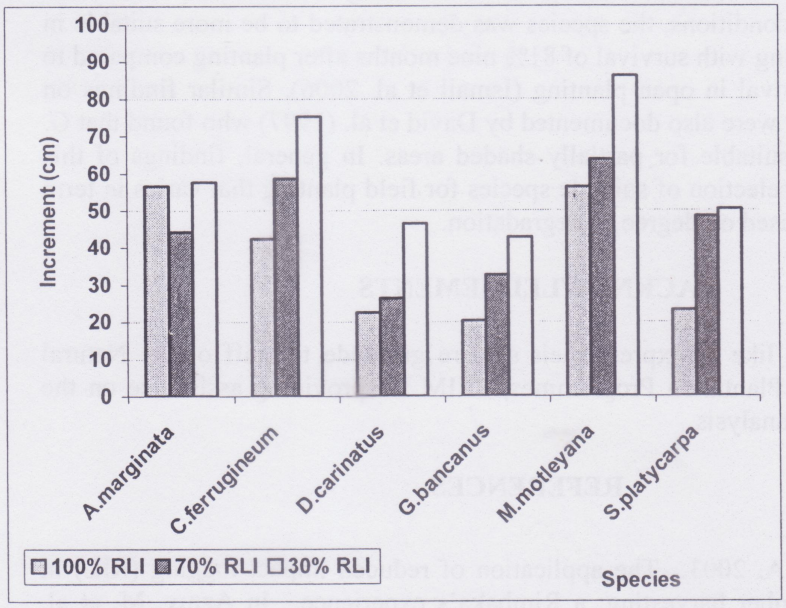


*Figure 2. Average total height (THI) increment in two years.*

## CONCLUSIONS

Results of plant survival in two years of treatments were ranging from 85 to 100%. Meanwhile, based on results of BDI and THI, they showed that light preferences for survival and growth are different among species, where growth varied. The BDI and THI of all species were significantly affected by different light intensities. It shows that in order to have better growth performances, tree species have their own light intensity preferences, and some species could adapt into wider ranges of light conditions. Though, some species could adapt well in all type of light conditions, yet they still have their preferred light condition for optimum growth.

Species tested in this study are recommended be used in rehabilitation works in degraded PSF mainly due to its commercial value. Nonetheless, their selection should be based on site matching. Based on the findings of this study, species recommended to be planted in moderately shade to open areas are *A. marginata*, *G. bancanus, M. motleyana* and *S. platycarpa*, while *C. ferrugenium* and *D. carinatus* are more suitable for under-canopy planting.

Interestingly, a number of species were found to grow well in all light conditions. However, it is not necessarily that they are suitable for open planting such as in highly degraded or grass-occupied areas due to lack of water supply and excessive sunlight. For example, though from the study *G. bancanus* was found survive in all light conditions, the species was demonstrated to be more suitable in under-canopy planting with survival of 81% nine months after planting compared to a meagre 30% survival in open planting (Ismail et al. 2006). Similar findings on light intensity study were also documented by David et al. (1997) who found that *G. bancanus* is more suitable for partially shaded areas. In general, findings of this study are useful in selection of suitable species for field planting that varies in term of light condition based on degree of degradation.

## ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to staff of the Natural Forests and Forest Plantation Programmes, FRIM for providing assistance on the data collection and analysis.

## REFERENCES

Chong WC, Latifi A. 2003. The application of reduced impact logging (RIL) in peat swamp timber harvesting: a Rimbaka's experience. In Azmy, M. et al. (eds), *Proceeding of The International Conference of Forestry and Forest Products Research (CFFPR 2001): Tropical forestry research in the new millennium - meeting demands and challenges*. Forest Research Institute Malaysia (FRIM). Pp. 349-357.

David WL, Krishnapillay B, Haris M, Marzalina M, Yap SK. 1997. Seedling development of *Gonystylus bancanus* (Ramin melawis) in response to light intensity and spectral quality. *Journal of Tropical Forest Science* **8**(4): 520 - 531.

Ismail P, Khali Aziz H, Zainudin MA. 2006. *Rehabilitation trials in peat swamp forests of Peninsular Malaysia.* Malaysian Forester. Forestry Department Peninsular Malaysia, Kuala Lumpur. Vol. **69** (1).

Ismail P, Wollesen L, Shamsudin I. 2005. Experience on rehabilitation of peat swamp forests in Peninsular Malaysia. In Thai SK et al. (eds.) Workshop on planning and implementation of sustainable forest management. Published by Forestry Department Headquarters, Kuala Lumpur. 24-28 May 2004, Penang. Pp. 72-87.

Ismail P, Abd Rahman K, Mohd. Nasir H, Mohd. Azmi MI, Mohd. Azani A, Hamdan N, Hashim M. 2006. Preliminary findings on development of restoration technique for secondary peat swamp forest in North Selangor. In Nik Zanariah NM et al. (eds.), Highlights of FRIM's IRPA Projects 2005: Identifying potential commercial collaborations. Pp. 53-59.

Jeyaraj K. 1987. Stomatal response to changing light by three species of varying shade tolerance. B.Sc. thesis. Faculty of Forestry, Universiti Pertanian Malaysia (UPM). 91 pp.

Lee DW, Oberbauer SF, Krishnapillay B, Marzalina M, Haris M, Yap SK. 1994. Forest shade and seedling development in five dipterocarps. In Appanah, S. and Khoo, K.C. (eds.), *Proceedings of Fifth Round Table Conference on Dipterocarps*. Pp. 102 – 116.

Nicholson DI. 1958. Natural regeneration of logged tropical rain forest North Borneo. *Malaysian Forest* **21**(2):65-71.

Otsamo R, Otsamo A, Adjers G. 1996. *Reforestation experiences with dipterocarp species on grassland.* In Dipterocarp Forest Ecosystems: Towards Sustainable Management, Schulte, A. and Schone, D. (eds.). World Scientific. Pp 464 – 477.

Soerianegara I, Lemmens RHMJ (eds.) 1994. Timber tree: major commercial timbers. In *Plant Resources of South-East Asia* (PROSEA) No. **5**(1). Pp. 221-230.

Sasaki S, Mori T. 1981. Growth responses of dipterocarp seedlings to light. *Malaysian Forest* **4**(2 and 3): 319 - 344.