



**GROWTH OF THREE INDIGENOUS TIMBER SPECIES FOR ENRICHMENT
PLANTING IN AYER HITAM FOREST RESERVE, SELANGOR, MALAYSIA**

By

MOHAMAD FAKHRI BIN ISHAK

**Thesis Submitted to the School of Graduate Studies,
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Degree of Master of Science**

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirement for the degree of Master of Science

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Forest gap opening due to natural or anthropogenic factors affects the growth of regenerated plants. It takes a long period to rehabilitate this disturbed area and it is mostly dominated by pioneer species. Therefore, a study to determine the survival rate, basal diameter and total height of three timber species based on different gap sizes and to determine the most suitable species for gap planting techniques was conducted in Ayer Hitam Forest Reserve, Selangor. This study was set up in Complete Randomized Design. Four plots were established with a 1 ha for each plot. In this study each plot represented a different planting design. Number and size of subplots for each plot varies depending on planting design. Plot 1 comprised nine subplots of 10 m x 10 m, Plot 2 has nine subplots of 20 m x 20 m, Plot 3 has five subplots of 10 m x 10 m and Plot 4 has five subplots of 20 m x 20 m. The mean percentage of canopy openness in plots 1, 2, 3 and 4 were 17.34%, 21.09%, 15.87% and 19.74%, respectively.

Three species of dipterocarp namely *Anisoptera marginata*, *Shorea assamica* and *Shorea platyclados* were planted for this research. Data on growth for these species were measured for a period of one year. Soil in this area is in moderately acidic. Total N, available P and cation exchange capacity (CEC) are low, while exchangeable K, Ca and Mg are very low.

One year after planting, *A. marginata* showed the best survival rate in all plots followed by *S. assamica* and *S. platyclados*. Percentage survival of species were 96%, 97%, 100% and 99%, respectively for Plot 1, 2, 3 and 4 for *A. marginata*; 52%, 86%, 67% and 91%, respectively for Plot 1, 2, 3 and 4 for *S. assamica*; and 33%, 77%, 53% and 85%, respectively for Plot 1, 2, 3 and 4 for *S. platyclados*. In term of basal diameter increment, no significant difference ($p>0.05$) was observed between species and plots. *Shorea platyclados*

showed the best growth increment in total height compared to *A. marginata* and *S. assamica* at 36.15 ± 2.08 cm, 23.79 ± 1.28 cm and 13.05 ± 0.92 cm, respectively. There was significant difference ($p < 0.01$) between species. However, there was no significant difference ($p > 0.05$) was observed between plots. The study also revealed that total leaf area was not significantly different ($p > 0.05$) between species and plot. Overall, *S. platyclados* was found to be the best species compared to *A. marginata* and *S. assamica* in performance of growth increment.

Study using various gap sizes should be conducted in the future to determine more accurately the suitable gap size for selected tree species. In addition, observation of pests and diseases should be done. Implementation of fertilizer is also required in support the growth increment of the tree. Besides that, observations on these studies should involve longer duration in order to have significant effects on all the parameters measured.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**PERTUMBUHAN TIGA SPESIES BALAK TEMPATAN UNTUK
PENANAMAN MENGAYA DI HUTAN SIMPAN AYER HITAM, SELANGOR,
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Pembukaan ruang hutan yang disebabkan oleh faktor semulajadi ataupun aktiviti manusia akan memberikan kesan terhadap pertumbuhan regenerasi baru. Ia mengambil tempoh yang lama untuk memulihkan kawasan terganggu ini dan kebanyakan spesies yang tumbuh didominasi oleh spesies perintis. Oleh itu, satu kajian untuk menentukan kadar kemandirian, diameter pangkal dan ketinggian tiga spesies pokok berdasarkan pada saiz ruang yang berbeza dan untuk menentukan spesies yang paling sesuai untuk teknik penanaman ruang telah dijalankan di Hutan Simpan Ayer Hitam, Puchong Selangor. Kajian ini telah ditubuhkan dengan rekabentuk rawak lengkap. Empat plot telah ditubuhkan dengan keluasan 1 ha untuk setiap plot. Dalam kajian ini setiap plot mewakili rekabentuk penanaman yang berbeza. Bilangan dan saiz subplot untuk setiap plot adalah berbeza bergantung pada rekabentuk penanaman. Plot 1 terdiri daripada sembilan subplot bersaiz 10 m x 10 m, Plot 2 mempunyai sembilan subplot bersaiz 20 m x 20 m, Plot 3 mempunyai lima subplot bersaiz 10 m x 10 m dan Plot 4 mempunyai lima subplot bersaiz 20 m x 20 m. Purata peratusan pembukaan kanopi dalam kajian ini adalah 17.34%, 21.09%, 15.87% dan 19.74% untuk Plot 1, 2, 3 dan 4. Tiga spesies dipterokap iaitu *Anisoptera marginata*, *Shorea assamica* and *Shorea platyclados* telah ditanam untuk kajian ini. Data pertumbuhan untuk spesies ini diukur untuk tempoh satu tahun. Tanah di kawasan kajian adalah dalam keadaan sederhana berasid. Jumlah N, ketersediaan P dan keupayaan pertukaran kation (KPK) adalah rendah manakala pertukaran K, Ca dan Mg adalah sangat rendah.

Selepas setahun penanaman, *A. marginata* menunjukkan kadar kemandirian yang terbaik di semua plot diikuti dengan *S. assamica* dan *S. platyclados*. Peratusan kemandirian spesies adalah; 96%, 97%, 100% dan 99% untuk Plot 1, 2, 3 dan 4 untuk *A. marginata*; 52%, 86%, 67% dan 91% untuk Plot 1, 2, 3 dan 4 untuk *S. assamica*; dan 33%, 77%, 53% dan 85% untuk Plot 1, 2, 3 dan

4 untuk *S. platyclados*. Bagi pertumbuhan diameter pangkal pokok tiada perbezaan yang ketara ($p>0.05$) ditunjukkan di antara spesies dan plot. *Shorea platyclados* menunjukkan pertumbuhan tinggi yang terbaik berbanding *A. marginata* dan *S. assamica* pada 36.15 ± 2.08 cm, 23.79 ± 1.28 cm and 13.05 ± 0.92 cm. Terdapat perbezaan yang ketara ($p<0.01$) di antara spesies. Walau bagaimanapun, tiada perbezaan yang ketara diperhatikan diantara plot. Kajian ini juga menunjukkan bahawa tiada perbezaan yang ketara ($p>0.05$) bagi pertumbuhan daun diantara spesies dan plot. Secara keseluruhan, *S. platyclados* merupakan spesies terbaik dibandingkan dengan *A. marginata* dan *S. assamica* di dalam prestasi peningkatan pertumbuhan.

Kajian dengan pelbagai saiz ruangan harus dijalankan pada masa hadapan untuk mengetahui dengan lebih tepat kesesuaian ruangan dengan spesies pokok yang dipilih. Selain itu pemerhatian terhadap serangga perosak dan penyakit perlu dilakukan. Pembajaan yang sempurna juga diperlukan bagi membantu pertumbuhan pokok. Selain itu, pemerhatian ke atas kajian ini perlu melibatkan tempoh masa yang lebih panjang untuk melihat kesan yang ketara ke atas semua parameter yang diukur.

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LIST OF ABBREVIATIONS

AHFR	Ayer Hitam Forest Reserve
ANOVA	Analysis of Variance
C	Celsius
CEC	Cations Exchangeable Capacity
cm	Centimeter
a.s.l	Above sea level
Dbh	Diameter at breast height
Exch.	Exchangeable
FRIM	Forest Research Institute Malaysia
ha	Hectare
m	Meter
mm	Millimeter
m ²	Meter square
m/s	Meter per second
RH	Relative humidity
sp.	Species
SPSS	Statistical Package for Social Science
UPM	Universiti Putra Malaysia

CHAPTER 1

INTRODUCTION

1.1 General

Tropical rain forests are decreasing rapidly at the rate 16.9 million ha per year mainly due to land clearing for agriculture, shifting cultivation and timber harvesting (Kobayashi, 2004). These activities caused more than 5 million ha of tropical forest becoming secondary forest every year. These values indicated that human activities are the main contributor for the depletion and destruction of forest resources. As a result, natural forest dominated by pioneer species and with various quality of timber species will change to secondary forest.

In most cases, successful regeneration and reforestation highly depend on the accurate evaluation of site conditions created by harvesting, for example the success of natural regeneration by commercial tree species is strongly influenced by intensity of harvesting (Kobayashi et al., 1999). It has been estimated that the growth and regeneration rate of trees in the tropics has decreased drastically due to multiple factors, such as forest degradation, soil erosion and landslide (Kobayashi, 2007). Therefore, evaluation such as forest degradation, effects of machinery used during logging and environmental temperature are key elements in determining the most suitable rehabilitation technique to be carried out in the harvested areas. In general, most of the reforestation efforts using indigenous tree species conducted until present involves four identified planting techniques namely, open planting, planting with nurse tree, under shade planting and line planting (Mohd Zaki and Nik Muhamad, 2001).

At present, enrichment planting is the most suitable approach and is often practiced to accelerate rehabilitation of poorly-stocked forest areas especially in Peninsular Malaysia. This approach promotes the recovery of degraded forest containing low value timber species compared to other approaches. Similarly, typical methods such as line planting and gap planting are often used in enrichment planting. However, both methods are not suitable as provision and maintenance of appropriate light intensity are needed according to different growth stages of each target species prior to stand establishment (Kobayashi et al., 1999). Some species recommended by Wan Mohd Shukri et al. (2008) for enrichment planting particularly in logged-over forest areas with relatively low residual stocking of commercial species are *Shorea leprosula*, *S. parvifolia*, *S. platyclados*, *Dryobalanops aromatica* and *Dyera costulata*.

The main rehabilitation question is how to create the appropriate growing conditions, particularly light conditions for each species from juvenile to mature stages (Weidelt and Banaag, 1982). Therefore, studies should be continuously

conducted, even though it is very difficult to rehabilitate harvested areas back to original forest due to lack of mother trees of the primary species (Mori, 1999).

1.2 Problem statements and justification

Forest gap opening due to natural processes or human activities is one of the issues that need to be given attention. Usually, when a forest gap is created, it takes a long time to recover back to original condition and is usually dominated by fast growing pioneer species compared to valuable tree species. It indicates decreasing number of valuable tree species in the future if appropriate action is not taken immediately. To solve this problem, enrichment planting can be introduced by planting selected valuable species in forest gap. However, the performance of tree species in terms of survival rate and growth increment in response to gap sizes is different. Therefore, determination of suitable gap sizes and tree species is important to address this problem. By introducing this method, new regeneration of valuable timber species can be achieved in shorter period and thus producing forest stands with better quality.

The objectives of this study are:

1. To determine the survival rate, basal diameter and total height of three timber species based on different gap sizes.
2. To determine the most suitable species for gap planting technique.

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