



UNIVERSITI PUTRA MALAYSIA

**SILVICULTURE TREATMENTS AND AGE ON GROWTH AND WOOD
PROPERTIES OF NATURALLY REGENERATED *Acacia mangium*
WILLD. IN KEMASUL FOREST RESERVE, PAHANG, MALAYSIA**

AMIR SARIFFUDIN KASSIM

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By

AMIR SARIFFUDIN BIN KASSIM

**This Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfillment of the Requirements for the Degree of Master of
Science**

MAY 2013

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To my wife, Khadijah and my daughter Nurul Huda

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

SILVICULTURE TREATMENTS AND AGE ON GROWTH AND WOOD PROPERTIES OF NATURALLY REGENERATED *Acacia mangium* WILLD. IN KEMASUL FOREST RESERVE, PAHANG, MALAYSIA

By

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MAY 2013

Chairman: Associate Professor Mohamad Azani Alias, PhD

Faculty: Forestry

High planting cost and labor shortages was the main problem in new plantation establishment. Natural regeneration is an attractive method for establishment of second rotation *Acacia mangium* stand. However, the management procedure of this stand needs to be established to avoid risk of using inappropriate silvicultural strategies. The objective of this study is to determine the best timing for first thinning, to study the effect of stand density and to determine the wood specific gravity of four and five year old stand after one year of the first thinning. This study was conducted in two – four years old naturally regenerated *A. mangium* stands at Kemasul Forest Reserve, Pahang. The trial consists of three replicates and twelve treatments of 0.09 ha (30 x 30 m) plots aged two, three and four years. The total number of plots: 36 and total research area covers 3.24 ha. Selective low thinning concepts with the retention of most vigorous individual trees were used for crop trees selection although it was selected as evenly spaced as possible. Mean annual diameter at breast height (DBH) increment for thinning at age three (3.1 cm year^{-1}) shows significantly higher differences

($p < 0.05$) compared to thinning at age two (2.4 cm year^{-1}) and four (2.9 cm year^{-1}) years. DBH increment for $600 \text{ stems ha}^{-1}$ was significantly larger at 3.8 cm year^{-1} . Mean height increment however, does not show significant difference between thinning treatments. Thinning the naturally regenerated *A. mangium* stand at age three also shows significantly larger basal area ($0.06 \text{ m}^2 \text{ tree}^{-1}$) and volume ($0.07 \text{ m}^3 \text{ tree}^{-1}$) increments between all age classes. Periodic annual increment (PAI) data from stand and stock tables shows that plot T5 produces greatest DBH (4.8 cm) and basal area ($3.4 \text{ m}^2 \text{ ha}^{-1}$) increments. Largest periodic annual volume increment (PAI_v) was from T7; ($42.5 \text{ m}^3 \text{ ha}^{-1}$). Mean increment of wood specific gravity (SG) from pith to bark was 31%. The variation in the mean SG value however, was not significant at $p < 0.0001$ between the different stand age, thinning treatments and the interaction of both age and thinning treatment. To create uniform regenerated stands and to avoid root diseases, establishment work which includes stacking and burning is proposed. In areas with low regeneration rates, direct sowing and refilling can also be practice. Thinning treatment in the naturally regenerated *A. mangium* stand should be done at age three years. Preliminary growth, yield and wood properties result from this trial would help researchers to identify processes that control productivity and future prediction of timing for the final harvest.

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

RAWATAN SILVIKULTUR DAN USIA TERHADAP PERTUMBUHAN, DAN SIFAT KAYU REGENERASI SEMULAJADI *Acacia mangium* WILLD. DI HUTAN SIMPAN KEMASUL PAHANG, MALAYSIA

Oleh

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Kos yang tinggi dan kekurangan buruh adalah masalah utama dalam penubuhan ladang. Regenerasi semulajadi adalah satu kaedah penubuhan kitaran kedua *Acacia mangium*. Bagaimanapun, prosedur pengurusan dirian ini perlu diwujudkan bagi mengelakkan risiko menggunakan strategi silvikultur yang salah. Objektif kajian ini adalah untuk menentukan masa yang terbaik bagi penjarangan pertama, mengkaji kesan kepadatan dirian dan menentukan graviti spesifik (SG) kayu berusia empat dan lima tahun setelah setahun penjarangan. Kajian ini dijalankan di kawasan regenerasi semulajadi *A. mangium* berusia dua hingga empat tahun di Hutan Simpan Kemasul, Pahang. Ia mengandungi tiga replikasi dan dua belas plot rawatan bersaiz 0.09 ha (30 x 30 m) berumur dua, tiga dan empat tahun. Jumlah keseluruhan plot adalah: 36 dan keluasan keseluruhan kawasan kajian adalah 3.24 ha. Konsep pemilihan selektif kelas bawah dengan hanya menyimpan pokok paling besar dilakukan walaupun ianya dipilih dari kedudukan yang paling sesuai dijarakkan. Kenaikan perepang tahunan

untuk penjarangan pada usia tiga tahun ($3.1 \text{ cm tahun}^{-1}$) menunjukkan perbezaan yang ketara ($p < 0.05$) berbanding penjarangan pada umur dua ($2.4 \text{ cm tahun}^{-1}$) dan empat ($2.9 \text{ cm tahun}^{-1}$) tahun. Kenaikan perepang tahunan dirian $600 \text{ pokok ha}^{-1}$ adalah sangat ketara pada kadar $3.8 \text{ cm tahun}^{-1}$. Kenaikan purata ketinggian pokok tidak menunjukkan perbezaan ketara diantara kesemua rawatan penjarangan. Penjarangan dirian regenerasi semulajadi *A. mangium* pada umur tiga tahun menunjukkan perbezaan ketara pada pertumbuhan luas permukaan ($0.06 \text{ m}^2 \text{ pokok}^{-1}$) dan isipadu ($0.07 \text{ m}^3 \text{ tree}^{-1}$) diantara kesemua kelas umur. Pertumbuhan tahunan seketika (PAI) daripada jadual dirian dan stok menunjukkan plot T5 menghasilkan pertambahan perepang (4.8 cm) dan luas permukaan ($3.4 \text{ m}^2 \text{ ha}^{-1}$) tahunan tertinggi. Pertumbuhan isipadu seketika dirian (PAI_v) tertinggi pula daripada T7 ($42.5 \text{ m}^3 \text{ ha}^{-1}$). Kenaikan purata graviti spesifik (SG) daripada tengah ke kulit kayu adalah 31%. Variasi purata nilai SG bagaimanapun, adalah tidak ketara pada $p < 0.0001$ diantara umur dirian, rawatan penjarangan dan interaksi diantara keduanya. Untuk mewujudkan dirian yang sekata dan mengelakan serangan penyakit akar, kegiatan penubuhan yang melibatkan pengumpulan dan pembakaran adalah dicadangkan. Dikawasan yang mempunyai kadar pertumbuhan yang rendah, pembenihan terus dan pengisian pokok boleh juga diamalkan. Rawatan penjarangan bagi dirian regenerasi semulajadi *A. mangium* perlu dijalankan pada usia tiga tahun. Keputusan pertumbuhan peringkat awal, hasil dan sifat kayu dari kajian ini dapat membantu penyelidik mengenalpasti proses yang mengawal pengeluaran dan menganggarkan masa yang paling sesuai untuk tebaran akhir.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
asl	Above sea level
DBH	Diameter at Breast Height
FAO	Food Agriculture Organization
GLM	Generalized linear Model
ha	Hectare
LSD	Least Significant Difference
MAI	Mean Annual Increment
PAI	Periodic Annual Increment
PROC	Procedure
SAFODA	Sabah Forestry Development Authority
SAS	Statistical Analysis System
SG	Specific Gravity
SNK	Student Newman Keuls
UPM	Universiti Putra Malaysia
USDA	United States Department of Agriculture

CHAPTER 1

INTRODUCTION

1.1 General Introduction

Natural forests of the tropics will not be able to sustain increasing domestic and international demands for wood and wood products. Environmental concerns, social pressures and the rapidly diminishing resource all constrain the harvest of timber from natural forests. Globally, an increasing demands for wood (resulting from increasing populations and increasing incomes) from a diminishing or more restricted, forest supply base. The scenario of acute timber shortages is reflected in the utilization of medium size *Acacia mangium* from the plantation established in 1980s for furniture manufacturing and wood composite product. Tropical country must move towards sustainable wood production systems on a more limited land area through plantation forestry. The re-establishment of second rotation plantations with emphasis on the strategy of tending the naturally regenerated stands is as an alternative for *A. mangium* plantation management system. Natural regeneration of forests is an attractive method for reforestation because of the limited investment required (Daskin and Andelson, 2009).

According to the Malaysian Timber Council (MTC) report in 2009, the timber sector has contributed RM19.49 billion or 3.5% from the total export earnings. The timber sector remained the fifth largest export earner for the country in the second consecutive year after electrical and electronic

products, palm oil and palm oil-based products, liquefied natural gas and crude petroleum.

To overcome the projected short-fall in timber supply at the end of the century, in the year 1982, the Forestry Department Peninsular Malaysia has established the Compensatory Forest Plantation Project (CFPP). *A. mangium* was the major species planted because of its promising fast growth rate and tolerance over wide varieties of soils and sites. Total of 58,000 ha plantation has been established in the seven participating states in Peninsular Malaysia (Abdul Rahman *et.al.*, 2001). The plantation has reached its first rotation economic life and Malaysia is committed to managing and preserving all of the permanent forest estates on a sustainable basis. Commercially managed of the regenerated *A. mangium* forest is proposed for the solutions of the high investment needed for successful second rotations plantations establishment.

The presence of the naturally regenerated *A. mangium* stands provides the opportunity to establish the next production plantation either for saw log or pulpwood. However, little is known on the growth performance and wood properties of the natural regeneration forest. This study is crucial for the next generation of this forest be able to contribute towards a steady supply of timber in the country for the security of raw material supplies and stable raw material pricing.

1.2 Justifications

The acceptance of *Acacia mangium* in the wood industries market has greater implication on the government decision as one of the selected second rotation plantation species. An observation on the first rotation planting has shown that seeds of *A. mangium* species remained dormant, and will regenerate into forest stands when the existing trees are removed. Study on the natural regeneration behaviors as well as wood properties from the naturally regenerated *A. mangium* trees are among urgently needed investigation in the current silvicultural management for this species (Weinland, 1992).

Various aspects of natural regeneration thus merit study, and research should develop techniques and schedules for tending, pruning, and thinning to make productive use of naturally produce crops. Studies will also be needed to determine the form, rate of growth, and quality of crop raise from natural regeneration (Srivastava, 1993). For the possibilities of building a forest industry which relies on the wood of naturally regenerated *A. mangium* forest, it is necessary to be able to predict its growth performance and the wood properties with different initial stand densities and silvicultural regimes.

1.3 Problem statement

Investment into forest plantation establishment is a labour intensive venture which requires a readily supply of skilled labour workforce to carry out a wide range of forest plantation activities. In the Malaysian situation, the use of machineries for forest plantation establishment is rather limited due to terrain conditions. As an alternative, companies like Asia Prima RCF, Robina and SAFODA are among *Acacia mangium* plantation concessions owners who relies upon natural regenerate saplings in part of theirs logged-over areas into production forest.

The characteristics of forest from the naturally regenerated stand can be limiting in certain aspects, it is important to understand the characteristics of this forest for the development of proper management to avoid risk of using inappropriate silvicultural strategies. Thus there is no scientific study on the optimal management procedures for naturally regenerated *A. mangium* in the humid tropics.

The aim of this research is to investigate the optimum stand production based on the hypothesis that an early and high-intensity thinning significantly increases the size of the remaining trees while the wood specific gravity varies with the intensity of thinning. It is expected that with increasing silvicultural treatment, the growth rates and the wood quality will increase.

1.4 Objectives

To study the effect of thinning intensity and timing schedule of the first thinning for high individual tree growth:

1. To determine the appropriate stoking density of naturally regenerated *A. mangium* for optimal growth and volume.
2. To determine the appropriate timing of thinning for naturally generated *A. mangium* stand.
3. To determine the effect of stand density and specific gravity of four and five year's old stands based on the first thinning applications.

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