

# GROWTH AND PHOTOCHEMICAL EFFICIENCY OF Paulownia HYBRID EXPOSED TO DIFFERENT WATER REGIMES

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FH 2018 35

## GROWTH AND PHOTOCHEMICAL EFFICIENCY OF *Paulownia* HYBRID EXPOSED TO DIFFERENT WATER REGIMES



By

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A Project Report Submitted in Partial Fulfilment of the Requirements For the Degree of Bachelor of Forestry Science in the Faculty of Forestry Universiti Putra Malaysia

2018

### DEDICATION

Thanks to Allah S.W.T, who had given strength to complete this thesis. Thanks to my beloved parent... Subahi bin Kardi and Jaliha binti Yasin My siblings... Mohd Shahrizan, Mohd Shahrom, Nurjiehan, Mohd Shahrin and whole family

> My supervisor Associate Professor Dr Hazandy Abdul Hamid

My supportive lab assistant Mr. Mohd Kamil bin Ismail Thanks for your support, encouragement and advice

> All my precious friends Thanks for your present in my life.

Thank you for your love, pray and support.

"Dedication and commitment are what transfer dreams into realities"

### ABSTRACT

Paulownia hybrid was a new introduced species for forest plantation and was still lacking in physiological data. As every state has received different amount of precipitation, water becomes major environmental variables where it can influence the physiological activity. The main objective of this research was to determine the effect of different levels of water regime on the growth, photochemical efficiency and efficiency growth of Paulownia hybrid. The plants were exposed to the treatment, which was different water regimes: low, medium and high. The growth and efficiency parameters of Paulownia hybrid such as height, diameter, leaf area and dry mass were taken. The measurements of chlorophyll fluorescence include the determination of initial fluorescence (Fo), maximal fluorescence (Fm), variable fluorescence (Fv) and photochemical efficiency (Fm/Fv). These data were analysed by using General Linear Model and analysis of variance (ANOVA) where treatment as a fixed factor. As a result, Paulownia hybrid gave a higher mean value in term of growth and biomass when exposed to high water regime rather than low and medium water regime. An efficiency growth (EG) of Paulownia hybrid when exposed to different water regimes did not had significant difference. However, low water regime had high mean value of EG compared to medium and high water regime. Paulownia hybrid showed similar pattern line of chlorophyll fluorescence within five second intervals by using SigmaPlot 14.0 software. Fv/Fm of all water regimes were not in range of 0.79 to 0.84, indicating that all the leaves were under stress. Therefore, Paulownia hybrid was affected by water regime in term of growth, biomass and photochemical efficiency but not in chlorophyll fluorescence.

### ABSTRAK

Paulownia hibrid adalah spesies baru yang diperkenalkan untuk perladangan hutan dan masih kekurangan data fisiologi. Oleh kerana setiap negeri telah menerima jumlah hujan yang berlainan, air menjadi pembolehubah persekitaran yang utama di mana ia boleh mempengaruhi aktiviti fisiologi. Objektif utama kajian ini adalah untuk menentukan kesan rejim air yang berbeza pada pertumbuhan, kecekapan fotokimia dan pertumbuhan kecekapan Paulownia hibrid. Tumbuh-tumbuhan itu didedahkan kepada rawatan, yang merupakan rezim air yang berbeza; rendah, sederhana dan tinggi. Pertumbuhan dan parameter kecekapan Paulownia hibrid seperti ketinggian, diameter, luas daun dan jisim kering telah diambil. Pengukuran pendarfluor klorofil termasuk penentuan pendarfluor awal (Fo), pendarfluor maksima (Fm), pendarfluor ubah (Fv) dan kecekapan fotokimia (Fm / Fv). Data-data ini dianalisis dengan menggunakan Model Linear Umum dan analisis varians (ANOVA) di mana rawatan sebagai faktor tetap. Akibatnya, Paulownia hibrid memberikan nilai min yang lebih tinggi dari segi pertumbuhan dan biomas apabila didedahkan kepada rejim air yang tinggi dan bukan rejim air rendah dan sederhana. Kecekapan pertumbuhan (EG) Paulownia hibrid apabila didedahkan kepada rejim air yang berbeza tidak mempunyai perbezaan yang ketara. Walau bagaimanapun, rejim air rendah mempunyai nilai purata EG yang tinggi berbanding rejim air sederhana dan tinggi. Paulownia hibrid menunjukkan garis pola pendarfluor klorofil yang sama dalam lima saat dengan menggunakan perisian SigmaPlot 14.0. Fv/ Fm bagi semua rejim air tidak didalam kalangan antara 0.79 hingga 0.84, menunjukkan bahawa semua daun berada di bawah tekanan. Oleh itu, Paulownia hibrid telah terjejas oleh rejim air dari segi pertumbuhan, biomas dan kecekapan fotokimia tetapi tidak dalam pendarfluor klorofil.

#### ACKNOWLEDGEMENTS

First of all, I would like to express my deepest gratitude to my supervisor Associate Professor Dr. Hazandy Abdul Hamid for his unwavering support and mentorship throughout this project. I wish to extend my appreciation and sincere thanks to my examiners, Associate Professor Dr Kamziah Abd Kudus and Dr Norhisham Ahmad Razi for their comments, suggestion and critics.

Thanks also to Mr. Mohd Kamil Ismail who has assited me with the related laboratory and field work. Not forgetting my sincere appreciation to Mr. Hasnan Md Isa, Mr. Mohamad Syakir Othman, Mr. Firdaus and all staffs in Institute of Tropical Forestry and Forest Products (INTROP) for their help in completing this project.

Last but not least, special thanks to my beloved family, especially my parents, Mr. Subahi Kardi, Mrs. Jaliha Yasin, and also my lovely siblings. Finally, I would like thanks to many of my friends who support and encourage me throughout this study specially Alyani Izzareena, Maizatun Nadiah, Farah Wahida, Nur Hidayah, Husna Izzati, Nor Aznida and all colleages in faculty of Forestry. Hope our love lasting and never die.

## **APPROVAL SHEET**

I certify that this research project report entitled "Growth and Photochemical Efficiency of *Paulownia* Hybrid Exposed to Different Water Regimes" by Nursuhaili binti Subahi has been examined and approved as a partial fulfilment of the requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry, Universiti Putra Malaysia.



Prof. Dr. Mohamed Zakaria Bin Hussin Dean Faculty of Forestry Universiti Putra Malaysia

Date: January 2018

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## LIST OF ABBREVIATIONS

- AGRD Absolute Growth Rate of Diameter
- AGRH Absolute Growth Rate of Height
- AGRm Absolute Growth Rate of Mass
- ANOVA Analysis of Variance
- AL Area of Leaf
- Chl Chlorophyll
- cm Centimeter
- CO<sub>2</sub> Carbon dioxide
- CRD Complete Randomized Design
- Fo Initial Fluorescence
- *Fm* Maximum Fluorescence
- Fv Variable Fluorescence
- *Fv/Fm* Photochemical Efficiency
- INTROP Institute of Tropical Forestry and Forest Products
- MPIC Ministry of Plantation Industries and Commodities
- mm m<mark>ilimeter</mark>
- PEA Plant Efficiency Analyzer
- PS II Photosystem II
- R & D Research & Development
- RGRD Relative Growth Rate of Diameter
- RGRH Relative Growth Rate of Height
- RGRm Relative Growth Rate of mass
- UPM Universiti Putra Malaysia



#### **CHAPTER 1**

#### INTRODUCTION

#### 1.1 General Background

Global warming is not a new issue in the world. The main reason of this changes was human activity. In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change, a group of 1,300 independent scientific experts from countries all over the world under the auspices of the United Nations, concluded there's a more than 95 percent probability that human activities over the past 50 years have warmed our planet. Human activity is releasing vast amount of carbon dioxide (CO<sub>2</sub>). Land-use changes such as destruction of tropical forest and the unsustainable exploitation are also giving an impact.

As the human population increases, deforestation rates and the emissions of carbon dioxide into the atmosphere also increases cause global warming. In order to cease any more increase of CO2 in the atmosphere by means of additional plantation areas could be an important means The global concern in ameliorating global warming and climate change and they fulfilled their responsibility by expand the forest plantation in Malaysia.

The tropical forests make up 80 per cent of the total world forests and are recognised as having the greatest long term potential to sequester atmospheric carbon (Nadagoudar, 2012). The reduction of natural forests, which are the main source of these resources, and the growing pressure for

the conservation of these ecosystems underscore the importance of planted forests, which could supply up to 50% of the global demand for wood by 2050 (WWF 2012). Compared to natural forests, forest plantation can produce far greater quantity of wood and non-wood produces within a relatively shorter period of time, from 3-30 years (Hashim *et al*, 2011). Furthermore, it also can act as store (sequester) the emissions greenhouse gas in the growth development process which in turn contributes to the global environment.

The establishment of forest plantation can deficit the problems of timber shortage and high pressure on natural forests caused by deforestation, where more information on species selection and performance are required in developing the successful plantation. Besides that, forest plantation also can help in depletion of carbon dioxide and act as a carbon sink through biochemical process photosynthesis. Forest, which are the main component of so-called "land sinks," play a vital role in the global carbon cycle through the absorption of 2.9 6 0.8 Pg of carbon (C) per year (in the period 2004–2013), thus mitigating climate change related to the increase of anthropogenic carbon dioxide (CO2) in the atmosphere (Le Que're' et al. 2009).

Recently, *Paulownia* species, a newly introduced forest plantation species has received a great concern due to its characteristics such fast growing, drought tolerant, short rotation woody crop and also beneficial to the environment. This species was introduced to Malaysia based on the successful history of plantations in North America and China especially on timber production and seemed to be able to meet the demand for sustainable wood production in the future as well as can act as a fast carbon sink.

### **1.2 Problem Statement and Justification**

Information about the carbon sequestration's function of forests was of great concern not only for production but also to assess the possible effects on the global warming phenomenon, where forest plantations, in particular would play a leading role in the future. Nevertheless, fundamental information on the potential of planted exotic species to the site quality and variation is scarce especially in Malaysia.

Most study of forest plantation species was focused on species composition and growth. However, in term to grow trees efficiently, foresters must understand how trees grow and this requires some understanding of tree physiology (Kramer. P. J, 1986). Therefore, intensive research needs to be done to clarify the role of exotic forest plantation for improving carbon sink as well as reducing emissions greenhouse gas in line with the Kyoto Protocol.

In Malaysia, there are many microclimates such as temperature and rainfall that can be affecting performance of plants or trees even human activities. The climate of Malaysia are uniform temperature, high humidity and copious rainfall. Winds were generally light and variable. The seasonal wind flow patterns coupled with the local topographic features determine the rainfall distribution patterns over the country. It is best to describe the rainfall distribution of the country according to seasons.

Therefore, water is major environmental variables influences on tree growth and a big scale plantation is normally rely on the amount of precipitation and it always varies throughout Malaysia. As every state had received different amount of precipitation, water become major environmental variables where it can influences the physiological activity. Plant growth and productivity are adversely affected by water stress. Therefore, the development of plants with increased survivability and growth during water stress is a major objective in the forest plantation.

*Paulownia* hybrid is still new species had been introduced in Malaysia. The productivity and physiology data of *Paulownia* hybrid are the important things in successful plantation. Therefore, research on establishment and maintenance of *Paulownia* hybrid are still in average and need more comprehensive research. Malaysia's climate and soil conditions are highly conducive for the fast growth of tree plantation like *Paulownia* hybrid. So, this study is design to study the response of *Paulownia* hybrid to our environment condition where wet and dry season.

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## 1.3 Objectives

This study was conducted to determine the effect of different levels of water regime of Paulownia hybrid. Three specific objectives were designed to meet this study which are:

- i. To identify the effect of different levels of water regimes on growth performance of *Paulownia* hybrid.
- ii. To determine the effect of different levels of water regimes on photochemical efficiency of *Paulownia* hybrid.
- iii. To identify the effect of different levels of water regimes on efficiency of growth of *Paulownia* hybrid based on biomass distribution.

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