



***ASSESSMENT OF PHYSIOLOGICAL CHARACTERISTICS OF PAULOWNIA
HYBRID EXPOSED TO DIFFERENT WATER REGIMES***

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**ASSESSMENT OF PHYSIOLOGICAL CHARACTERISTICS OF
PAULOWNIA HYBRID EXPOSED TO DIFFERENT WATER REGIMES**

By

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**A Project Report Submitted in Partial Fulfillment of the Requirements
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DEDICATION

For my supervisor:

Associate Prof. Dr. Hazandy Bin Abdul Hamid

For my beloved family:

Maskin @ Ashikin Bin Bolhi

Siti Rokiah Binti Razali

To all my friends,

Thank you for your encouragements supports

And the sacrifices that you have given.

Thank you for everything.

May Allah Bless All of us.

ABSTRACT

Paulownia is a genus belonging to family Paulowniaceae which is indigenous to China. It is known as a fast growing species and had been introduced to be planted in Malaysia. However, there is a lack of information about the plasticity of the species to adapt with the environment when planted in Malaysia as the country is well known for having different precipitation in diverse zone. Therefore, this study was conducted to examine the physiological characteristics and water use efficiency of the species by exposed them to three different water regimes, which were low, medium and high. The results showed that the plant that was exposed to a high water regime had greater net photosynthesis ($16.425 \mu\text{mol m}^{-2}\text{s}^{-1}$), stomata conductance ($0.579 \text{ mol H}_2\text{O m}^{-2}\text{s}^{-1}$), intercellular CO_2 ($365.817 \mu\text{mol CO}_2\text{m}^{-2}\text{s}^{-1}$) and transpiration rate ($3.931 \text{ mmol H}_2\text{O m}^{-2}\text{s}^{-1}$) than the plant that was exposed to the low and medium water regimes. However, the plant that was exposed to the high water regime also had the lowest values for the leaf to air vapour deficit in leaf (0.950 D), intrinsic water use efficiency ($37.834 \mu\text{mol CO}_2\text{mol H}_2\text{O}$) and instantaneous water use efficiency ($4.430 \mu\text{mol CO}_2\text{mol H}_2\text{O}$). Measurements of the gas exchange are useful for the detection of the effects of water regimes that exposed to the *Paulownia* hybrid. Different levels of water regimes were significantly affecting the physiological characteristic of the *Paulownia* hybrid.

ABSTRAK

Paulownia adalah genus daripada keluarga Paulowniaceae yang berasal dari China. Ia dikenali sebagai spesies yang boleh membiak dalam masa yang singkat dan diperkenalkan untuk ditanam di Malaysia. Walau bagaimanapun, terdapat kekurangan maklumat mengenai kepelbagaian spesies untuk menyesuaikan diri dengan keadaan cuaca apabila ditanam di Malaysia kerana Malaysia dikenali sebagai negara yang mempunyai hujan yang berbeza di zon yang pelbagai. Oleh itu, kajian ini dijalankan untuk mengkaji ciri-ciri fisiologi dan kecekapan penggunaan air spesies dengan mendedahkannya kepada tiga rutin kehadiran air yang berbeza, yang rendah, sederhana dan tinggi. Keputusan menunjukkan bahawa tumbuhan yang terdedah kepada kehadiran air tinggi mempunyai fotosintesis bersih yang lebih besar ($16.425 \mu\text{mol m}^{-2}\text{s}^{-1}$), stomata ($0.579 \text{ mol H}_2\text{O m}^{-2}\text{s}^{-1}$), CO_2 "intercellular" ($365.817 \mu\text{mol CO}_2\text{m}^{-2}\text{s}^{-1}$) dan kadar transpirasi ($3.931 \text{ mmol H}_2\text{O m}^{-2}\text{s}^{-1}$) daripada tumbuhan yang terdedah kepada kehadiran air rendah dan sederhana. Walau bagaimanapun, tumbuhan yang terdedah kepada kehadiran air yang tinggi juga mempunyai nilai terendah untuk daun ke udara defisit wap (0.950 D), kecekapan penggunaan air intrinsik ($37.834 \mu\text{mol CO}_2\text{mol H}_2\text{O}$) dan kecekapan penggunaan air segera ($4.430 \mu\text{mol CO}_2\text{mol H}_2\text{O}$). Pengukuran pertukaran gas berguna untuk mengesan kesan kehadiran air yang terdedah kepada *Paulownia*. Tahap kehadiran air yang berbeza menjejaskan ciri fisiologi *Paulownia*.

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APPROVAL SHEET

I certify that this research project report entitled “Assessment of Physiological Characteristics of *Paulownia* Hybrid Exposed to The Different Water Regimes” by Alyani Izzareena Binti Maskin has been examined and approved as a partial fulfillment of the requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry, Univeristi Putra Malaysia.

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LIST OF ABBREVIATIONS

WUE	Water Use Efficiency
INTROP	Institute of Tropical Forestry and Forest Products
MTIB	Malaysian Timber Industry Board
CRD	Complete Randomized Design
ANOVA	Analysis of Variance
$m^{-2}s^{-1}$	Meter per second
CO ₂	Carbon dioxide
WUEinst	Water Use Efficiency instantaneous
m	Metre
WUEi	Water Use Efficiency intrinsic
MPIC	Ministry of Plantation Industries and Commodities
Anet	Net photosynthesis
CI	intercellular CO ₂
Vpdl	Vapour pressure deficit in leaf

CHAPTER 1

INTRODUCTION

1.1 General background

Forest degradation is proceeding at unprecedented rate in various tropical regions, jeopardizing prospects for conservation of biological diversity, sustainable economic development and forest resources. The Malaysian Timber Industry Board (MTIB) predicts that the wood resources from the natural forest will extremely decrease on year 2034.

Aware of the prediction, the Institute of Tropical Forestry and Forest Products (INTROP), Universiti Putra Malaysia (UPM) has decided to introduce new species; *Paulownia* species. Native to China, *Paulownia* exhibits rapid growth and high wood quality. This species is commonly used in manufacturing furniture, musical instruments, and fencing (Alcaraz & Castellanos, 2010).

Paulownia has been introduced into Asia, USA, Australia and Europe as a high-yielding plant. These trees can be used for the production of energy, paper pulp and wooden building materials (Ohriski, 2015). This species was known because of its good properties, such as short rotation, high-quality wood, high biomass, pollution tolerance and attractive flowers, *Paulownia* is versatile for fodder, paper industry, pencil manufacturing, house construction,

furniture making, solid biofuel, forestation and ornamental plant (Yan et al., 2017).

As a new introduced species, it is quite risky to commercialize this species yet as there are no significant details about the plasticity of this species growing in different climatic conditions especially under Malaysia's climate especially related to the water stress. Water stress in plants induces cellular, physiological, and developmental changes. Plants adapt to water stress by inducing rapid physiological responses, such as opening and closing stomata and changing the angles of leaves (Alcaraz & Castellanos, 2010).

Therefore, in this study, we evaluated physiological assessment of the Paulownia hybrid when exposed to the different water regime (low, medium and high) by measured the gas exchange and calculated the water use efficiency (WUE) of the plant. This research was very important before this species plantation being introduced for big scale forest plantation. Understanding of the relationship between physiological characteristics may help to explain variation in growth rate, productivity and WUE between species and growth environment.

1.2 Problem Statement and Justification

The *Paulownia* species is an introduced species in Malaysia. This tree has been chosen for the plantation because of various factors. For example, the species in the *Paulownia* genus are fast growing species. This species also has high timber quality, can prevent landslide, the leaves can be used as fodder for living stock, shading for crops and control the air pollution. Species in the *Paulownia* genus are highly adaptive to a wide range of climate and soil conditions (Ohridski, 2015).

However, as it is an introduced species; there are lack of details about the ability of this species when planted in Malaysia. Therefore, it is a quite risky if this species is being planted in a large scale plantation which is no data to verify that this species is suitable to be planted and can adapt well to Malaysia climate or not.

Furthermore, Malaysia is a typical tropical country with a mean annual precipitation greater than 2500 mm/yr and a mean monthly temperature range from 23 to 32 °C. The Peninsular and East Malaysia have different climates. Rainfall amount in Peninsular Malaysia is highly variable due to the prevailing monsoon seasons. In addition, the terrain of Peninsular Malaysia is highly variable from coastal to highlands. (Varikoden et al., 2010).

Therefore, the precipitation rate will differ in every zone. Different precipitation rate will affect the plantation. However, there are no details

about this species on what condition of water regime that it can survive. Little is known about the physiology of *Paulownia* species (Alcaraz & Castellanos, 2010).

This preliminary research about the assessment of its physiological characteristics that related with the water regime was done. Its physiology and drought adaptive characteristics carefully studied to ensure a successful introduction (Alcaraz & Castellanos, 2010).

1.3 Research Question

Are the physiological characteristics of the *Paulownia* hybrid showing better plasticity when exposed to different water regimes?

1.4 Objective

The objective of this research was:

- i. To determine the physiological process by assessing the gas exchanges and water use efficiency of *Paulownia* hybrid when exposed to different water regimes.

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