UNIVERSITI PUTRA MALAYSIA

EFFECT OF LIGHT INTENSITY ON THE GROWTH AND CHLOROPHYLL CONTENT OF PENNYWORT (*HYDROCOTYLE BONARIENSIS* COMM. EX LAM.)

LIM GUAT GOH

FS 2007 52

EFFECT OF LIGHT INTENSITY ON THE GROWTH AND CHLOROPHYLL CONTENT OF PENNYWORT (*HYDROCOTYLE BONARIENSIS* COMM. EX LAM.)

By

LIM GUAT GOH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

July 2007

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

EFFECT OF LIGHT INTENSITY ON THE GROWTH AND CHLOROPHYLL CONTENT OF PENNYWORT (*HYDROCOTYLE BONARIENSIS* COMM. EX LAM.)

By

LIM GUAT GOH

July 2007

Chairman: **Hishamuddin Omar, PhD**

Faculty: **Science**

Pennywort (*Hydrocotyle bonariensis*) is one of the most common vegetables and medicinal herbs used in Malaysia. It was believed to help in wound-healing, blood circulation, and has effects on blood pressure, tumours and depression. Most of the pennyworts used come from the wild or are imported. Lack of knowledge regarding the agronomical parameters of this plant may affect the medicinal value of the herb, cause extinction, or loss of foreign exchange in the herb trade. This study examined the effects of light intensities and fertilizers on the growth and chlorophyll content of the pennywort.

A 2x3 factorial using complete randomized block design experiment with five replicates was carried out. Thirty boxes (32 cm x 42 cm x 15 cm) of pennywort were fertilized weekly under three fertilizer conditions: organic (50 gm^{-2}), inorganic (12.5 gm^{-2}), and control. They were grown under moderate (542.6 $\mu mols^{-1}m^{-2}$) and high (1089.2 $\mu mols^{-1}m^{-2}$) light intensities.

Results showed that leaf area was the most suitable method to determine growth. The result also exhibited that chlorophyll content in *H. bonariensis* was maximum in the third week of growth for all treatment. For productivity, *H. bonariensis* gave higher productivity compared to *Centella asiatica*. The most significant result was that plant in moderate light intensity was better in all growth aspects and chlorophyll content ($p<0.05$), except density. However, due to the bigger sized leaves, this disadvantage was negligible.

Results showed that rate of fertilizing at 50 gm^{-2} of organic fertilizer weekly or 12.5 gm^{-2} inorganic fertilizers weekly was adequate to maintain healthy growth. The experimental results indicate that both organically and inorganically fertilized plants were significantly higher in all growth aspects compared to the control plant ($p<0.05$). However, there were no significant effects of fertilizers on plant's chlorophyll content.

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

KESAN KEAMATAN CAHAYA KE ATAS PERTUMBUHAN DAN KANDUNGAN KLOROFIL PEGAGA (*HYDROCOTYLE BONARIENSIS* COMM. EX LAM.)

Oleh

LIM GUAT GOH

Julai 2007

Pengerusi: **Hishamuddin Omar, PhD**

Fakulti: **Sains**

Pegaga (*Hydrocotyle bonariensis*) adalah herba yang umumnya digunakan di Malaysia sebagai ulam dan ubatan. Ia dipercayai dapat membantu dalam pemulihan luka, peredaran darah, dan mengurangkan tekanan darah, radang, tumor dan depresi. Sumber pegaga untuk tujuan tersebut diperolehi dari liar ataupun diimport. Kekurangan pengetahuan tentang parameter agronomi tumbuhan ini mungkin mempengaruhi nilai perubatan herba ini, menyebabkan kepupusannya, atau kerugian pertukaran matawang asing dalam perdagangan herba ini. Kajian ini meninjau kesan keamatan cahaya dan baja ke atas pertumbuhan dan kandungan klorofil pegaga.

Satu eksperimen menggunakan rekabentuk 2x3 faktorial blok rawak lengkap dengan lima replikat telah dijalankan. Tiga puluh kotak pegaga (32 cm x 42 cm x 15 cm) telah dibaja setiap minggu di bawah tiga keadaan pembajaan iaitu: organik ($50gm^{-2}$), bukan organik ($12.5gm^{-2}$), dan kawalan. Pegaga itu telah ditumbuhkan di bawah keamatan cahaya sederhana (542.6 $\mu mols^{-1}m^{-2}$) dan tinggi (1089.2 $\mu mols^{-1}m^{-2}$)

Hasil kajian pertumbuhan mendapati kaedah keluasan daun merupakan kaedah terbaik untuk penentuan tumbesaran. Kajian juga mendapati kandungan klorofil dalam *H. bonariensis* adalah maksimum pada minggu ketiga untuk semua rawatan. Dari segi produktiviti, *H. bonariensis* adalah lebih tinggi produktivitinya berbanding *Centella asiatica*. Penemuan yang paling signifikan ialah tumbuhan bawah keamatan cahaya sederhana adalah lebih baik dalam semua aspek pertumbuhan dan kandungan klorofil ($p<0.05$), kecuali aspek ketumpatan tumbuhan. Namun, disebabkan saiz daun yang lebih besar, kekurangan ini dapat diatasi.

Kajian ini mendapati bahawa pembajaan dengan kadar 50 gm^{-2} baja organik atau 12.5 gm^{-2} baja bukan organik setiap minggu dapat menampung pertumbuhan yang sihat. Didapati juga bahawa tumbuhan di bawah pembajaan organik dan bukan organik adalah tinggi secara signifikan dalam semua aspek pertumbuhan berbanding kawalan ($p<0.05$). Namun tiada kesan signifikan untuk pembajaan ke atas kandungan klorofil tumbuhan diperolehi.

ACKNOWLEDGEMENTS

No research can be carried out without the assistance and support of various parties and individuals. I received lots of help, suggestions, and encouragement to carry out this research. I would like to take this opportunity to thank those who had contributed directly or indirectly in my research.

Thanks to the Teacher Education Division, Ministry of Education Malaysia for the scholarship offered. With the scholarship as financial support, I could concentrate fully in my studies.

Deepest appreciation to Dr. Hishamuddin Omar, my supervisor, for brought me into the interesting world of plant physiology. His dedication and patience in supervising, guiding, advising and demonstrating has taught me what "Leadership by example" means. He is great not only with ideas and wide range of knowledge, but also with moral support.

Not to forget my hearties gratitude to Dr. Misri Kusnan, my co-supervisor. Great ideas were given by him during discussions and enquiries. His answers were always short, but precise and practical.

I am grateful to En. Jamal and Pn. Zaleha of University Agriculture Park, UPM for permission given to use the facilities in the nursery. The assistance and cooperation given especially in providing the cuttings of pennywort was remembered.

Applauses to my three friends, Chong Siew Fong, Lau Kar Yin, and Ravi a/l Munisamy for trying out their research with me. Two semesters of working experience with you all made me feel not alone in my research work. Not forgetting my course mate - Wee Pou Lis for her moral support and encouragement.

I owe my gratitude to one of my colleague from the English Language Unit, Language Department, Institut Perguruan Tun Hussein Onn for her kindness in read through my writing.

Last but not least, I would like to say thanks to my family members who had given me endless support, encouragement, time and energy during my study.

I certify that an Examination Committee met on 6th July 2007 to conduct the final examination of Lim Guat Goh on her Master of Science thesis entitled "Effect of light intensity on the growth and chlorophyll content of pennywort (*Hydrocotyle bonariensis* Comm. ex Lam.)" in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Putra Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Aziz Arshad, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Faridah Abdullah, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Faridah Qamaruz Zaman, PhD
Lecturer
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Mashhor Mansor, PhD
Professor
School of Biological Sciences
Universiti Sains Malaysia
(External Examiner)

_____
HASANAH MOHD. GHAZALI, PhD
Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Hishamuddin Omar, PhD
Lecturer
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Misri Kusnan, PhD
Lecturer
Faculty of Science
Universiti Putra Malaysia
(Member)

_____
AINI IDERIS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 22 January 2008

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

LIM GUAT GOH

Date:

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

C	Carbon
CHO	Aldehyde group
CH_2O	Simple sugar
CH_3	Methyl group
CO_2	Carbon dioxide
$CuSO_4$	Copper sulphate
Fe^{2+}	Ferric
Fe^{3+}	Ferous
H	Hydrogen
H_2O	Hydrogen oxide/ Water
H_2O_2	Hydrogen peroxide
$H_2PO_4^-$	Dihydrogen phosphate
H_2S	Hydrogen sulfide
HCl	Hydrogen chloride
HPO_4^-	Monohydrogen phosphate
K	Potassium
KCl	Potassium chloride
KNO_3	Potassium nitrate
Mg	Magnesium
N	Nitrogen
$N_2H_6SO_4$	Hydrazine sulphate
N_2O	Nitrous oxide
NaOH	Sodium hydroxide

NED	N-1-naphthylethylenediamine dihydrochloride
$NH_2C_6H_4SO_4NH_2$	Sulpanilamide
NH_3	Ammonia
NH_4^+	Ammonium ion
NH_4Cl	Ammonium chloride
NO_2^-	Nitrite
NO_3^-	Nitrate
O	Oxygen atom
O_2	Oxygen molecule
P	Phosphorous
SO_4^{2-}	Sulphate
$ZnSO_4$	Zinc sulphate
ATP	Adenosine triphosphate
RNA	Ribonucleic acids
DNA	Deoxyribonucleic acid
α	Alpha
β	Beta
γ	Gamma
μ	Miu
min	Minute
s	Second
cm	Centimeter
m	Meter
nm	Nanometer

mg	Milligram
g	Gram
kg	Kilogram
gm^{-2}	Gram over meter square
kgm^{-2}	Kilogram over meter square
ml	Mililitre
°C	Degree Celcius
ppm	Part per million
p	Probability
%	Percent
>	Greater than
<	Less than
USD	United State Dollar
RM	Ringgit Malaysia
O.D.	Absorbance density

CHAPTER 1

INTRODUCTION

Earth is a planet that supports life. There are a very rich biodiversity of living things on Earth. According to Handa (2005), six of the world's eighteen biodiversity hot-spots are located in Asia, and Peninsula Malaysia is one of it having 12 000 plant species. This makes Malaysia one of the world's 12 "mega diversity" countries that are rich in variety of plant species unexploited. Among these plant species, it is estimated that there are about 1230 species of plants that contain medicinal values (Muhamad and Mustafa, 1992).

People live in rural area of Asia Pacific used the plants growing close to their living, for example homes, in the open fields, waste lands, nearby forest area to cure and relieve many ailments. These practices lead to various Asian systems of medicine, including Ayurveda of India, Unani system of Middle East and Far East Asia, Yin and Yang principles of Chinese herbal medicine, Jamu of Indonesia and others (Sharma *et al*., 1998; Natesh, 2000). These systems are still in use today.

Herbal medicine has been widely use for more than forty years in western countries (Griggs, 1981). People resort to herbal medicine for some reasons. According to Abas (2000), for a certain fraction of the population, herbal use is intrinsically part of their culture and belief, and the relatively low cost and easy availability of herbal medicine makes it affordable to the lower income group. He also says that the general public's impression of herbals being natural, safer and less harmful and that

they do not contain chemicals also play an important role in the use of herbal medicine.

With the advancement and development of modern medicine, people have shifted to modern medication. The reasons are that it is more convenient, that is easy to bring along, ready to be consumed in pill or solution form, and shows fast results. Herbal medicine became less popular.

In the end of the last century, herbal and traditional medication showed a revival. With the increment in education and socioeconomic status, people are more health conscious now. They take herbals as supplements. Modern medicines come with many side effects. For example, Vioxx may cause heart attack (Dogne *et al*., 2006), Viagra which is intended for impotence may cause heart attack (Czap, 2005), and recently the Tamiflu that intended to fight H5N1 bird flu virus has caused death in Japan (Fuyuno, 2007).

It has been estimated that 80% of the world's rural population is still dependent on herbal medicine for primary health care (Sasson, 1996; Natesh, 2000). The use of herbal medicines is growing rapidly at a rate of 10-20% annually (Philipson, 1995). The global market value for herbal medicine was estimated to be worth USD 800 billion a year (Rajasekharam and Ganeshan, 2002) and is still increasing. In Malaysia, the sale of herbal products is valued at RM 2 billion in 2000, RM 2.35 billion in 2004, RM 3.13 billion in 2005 (Rohana, 2004) and RM 5.2 billion in 2010. As such, it can be seen that the use of herbal medicine is generally on the increasing trend now.