UNIVERSITI PUTRA MALAYSIA

EFFECT OF TYPE OF LIGHT SOURCE ON THE GROWTH PERFORMANCE OF ARABIDOPSIS THALIANA (COL-0) IN UPM TRANSGENIC GREENHOUSE

MOHD SHAHRUL NIZWANSHAH BIN KARIM

FP 2014 12

EFFECT OF TYPE OF LIGHT SOURCE ON THE GROWTH PERFORMANCE OF *ARABIDOPSIS THALIANA* (COL-0) IN UPM TRANSGENIC GREENHOUSE

BY

MOHD SHAHRUL NIZWANSHAH BIN KARIM

A project report submitted to Faculty of Agriculture, Universiti Putra Malaysia, in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science

FACULTY OF AGRICULTURE

UNIVERSITI PUTRA MALAYSIA

SERDANG, SELANGOR DARUL EHSAN

2013/2014

© COPYRIGHT UPM

CERTIFICATION

This project report entitled "The Effect of Type of Light Source on the Growth Performance of *Arabidopsis Thaliana* (Col-0) in UPM Transgenic Greenhouse" is prepared by Mohd Shahrul Nizwanshah Bin Karim and submitted to the Faculty of Agriculture in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science.

Student's name: Student's signature:

Mohd Shahrul Nizwanshah Bin Karim

Bachelor of Agricultural Science ……

Certified by:

……

Prof. Datin Dr. Siti Nor Akmar Abdullah

Department of Agriculture Technology,

Faculty of Agriculture,

Universiti Putra Malaysia,

43400 Selangor Darul Ehsan.

Date:…….

© COPYRIGHT UPM

ACKNOWLEDGEMENT

Praise to Allah S.W.T, the work presented in this final year project could not have been possible to complete without guidance and support from many people.

I would like to express my deep gratitude and appreciation to my supervisor, Prof. Datin Dr. Siti Nor Akmar Abdullah for her caring guidance, generous assistance and valuable advice during my study and the preparation as well as completion of the report. Her suggestions and full support have been most constructive and highly appreciated.

Gratitude is extended to Miss Farzaneh and Miss Rozila for the valuable advice and assistance at all stages of the research work. Special thank is also extended to all staff of Agricultural Biotechnology Laboratory, and UPM Transgenic Greenhouse for their help and guidance. Thanks to all my course mates for their encouragement and support all the time.

Last but not least, I would like to express my sincere gratitude and thanks to my parents and my family members for their patience, blessing and support throughout my study period.

Thank You

© COPYRIGHT UPM

TABLE OF CONTENTS

CHAPTERS		PAGE
ENDORSEMENT		i
ACKNOLEDGEMENT		ii
TABLE OF CONTENT		iii
LIST OF TABLES		v
LIST OF FIGURES		vi
LIST OF APPENDICES		vii
ABSTRAK		viii
ABSTRAK		ix
1.0	INTRODUCTION	1
2.0	LITERATURE REVIEWS	4
	2.1 *Arabidopsis thaliana* Growth	4
	2.2 Light Source	5
	2.3 The Effectof Lighton the Growthof Plants	8
	2.4 Growth Performance Analysis	12
3.0 MATERIALS AND METHODS		15
	3.1 Materials	15
	3.2 Planting *Arabidopsis*	16
	3.3 Careof Plants During Growth	17
	3.4 Experimental Designand Data Analysis	18

© COPYRIGHT UPM

4.0 RESULT AND DISCUSSION 19

4.1 Successful 1 Complete Life Cycle of Arabidopsis Thaliana 19

4.2 Light-Based Growth Analysis 24

4.3 Chlorophyll Content Analysis 28

4.4 Leaf Area Analysis 30

5.0 CONCLUSION 32

REFERENCES 34

APPENDICES 38

© COPYRIGHT UPM

LIST OF TABLES

TablePage

Table 1: Principal Growth Stage 14

Table 2: Complete 1 Life Cycle of *Arabidopsis thaliana* (Col-0) 21

Grown in UPM Transgenic Greenhouse

© COPYRIGHT UPM

LIST OF FIGURES

Figure **Page**

Figures 1: Day of *A. thaliana* start to flower by replicate 24

Figures 2: Average days of *A. thaliana* start to flower 25

Figures 3: Height of replicate of *A. thaliana* in treatment 1 & 2 25

Figures 4: Average height of *A. thaliana* in treatment 1 & 2 26

Figures 5: Chlorophyll Content by replicate of *A. thaliana* 28

Figures 6: Average Chlorophyll content of *A. thaliana* by treatment 29

Figures 7: Leaf area by replicate of *A. thaliana* in treatment 1 & 2 30

Figures 8: Average leaf area of *A. thaliana* in treatment 1 & 2 31

© COPYRIGHT UPM

LIST OF APPENDICES

APPENDIX I :Day of *A. thaliana* Start to Flowers and Height of *A. thaliana* at the 80th day

APPENDIX II : Leaf Area of *A. thaliana* by treatment

APPENDIX III : Graph on Temperature in Room 1, UPM Transgenic Greenhouse

APPENDIX IV : Graph on Temperature in Room 1, UPM Transgenic Greenhouse

APPENDIX V : Graph on Light Intensities by Treatment

APPENDIX VI : SAS Analysis on Arabidopsis thaliana Chlorophyll Content

APPENDIX VII : SAS Analysis on Arabidopsis thaliana Average Leaf Area

APPENDIX VIII :SAS Analysis (Paired test) on Arabidopsis thaliana Average Chlorophyll Content

APPENDIX IX :SAS Analysis (Paired Test) on Arabidopsis thaliana Average Leaf Area

APPENDIX X :Device used in measurement

© COPYRIGHT UPM

ABSTRACT

Arabidopsis thaliana is a small flowering plant that is widely used as a model organism in plant biology especially in agricultural technology. Arabidopsis is a member of the mustard (Brassicaceae) family, which offers important advantages for basic research in genetics and molecular biology. It is important to identify the best source of light to be applied when growing Arabidopsis in the greenhouse based on their growth performance and for further uses in Arabidopsis research and seed production. The objectives of this experiment were to achieve one complete life cycle of *Arabidopsis thaliana* by using one media and to study the effect of source of light on the growth performance of *A. thaliana* (Col-0) in UPM Transgenic Greenhouse. The sources of light used in this study were Fluorescent light and LED light. The plantswere successfully grown in the greenhouse and produced hundreds of healthy seeds. However it took about 5 months which is longer than typical period (~2 months) to complete 1 life cycle. Through this study, it was found that there were significant effect of light source and significant difference between the 2 treatments that had been applied to the growth performance of *A. thaliana* in UPM Transgenic Greenhouse in term of leaf area and chlorophyll content. Treatment 2, which is the LED light is recommended to be used as the source of light in greenhouse for better growth of *A. thaliana*. The plant grown under the exposure of LED light showed the highest growth rate and highest value of chlorophyll content.

© COPYRIGHT UPM

ABSTRAK

Arabidopsis thaliana merupakan sejenis tumbuhan berbunga kecil yang digunakan secara meluas sebagai model tumbuhan dalam biologi tumbuhan terutamanya di dalam bidang teknologi pertanian.*Arabidopsis thaliana* adalah tergolong daripada keluarga brassikasea yang mempunyai kesesuaian ciri-ciri untuk digunakan dalam penyelidikan genetik dan biology molekul. Oleh itu, adalah penting untuk menentukan sumber cahaya yang terbaik dalam menanam pokok *Arabidopsis* di dalam rumah hijau berdasarkan kadar tumbesaran dan untuk kegunaan lanjut dalam penyelidikan *Arabidopsis* dan pengeluaran biji benih. Objektif experiment ini adalah untutk mencapai satu kitaran hidup *Arabidopsis thaliana* yang lengkap dengan menggunakan satu medium tanaman dan untuk mempelajari kesan jenis dan sumber cahaya kepada kadar tumbesaran *Arabidopsis thaliana* di Rumah Hijau Transgenik, UPM. Sumber cahaya yang digunakan dalam kajian ini adalah lampu fluorescent dan lampu LED. Pokok tersebut Berjaya ditanam di dalam rumah hijau dan menghasilkan ratusan biji benih yang sihat. Walaubagaimanapun, ia mengambil masa selama 5 bulan untuk melengkapkan satu kitaran hidup berbanding kitaran biasa iaitu 2 bulan. Melalui experiment ini didapati ada signifikasi perbezaan kesan sumber cahaya dan signifikasi di antara dua rawatan yang telah diaplikasi kepada tumbesaran pokok Arabidopsis thaliana di Rumah Hijau Transgenik, UPM berdasarkan kandungan klorofil dan luas daun. Dimana, rawatan ke-2, iaitu lampu LED amatlah disyorkan untuk digunakan sebagai sumber pencahayaan di dalam rumah hijau untuk tumbesaran *Arabidopsis thaliana* yang lebih baik. Pokok yang didedahkan kepada lampu LED menunjukkan kadar tumbesaran dan kandungan klorofil yang tinggi Berbanding pokok yang didedahkan kepada lampu Fluorescent.

© COPYRIGHT UPM

CHAPTER 1

INTRODUCTION

Light is a form of electromagnetic radiation that is visible to the human eye. The radiation that we perceive as sunlight, or the visible spectrum, is a small fraction of the total electromagnetic spectrum that includes gamma rays, x-rays, and radio waves. For photosynthesis, plants respond strongest to blue and red light, and to red and infra-red light wavelengths for photoperiod growth responses and germination control. The intensity, duration, direction, and spectral quality of light radiation that plants receive has an effect on photosynthesis, flowering, climate response (temperature and water loss), and photo morphogenesis (Argus control, 2010).

Therefore, source of light in the greenhouse is one of the critical factors that plays a major role in green plants metabolism, growth and development in which the plants respond in various ways to the intensity and duration of light. There are many sources of light in the greenhouse which are incandescent, high intensity discharge (HID) fluorescent, high intensity fluorescent and light emitting diode (LED) lights that give different light qualities (Mortensen, 1987).

Arabidopsis thaliana is a small flowering plant native to Europe and Asia with a relatively short life cycle that has been a popular model organism in plant biology and genetics especially in Agricultural biotechnology due to its relatively small genome.

© COPYRIGHT UPM

Arabidopsis plants have proved to be an excellent model organism due to some advantageous characteristic as follows: short generation time, production of many seeds and the small size that enable researchers to grow them in a restricted space in the laboratories. These features have made *A. thaliana*an ideal model plant in studies for understanding the genetic, cellular and molecular biology of flowering plants (Menke*et al*,. 1998).

Successful germination and plant growth requires appropriate soil moisture, nutrient levels, light intensity, humidity, and temperature. *Arabidopsis* growth has four major stages which are germination, rosette production, bolting and senescence (TAIR). In the germination stage, the radical emerges from the coat and begins to grow. Next in the rosette production, the plant begin to produce large leaves just above the surface of the soil and in the bolting stage, the plant produces a large stem. On this stem, the plants produced flowers and the siliques (seed pods) which is then followed by the last stage which is the senescence stage.

The ideal temperature range for growth is 16-25 °C and there are many different varieties, or ecotypes of *Arabidopsis.* There are three standards of *Arabidopsis* ecotypes used by the researcher i.e. N933 (Col-4), NW20 (Ler) and N1601 (WS). The N933 or known as Columbian ecotypes which has been sequenced in the public *Arabidopsis* Genome Initiative, is the widely used ecotypes, because it has very robust growth, average growth characteristics and considered to be wild type (Cotter, 2005).

Plant growth can be defined as an irreversible change with time and can be affected by the environment factors such as light sources and its intensity (Hunt, 2003). Single altered

© COPYRIGHT UPM

environment condition may affect several traits and resulting in morphological changes and/or altered timing of development (Boyes*et al*., 2001).

Morphological changes can be identified and recorded through an extensive phenotypic analysis process to describe the growth and the development of a plant in response to the effect of different light sources. It was reported that Hoffman *et al*., 2001 used the BASF, Bayer, Ciba-Geigy, Hoechst (BBCH) scale as a basis to be used in the phenotypic analysis of *A. thaliana*.

As a model organism, *A. thaliana* is grown for research use and seed production. For that purposes, *Arabidopsis* must be as robust and vigorous as possible and must be grown under precise condition to ensure the experimental result can be repeated by others. Robust plant and high quality seeds are the result of good production practices which include good growing condition(Parvees*et al*, 2010).

Therefore, it is important to identify the best source of light when growing *Arabidopsis* in the greenhouse based on their growth performance as an indicator for further uses in *Arabidopsis* research and seed production in future.

The objectives of this experiment were to achieve one complete life cycle of *Arabidopsis thaliana* by using one media and to study the effect of two different light sources used in the greenhouse on the growth performance of *A. thaliana* (Col-0) in UPM Transgenic Greenhouse. The two different light sources used in this study were Phillips Fluorescence Light and Phillips LED light.

© COPYRIGHT UPM

REFERENCES

Boom, E. Weber, P. Zwenger. 2009. The BBCH system to coding the phonological growth stages of plants. Journal for Kulturplanzen.61: 41-52.

Busheva, M. Andreeva, A. Apostolova, E.2000. Effect of modification of light-harvesting complex II on fluorescence properties of thylakoid membranes of *Arabidopsis thaliana.* Journal of Photochemistry and Photobiology B: Biology 56 :78–8.

Brockman, J.A. Norman, H.A and Hildebr, D.F. 1990. Effects of temperature, light and a chemical modulator on linolenate biosynthesis in mutant and wild type *Arabidopsis* call1. Phytochemistry . 29(5): 1447-1453.

Chang, M.H. Das, D. Varde, P.V. Pecht, M. 2012. Light emitting diodes reliability review.Microelectronics Reliability 52 :762–782.

Eskins, K. Warner, K. and Felker, F.C. 1996. Light quality during early seedling development influences the morphology and bitter taste intensity of mature lettuce *(Lactuca sativa)* Leaves. *Plant Physiology*. 7: 709-713.

Eskins, K. and Alexander, N. 1993. Blue and red-light irradiance switching of nuclear- and chloroplasten coded gene expression in Arabidopsisand Sorghum. J. Photochemistry. 18 : 253-258.

© COPYRIGHT UPM

Edwards, A.E And Silva, E. 2001. Effect of visible light on selected enzymes, vitamins and amino acids. Journal of Photochemistry and Photobiology B: Biology 63 : 126–131

Fan, X.X. Xu, Z.G. Liua, X.Y. Tang, C.M. Wang, L.W. Han, X.L. 2013. Effects of light intensity on the growth and leaf development of young tomato plants grown under a combination of red and blue light. Scientia Horticulturae 153 :50–55.

Hunt, R.2003. Growth Analysis, Individual Plant. Elsevier Ltd.

Islam, A. Kuwar, G. Clarke, J.L. Blystad, D.R. Gislerod, H.R. Olsen, J.E. Torre, S. 2012. Artificial light from light emitting diodes (LEDs) with a high portion of blue light results in shorter poinsettias compared to high pressure sodium (HPS) lamps. Scientia Horticulturae. 147 :136–143.

Ilieva, I. Ivanova, T. Naydenov, Y. Dandolov, I. Stefanov, D. 2010. Plant experiments with light-emitting diode module in Svet space greenhouse. Advances in Space Research 46 : 840–845.

Kuepper, G. 2004 Potting Mixes for Certified Organic Production. Horticultural Technical Note

Koorneef, M. and D. Meinke. 2010. Development of Arabidopsis as model plant. The Plant Journal. 61: 909-921.

© COPYRIGHT UPM

Kreslavski, V.D. Shirshikova, G.N. Lyubimov, V.Y. Shmarev, A.N. Boutanaev, A.M. Kosobryukhov, A.A. Schmitt, F.J. Friedrich, T. Allakhverdiev, S.I. 2013. Effect of preillumination with red light on photosynthetic parameters and oxidant-/antioxidant balance in *Arabidopsis thaliana* in response to UV-A. Journal of Photochemistry and Photobiology B: Biology 127 : 229–236.

Koranski, D.S. 1987. Interaction of Photoperiod, Light Intensity, Light Quality and Ancymidol on Growth and Flowering of *Clerodendrum thomsoniae* Balf. 'Wisconsin'. *Scientia Horticulturae,* 33 :147-154.

Kurata, K and Yamamoto, K.T. 1996. Light-stimulated root elongation in *Arabidopsis thaliana*. Plant Physiology 427: 303-342.

Leister, D., C. Varotto, P. Pesarisi, A. Nigerwall, F. Salamini 1999. Large scale evaluation of plant growth in *Arabidopsis thaliana* by non-invasive image analysis. Plant Physiology. Biochemistry. 37(9): 671-678.

Li, H., Tang, C. Xu, X. 2013. The effects of different light qualities on rapeseed (Brassica napus L.) plantlet growth and morphogenesis. Scientia Horticulturae. 150: 117-124.

Lin, K.H. Huang, M.Y. Huang, W.R. Hsu, M.H. Yang, Z.W. Yang, C.M. 2013. The effects of red, blue, and white light-emitting diodes on the growth,development, and edible quality of hydroponically grown lettuce. Scientia Horticulturae 150 ; 86–91.

© COPYRIGHT UPM

Lokhande, S.D. Ogawa, K. Tanaka, A. Hara, T.2003. Effect of temperature on ascorbate peroxidase activity and flowering of *Arabidopsis thaliana* ecotypes under differen light conditions. Plant Physiology. 160:57–64.

Meier, U., H. Bleiholder, L. Buhr, C. Feller, H. Hack, M. Hefs, P.D Lancashire, U. Schnock, R. Stauf, T. Boom, E. Weber, P. Zwenger. 2009. The BBCH system to coding the phonological growth stages of plants. Journal for Kulturplantzen 61: 41-52.

Macedo, A.F. Leal-Costa, M.V. Tavares, E.S. Salgueiro Lage, C.L. Esquibel, M.A. 2011. The effect of light quality on leaf production and development of in vitro-cultured plants of *Alternanthera brasiliana* Kuntze. Environmental and Experimental Botany 70 : 43–50.

Morelli, M and Ruberti, I. 2002. Light and shade in the photocontrol of Arabidopsis growth.Journal of Photochemistry and Photobiology Pp 399-404

Shimada, A. And Taniguchi, Y. 2011. Red and blue pulse timing control for pulse width modulation light dimming of light emitting diodes for plant cultivation. Journal of Photochemistry and Photobiology B: Biology 104 : 399–404.

Wang , C.Y. Fu, C.C. Liu, Y.C. 2007. Effects of using light-emitting diodes on the cultivation of *Spirulina platensis.* Biochemical Engineering Journal 37 : 21–25.

© COPYRIGHT UPM