UNIVERSITI PUTRA MALAYSIA

GROWTH AND PHOTOSYNTHETIC CHARACTERISTICS OF KAILAN (*Brassica oleraceae* var. Alboglabra) GROWN UNDER LED AND FLOURESCENT LIGHTS

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BY

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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 degree of Bachelor of Horticultural Science

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CERTIFICATION FORM

This project entitled growth and photosynthetic characteristics of kailan (*Brassica oleraceae* var. Alboglabra) grown under LED and fluorescent lights prepared by Nurul Amira Binti Hamidon in fulfilment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Horticultural Science .

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ABSTRACT

Light-emitting diode (LEDs) have tremendous potential and advantages over traditional forms of horticultural lighting. Their small size, durability, long lifetime, cool emitting temperature, and the option to select specific wavelength for a targeted plant response make LEDs more suitable for plant-based uses than many other light sources.

Previous study have demonstrated that the combination of red and blue LED light was effective light source for plant growth and development, and the light spectra, intensities, and durations can easily controlled by growers in artificial growing environments. Therefore, the goal of this study was to evaluate the effects of irradiation with different intensities on the growth and photosynthetic characteristics of kailan (*Brassica oleraceae* var. Alboglabra).

The experiment was conducted at the Physiology Laboratory, Department of Crop Science, Faculty of Agriculture using kailan as the plants material. Plant was cultured in plug tray, installed in the plastic container with 16 hour photoperiod at about 20-25°C and humidity 60-70% under fluorescent light (238.68 µmol/m²/s), red and blue light (171.54 µmol/m²/s and 187.00 µmol/m²/s) and red and white (107.69 µmol/m²/s). This experiment was conducted in a randomized complete block design (RCBD) with 4 replications.

Experiment gave positive results on the number of leaves, partitioning of dry weight, light response curve and net CO_2 assimilation rate-intercellular CO_2 concentration curve of kailan plants which was grown under high light intensity of red and blue light treatment and also under fluorescent light was higher than kailan plants grown under low light intensity especially in terms of the leaf photosynthesis characteristics of the plants. Kailan plants grown under red and white LED light show higher plant height compared to other treatment because red irradiance was essential for stem elongation. Therefore, it shows that plants absorb light directly from the irradiance source so that it can be used for plant photosynthesis and photomorphogenesis. It was also shows that the supplemental light quality can be used to enhance the nutritional value and growth of kailan plant.

ABSTRAK

Diod pemancar cahaya (LED) mempunyai potensi yang amat besar dan mempunyai kelebihan berbanding lampu tradisional hortikultur. Saiz kecil, ketahanan, jangka hayat panjang, suhu pemancar sejuk, dan pilihan untuk memilih panjang gelombang tertentu untuk tindak balas tumbuhan disasarkan membuat LED lebih sesuai untuk digunakan untuk berasaskan tumbuhan daripada sumber cahaya yang lain.

Kajian sebelum ini telah menunjukkan bahawa gabungan merah dan biru cahaya LED adalah sumber cahaya yang berkesan untuk pertumbuhan tumbuhan dan pembangunan, dan spektrum cahaya, keamatan, dan tempoh pencahayaan boleh dikawal oleh petani. Oleh itu, matlamat kajian ini adalah untuk menilai kesan penyinaran dengan keamatan yang berbeza ke atas pertumbuhan dan fotosintesis ciri-ciri kailan (*Brassica oleraceae* var. Alboglabra).

Kajian ini dijalankan di Makmal Fisiologi, Jabatan Sains Tanaman, Fakulti Pertanian menggunakan kailan sebagai bahan tanaman. Tanaman ditanama di dalam dulang palam, yang diletakkan di dalam bekas plastik dengan 16 jam fotokala pada kira-kira 20-25^{o}C dan kelembapan 60-70% di bawah cahaya pendarfluor (238.68 μmol / m² / s), cahaya merah dan biru (171.54 μmol / m² / s dan 187.00 μmol / m² / s) dan merah dan putih (107.69 μmol / m² / s). Kajian ini telah dijalankan dalam reka bentuk blok lengkap rawak (RCBD) dengan 4 replikasi.

Kajian menunjukkan hasil yang positif pada ketinggian tumbuhan, jumlah daun, pembahagian berat kering, lengkung reaksi cahaya dan kadar bersih-intercellular asimilasi CO_2 keluk cencentration CO_2 tumbuhan kailan yang telah berkembang di bawah keamatan cahaya yang tinggi rawatan cahaya merah dan biru dan juga di bawah lampu pendarfluor adalah lebih tinggi berbanding tumbuhan kailan yang tumbuh di bawah keamatan cahaya yang rendah terutamanya dari segi ciri-ciri fotosintesis daun tumbuh-tumbuhan. Tumbuh-tumbuhan kailan yang tumbuh di bawah cahaya LED merah dan putih menunjukkan ketinggian pokok yang lebih tinggi berbanding dengan rawatan lain kerana sinaran merah adalah penting untuk pemanjangan batang. Oleh itu, ia menunjukkan bahawa tumbuh-tumbuhan menyerap cahaya secara langsung dari sumber sinaran supaya ia boleh digunakan untuk fotosintesis tumbuhan dan photomorphogenesis. Ia juga menunjukkan bahawa kualiti cahaya tambahan boleh digunakan untuk meningkatkan nilai pemakanan dan pertumbuhan tumbuhan kailan.

CHAPTER 1

INTRODUCTION

1.1 Kailan

Kailan is a Cantonese name for a vegetables and it is also known as Chinese broccoli or Chinese kale. It is a leafy vegetable with thick stems, flat and has a small number of tiny flower heads similar to broccoli. Kailan belongs to the species of *Brassica oleraceae* var. alboglabra. It also has several varieties including the hybrid one. It has a flavour that is similar to the broccoli but slightly bitter (Rokewood Ltd., 2014).

Kailan is eaten widely in Chinese cuisine especially in Cantonese cuisine. World Cancer Research Fund in USA concluded that people who regularly eat kailan and other types of crucifer vegetables will reduce the risk of colon, lung and breast cancer (Dias, 2012). In addition, kailan vegetables contain high Vitamin C that is needed for growth and development of tissues, skin health and care also good for the digestive system and eyes (Dias, 2012).

Vegetables and fruits contain lots of benefits to the health of body. According to the report of World Health Organization (WHO) in 2003 shown that an average of 88.3% of Malaysian taking less than the daily recommendation intake of vegetables and fruits. Statistics shown from the Ministry of Health stated that one of the four Malaysians are at risk of getting cancer and it is caused of insufficient intake of fruits and vegetables in their diet meals.

1.2 Light-emitting diode (LED)

Light-emitting diode (LED) is a semiconductor device that can emit visible light when an electric current passes through it. The light of LED is not usually emitted brightly, but most of LEDs is a monochromatic light with a single wavelength. An LED can have a range from red to blue-violet light with a wavelength approximately 700 nanometre (nm) for the red LED and about 400 nanometre (nm) for a blue-violet LED. Studies show that plants have light receptors that can detect visible light and generate a response towards the light (LED Horticulture, 2014)

LED is a promising light source that has an eco-friendly feature and suitable for plant-based uses because of its characteristics that is small in mass and volume, durable, longer lifetime, cool emitting temperature and have a specific wavelength that can be selected for a targeted plant response. It can be used as a light source for plant growth in a restricted environment especially in a space-based plant culturing system, photosynthesis research, growth chamber and plant factory. Therefore, crops can be commercially produced in any season and climate.

Light is an important parts for photosynthesis process in all plant types. Natural sunlight is always free source and available but in horticulture it is not always attainable in adequate quantities that required for horticulture production. According to Mitchell et al. (2012), LED lighting has brought new opportunities for horticultural crops in term of providing the light intensity that the crops need. In a controlled surrounding, light is essential for photosynthesis and also as an indicator for the development and morphogenesis of plants growth (Bugbee and Salisbury, 1988; Kim et al., 2004).

Increase in world population could cause food insecurity. Scarcity of arable land leads to the increasing development of greenhouse production where it gives bad impacts to the climate changes because of the gaseous release from the greenhouse. In order to decrease the impact of greenhouse production, government started to introduce the importance of urban farming including the use of fully artificial light type plant factory. The main disadvantage of the fully artificial light type plant factory is the high cost of construction and production and will cause the increase in the commodity prices in the market.

Plants grown in the controlled environment under the LED light was reported to grow faster compared to the conventional method (Yeh et al., 2009). It is also reported that the stimulation of the plant that grow vegetative is the most potent in LED treatment (Yeh et al., 2009).

1.3 Objective study

Objective of the study is to evaluate the effects of sources of irradiance with different intensities on the growth and photosynthetic characteristics of kailan (*Brassica oleraceae* var Alboglabra).

1.4 Justification and Problem Statement

Global climate changes have made the production and the supply of agricultural product become unstable. Therefore, plant factories are expected to be safe and can produce a stable production of food. Food safety and food security has become a matter of concern. In general, there are two types of cultivation of plants which are sunlight type and fully artificial light type. The sunlight type uses sunlight as a main source to utilization whereas the fully artificial light uses artificial light as the main source. The fully artificial light type can be specifically control the plant growth environmental conditions such as light, temperature, humidity and nutrients. This study will be linked to the latter, in regulating the growth of plants under control environment.

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