THE EFFECT OF DIFFERENT PHOTOPERIOD ON GROWTH OF *CHRYSANTHEMUM SP.* AS CUT FLOWER IN LOWLAND AREA

FIONA ANTHONY LIJUA

DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTURE SCIENCE WITH HONOURS

HORTICULTURE AND LANDSCAPE PROGRAMME
SCHOOL OF SUSTAINABLE AGRICULTURE
UNIVERSITY MALAYSIA SABAH
2011

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS

JUDUL: THE EFFECT OF DIFFERENT PHOTOPERIOD ON GROWTH OF CHRYSANTHEMUM SP. AS CUT FLOWER UNDER LOWLAND AREA

IJAZAH: DEGREE OF BACHELOR OF AGRICULTURE SCIENCE WITH HONOURS

SAYA: FIONA ANTHONY LIJUA (HURUF BESAR) SESI PENGAJIAN: 2007/08

Mengaku membenarkan tesis * (LPSM/~~Sarjana/Doktor Falsafah~~) ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:-

1. Tesis adalah hakmilik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (/)

☐	SULIT	(Mengandungi maklumta yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana Penyelidikan dijalankan)
☐	TIDAK TERHAD	

PERPUSTAKAAN
UNIVERSITI MALAYSIA SABAH

NURULAIN BINTI ISMAIL
LIBRARIAN
UNIVERSITI MALAYSIA SABAH

Disahkan Oleh:

(TANDATANGAN PENULIS)

Alamat Tetap: _____

Tarikh: _____

(ROSMAH MURAD)
Penyelaras Penasihat Akademik
Sekolah Pertanian Lestari
Universiti Malaysia Sabah

(NAMA ~~PUSTAKAWAN~~ dan cop)
PENYELIA

Tarikh: 12/5/11

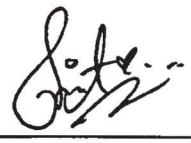
Catatan: - * Potong yang tidak berkenaan.

** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak yang berkuasa/organisasi berkenaan dengan menyatakan sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana Secara penyelidikan atau disertasi bagi pengajian secara kerja kursus dan Laporan Projek Sarjana Muda (LPSM)

DECLARATION

I hereby declare that this dissertation is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that no part of this dissertation has been previously or concurrently submitted for a degree at this or any other university.



Fiona Anthony Lijua
BR07160079
20 April 2011

VERIFIED BY

1. Mdm. Rosmah Murdad
   SUPERVISOR

ROSMAH MURDAD
Pensyarah Penasihat Akademik
Sekolah Pertanian Lestari
Universiti Malaysia Sabah

2. Mr. Assis Kamu
   EXAMINER 1

ASSIS KAMU
Lecture / Academic Advisor
School Of Sustainable Agriculture
Universiti Malaysia Sabah

3. Mr. Mohamad Amizi Ayob
   EXAMINER 2

MOHAMAD AMIZI BIN AYOB
Senior Lecturer / Academic Advisor
School Sustainable Agriculture
Universiti Malaysia Sabah

4. Assoc. Prof. Dr. Mahmud Hj. Sudin
   DEAN
   School of Sustainable Agriculture

ASSOCIATE PROF. DR MAHMUD SUDIN
DEAN
SCHOOL OF SUSTAINABLE AGRICULTURE
UNIVERSITI MALAYSIA SABAH

ACKNOWLEDGEMENT

With God's willing, I would like to express my deepest and sincere thanks to my family. With their blessings, I had been grateful for their support in lending a helping hand and their utmost encouragement in faith and funding throughout my progress of finishing my final year project.

Also, thank you so much to my supervisor, Mdm. Rosmah Murdad, for assisting me throughout my progress in furnishing my final year project in both documenting and during experimental progress. May all her deeds will blessed by Allah.

Not forgetting, I would like to express deepest thanks also to all my fellow coursemates, my examiners, Mr. Assis Kamu and Mr. Mohamad Amizi Ayob, also to Dr. Jalloh and other involving lecturers whom had been supporting and providing knowledge in my journey throughout accomplishing my final year project.

I would as well like to express sincere thanks to dean of School of Sustainable Agriculture (SSA), whom had been a great man of wisdom and his contribution to us all, as well for all the knowledge and especially ethics taught which were important in completing our final year project and future similar undertakings.

ABSTRACT

A field experiment was conducted at the School of Sustainable Agriculture Field Laboratory in University Malaysia Sabah, Kota Kinabalu, Sabah to study the effect of different photoperiod on *Chrysanthemum sp.* as cut flower under lowland area with mean daily temperature at 31 °C and 75 % of relative humidity. Effectiveness of each photoperiod given was measured through the rate of *Chrysanthemum* growth and the flower size obtained. The experiment was conducted by using Complete Random Design (CRD) by supplementing different photoperiod, which were 12 h, 14 h, 16 h, and 18 h of light. Each photoperiod was evaluated using 10 pseudoreplicates. Generally, the plant height was recorded from the first week after transplanting (WAT) whereas the bud opening was recorded only after the seventh week. The result clearly shown that there is significant different on different photoperiod on the plant heigh growth (One-way ANOVA). The 14 h photoperiod resulted to highest plant height (85.4 cm) and also had the shortest photoperiod response (3.5 weeks). Besides, 50% of flowers obtained were categorized as 'Fancy', 10% of 'Standard' and 40% of 'Short' grade. In conclusion, the 14 h of photoperiod is best suggested to obtained *Chrysanthemum* cut flower under lowland area. In conclusion, 14 h was suggested the best photoperiod treatment under lowland area which yields taller plant height, and had the shortest photoperiodic response. However, a further study in temperature effect to plant growth and flowering response of *Chrysanthemum* cultivated under lowland area should be conducted. Hence, through this that we may obtained a more promising protocol of *Chrysanthemum* cut flower production that is more flexible, easy and cheaper and subsequently to create an alternative way upon the competition on land use of highland area, especially in Sabah.

KESAN FOTOKALA YANG BERBEZA TERHADAP PERTUMBUHAN CHRYSANTHEMUM SP. DI KAWASAN TANAH RENDAH

ABSTRAK

Kajian ini telah dijalankan di Makmal Ladang, Sekolah Pertanian Lestari, Universiti Malaysia Sabah, Kota Kinabalu, Sabah untuk mengkaji kesan fotokala yang berbeza terhadap pertumbuhan dan pembungaan Chrysanthemum sp. sebagai bunga keratan di kawasan tanah rendah yang mempunyai purata suhu harian 31 °C dan kelembapan relatif 75%. Keberkesanan setiap fotokala yang digunakan diukur melalui kadar pertumbuhan Chrysanthemum dan saiz bunga yang diperolehi. Eksperimen dijalankan menggunakan Rekabentuk Rawak Lengkap dengan membekalkan fotokala yang berbeza iaitu, pada 12 j, 14 j, 16 j dan 18 j cahaya. Setiap fotokala dikaji menggunakan 10 replikasi. Secara amnya, Ketinggian pokok dicatat bermula selepas pemindahan ke ladang dan pembukaan kudup pula hanya direkodkan selepas minggu ketujuh. Hasil yang diperolehi menunjukkan dengan jelas bahawa pemberian fotokala berbeza mempengaruhi ketinggian pokok Chrysanthemum (ANOVA satu-hala). Pendedahan kepada 14 j cahaya menghasilkan pokok yang paling tinggi (85.4 cm) dan juga memberikan respon pencahayahan yang paling singkat (3.5 minggu). Selain itu, 50% daripada bunga yang dihasilkan tergolong dalam kategori 'Fancy', 10% 'Standard', dan 40% dalam gred 'Short'. Kesimpulannya, kesan pendedahan kepada fotokala selama 14 j cahaya disarankan untuk menghasilkan bunga keratan Chrysanthemum di kawasan tanah rendah. Ini kerana ia mampu menggalakkan pertumbuhan sehingga mencapai ketinggian piawai yang diterima oleh pasaran dan memberikan respon pembungaan yang paling singkat. Walau bagaimanapun, kajian lebih lanjut terhadap kesan suhu ke atas pertumbuhan dan pembungaan Chrysanthemum yang ditanam di kawasan tanah rendah perlu dijalankan agar dapat menghasilkan protokol pengeluaran bunga keratan yang mudah dan murah di samping menyediakan alternatif kepada persaingan guna tanah di kawasan tanah tinggi khasnya di negeri Sabah.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

"	Inch / Inci
ANOVA	Analysis of Variance
AQIS	Australian Quarantine and Inspection Service
CBR	Central Bud Removal
DNMRT	Duncan Multiple Range Test
F_r	Far Red
FS	Flower Size
Ft	Feet
h	Hour
ha	Hectare
Hz	Hertz
j	Jam
LD	Long Day
MARDI	Malaysia Agriculture Research and Development Instituition
MBR	Multiple Bud Removal
NAPIS	National Agricultural Pest Pest Information System
BI	Bud Initiation
BO	Bud Opening
NCR	North Central Region
ND	Natural Day
No.	Number
PH	Plant Height
PPF	Photosynthetic Photon Flux
PTRIC	Postharvest Technology Research and Information Centre
RH	Relative Humidity
RMK	Rancangan Malaysia Ke-9
SAF	Society of American Florists
SAM	Shoot Apex Meristem
SD	Short Day
sm	Sentimeter
TNB	Tenaga Nasional Berhad
W	Watt
WAT	Week After Transplanting

LIST OF FORMULAE

CHAPTER 1

INTRODUCTION

Plant in terms of light relation is mainly divided into two general terms which are short day (SD) or long day (LD) plant. SD plants are those that only flower, or flower more rapidly, when the daylength is shorter than a particular duration. In contrast, LD plants are those that only flower, or flower more rapidly, when the photoperiod is longer than a critical duration. However, in this context *Chrysanthemum* is scientifically classified as SD plant as growth development is governed by length of day likewise to its flowering development. This controlling of flowering by daylength is known as photoperiod. Hence, basic knowledge of how daylength affects plant development in photoperiodic plant plays a critical role in manipulating the natural photoperiod to promote vegetative growth or flowering, whichever is desired.

Generally, *Chrysanthemum* as cut flower is necessary to achieve height at approximately, 24 " (60 cm)-30 " (76 cm) of stem length. Therefore, manipulation of photoperiod plays vital role to the development phase of plant growth. On the other hand, the flower development in *Chrysanthemum* is affected by both photoperiod and temperature conditions. Low light levels is said to delay bud development and high light levels accelerate it (Cockshull and Hughes, 1971; Hidén and Larsen, 1994). However, the fastest flower bud development after initiation is achieved best when temperatures are held around 18–20 °C (Jong, 1978; Adams *et al.*, 1998). The relationship between daily light integral and mean day temperature, and its general effect on the rate of flower development of different *Chrysanthemum* cultivars has previously been described in a prediction model developed by Larsen and Persson

(1999) has been proven to be significant. However, only a few studies have been done concerning the actual growth of the flower head. Cockshull and Hughes found in 1971 that the number of florets formed on the receptacle was modified by light level during the initial period of floret formation. Another study showed that standard cultivars produced heavier flower heads when grown during summer than during winter (Ben-Jaacov and Langhans, 1971). *Karlsson et al.* (1989) pointed out that flower area increases linearly as PPF increases and that it reaches its maximum under the optimal temperature conditions of about 18–20 °C. It was also shown that in some cut flower cultivars, low night temperatures resulted in a larger flower diameter, a higher flower area per plant, and heavier flowers (Carvalho and Heuvelink, 2001).

Chrysanthemum is the second economically most important floricultural (cut-flower) crop following the Rose (Teixeira Da Silva, 2004) in the floriculture industry. It has become a source of economic growth which has been included in Malaysia plan period. Just recently, claimed that the expanding of floriculture was included in the ninth Malaysian plan and known as the new source of economic growth. The performance of this floriculture industry improved the numbers of cut flower to 126 million stalks in year 2005. Therefore, urged from the government seek in improvising in the floriculture industry including cut flower production to take advantage of the increasing demand on nursery products (RMK 9, 2006). *Chrysanthemum* is categorized as a temperate cut flower which is mostly found under highland cultivation. *Chrysanthemum* cut flower marketing demand has caught attention of highland growers to venture in *Chrysanthemum* marketing industry. Although *Chrysanthemum* may be planted as cut flower or potted plant but the demand as cut flower had managed to overcome the interest of growing *Chrysanthemum* as just, potted plant. Its commercial value is highly affected by its aesthetic value, including the shape, size and colors, in addition to the various varieties of *Chrysanthemum* available in the market.

The aim of study was to evaluate the different photoperiod treatments given on the growth of the *Chrysanthemum* under lowland environment in regards to the rapidity in developmental phase and flowering phase. Nevertheless, determination of flower head size is most important parameter to compare its size in the unit of inches. The flower size will be graded accordingly by referring to the standard measurement to clarify its marketing opportunity. In addition, study was conducted as a preliminary

study on growth of cut *Chrysanthemum* in Sabah lowland area. Thus, further research on other responses as well made possible in research of the responses to various growth factors such as temperature.

1.1 Problem Statement

The challenge in producing *Chrysanthemum* cut flower is on the possibility of growing *Chrysanthemum sp.* in lowland area. This had been one of the major challenges for *Chrysanthemum* growers due to difficulties of growing it under lowland environment which may be affected by unsuitability of land type and other environmental factors such as, light, temperature, and relative humidity. The reason to produce cut flower in lowland is to create alternative for growth in concern to the arability of land on highland which is limited and mostly reserved for crop production.

1.2 Objective

The objective of the study was to evaluate the effect of photoperiod on growth of *Chrysanthemum* as cut flower and to compare *Chrysanthemum sp.* in lowland area. for cut flower production by evaluating on the growth performance of relative flower in lowland area.

1.3 Scope of Study

Scope of study focused on the growth of the single flower *Chrysanthemum sp.*, a specific local commercial cultivar which is the *Chrysanthemum cineranaefolium sp.* (M97) which was conducted locally, in Sabah, to meet experimental goals. This study focused mainly onto the plant height (cm), photoperiodic response (week), and the final flower size (inches) of *Chrysanthemum sp.*, which will be during Anthesis. Other factors may be indirectly involved in this research but it has no regards to my scope of study. However, it may be recorded as reference hence not particularly important. Also to mention, that all evaluations were done by referring to each pseudoreplicates of the sample.

CHAPTER 2

LITERATURE REVIEW

2.1 Sabah

Malaysia is a federation of 13 states with total land area of 328,657 km^2 and Sabah as one of the country with total land area of (73,620 km^2), situated in the East of Malaysia, that occupy the northern third of Borneo Island. Generally, the climate in Sabah is hot and humid except in the higher mountains. Rainfall in Sabah is generally higher at approximately 5000 mm annually and distributed throughout the year long (Anonymous, 2010). Furthermore, the relative humidity (RH) generally ranging from 80–90%, except in the highlands and the temperature averages from 20–30 °C throughout the year (Anonymous, 2010). Lim *et al.* (1995) stated that the major production areas for temperate cut flowers in Sabah is Kundasang (85.1 ha).

2.1.1 Lowland

As in overview, Sabah agricultural land use is mostly focused on major industrial commodities instead of cut flower production due to the high cost for post harvest handling for transporting fresh cut produced to market. To see the importance of cut flower industry as the source of income and high demand for exportation especially in Japan, a promising possibility of growing *Chrysanthemum* yet having almost similar quality of those cut *Chrysanthemum* produced in highland is in demand.

2.2 Temperate Cut Flower

Cut flower refers to flower that are produced specially for the purpose of displaying, or as decorative fresh cut ornamentals. A temperate cut flower is flowers that are grown in commercially large scale under mostly highland cultivation. Temperate generally means a colder climate. In Malaysia, colder temperature basically ranges between 19-21 °C. Among all, *Chrysanthemum* is found to be the most popular temperate cut flower in Malaysia and export potentials primarily by Japan as compared to other cut flowers available (Auni *et al.*, 2006). Lim *et al.* (1997) stated that the cut flower industry in Malaysia is a relatively recent development compared to other agricultural enterprises. From its rather humble origins as a hobby industry, the cut flower industry in Malaysia has developed into a very viable commercial enterprise with the most marked growth in the mid 80s. In fact it has shown such tremendous growth in the last decade that production has increased tenfold and export twelve-fold in response to local and foreign demands. The trend is expected to continue in the future with growing affluence of the local population and that of the developed countries as well as improved market opportunities.

2.3 *Chrysanthemum* Cut Flower Industry

This culturally rich flower is also globally the second economically most important floricultural crop following rose, and one of the most important ornamental species. The production value of flowers in Japan has more than doubled in the last decade as a result of the rapid improvement of living conditions and a greater enjoyment of life, with *Chrysanthemums* occupying 35% of the total cut-flower production in terms of *Chrysanthemum* stem production per year (Boase *et al.*, 1998). According to recent statement, Japan is the leading producing country (2 billion), followed by the Netherlands (800 million), Colombia (600 million), Italy (500 million) and the USA (300 million), while *Chrysanthemums* are the second most important cut flower by sales value (UK Market Flowers and Plants Association, 2001). This cut flower production has the potential to increase income for both small and large farms production.

In Malaysia, we may see the importance of cut flower production. The prospect for cut flowers is very bright taking into consideration the growing demand in the domestic and export markets and the fact that flowers are relatively recession- proof.

The Malaysian government has recognized this fact and had accorded priority to floriculture in the National Agriculture Policy, providing various tax and financial incentives to attract investments. Malaysia should make full use of its inherent advantages and attempt to rise above current constraints and provide an adequate and consistent supply of quality cut flowers during periods of maximum demand. Current production and marketing activities including development of desired varieties, and the search for new markets should be upgraded with the full cooperation of all parties concerned. These efforts and other future development plans are expected to enable Malaysia to make the quantum leap and become one of the leading producers of tropical cut flowers in the world. In addition, we can see that the performance of this floriculture industry improved the numbers of cut flower to 126 million stalks in year 2005 itself. Therefore, the government had urge development in the floriculture industry including cut flower production to take advantage of the increasing demand on nursery products (RMK 9, 2006).

However, the cut flower industry in Malaysia is a relatively recent development compared to other agricultural enterprises. From its rather humble origins as a hobby industry, the cut flower industry in Malaysia has developed into a very viable commercial enterprise with the most marked growth in the mid 80s. In fact it has shown such tremendous growth in the last decade that production has increased tenfold and export twelve-fold in response to local and foreign demands. The trend is expected to continue in the future with growing affluence of the local population and that of the developed countries as well as improved market opportunities. The cut flower market consists of 3 important components categories which are temperate flowers, orchids and other lowland flowers. In general, the area of cultivation for cut flowers in Malaysia is determined by the climate and topography of the land. For instance, highlands such as the Cameron Highlands are the major growing areas of temperate flowers. Other cut flowers adapt better to the hot humid conditions in the lowlands with orchids constituting the major share of the production.

In the National Agriculture Policy (1992-2010) and the Seventh Malaysia Plan (1996-2000), cut flowers have been identified as a priority group of crops with good potential to meet the growing domestic and international demand and to generate higher income for producers. Therefore, we can see the robust demand of cut flower in the industry. As mentioned by (Lim *et al.*,2006) one of among the main thrust if the

policy is reflected in the substantial expansion of both highland and lowland varieties to meet the demand of an expanding market, in particular world demand. As to see *Chrysanthemum* as the second highest most demanded cut flower among other temperate cut flowers, which accumulates 78% of the total Malaysian cut flower production. Thus, this clearly implies to the importance of utilizing lowland for this beneficial demand.

2.4 *Chrysanthemum*

Chrysanthemum (mum) or scientifically referred to as *Dendranthema grandiflorum*. *Dendranthema* was derived from the Greek which means the "tree flower" (Anthemis Tribe) whereas *grandiflorum* referring to large flowered. Other similar saying was *Chrysanthemum morifolium* which was previously referring to *Chrysanthemum* as well. *Chrysanthemum* from the Greek meaning "golden flower" and *morifolium* referring to mulberry leaved. It is from *Asteraceae* family which is a dicotyledonous flowering plant which all florets may form as seeds. Relative taxanomy of *Chrysanthemum* are shown as Figure 2.1.

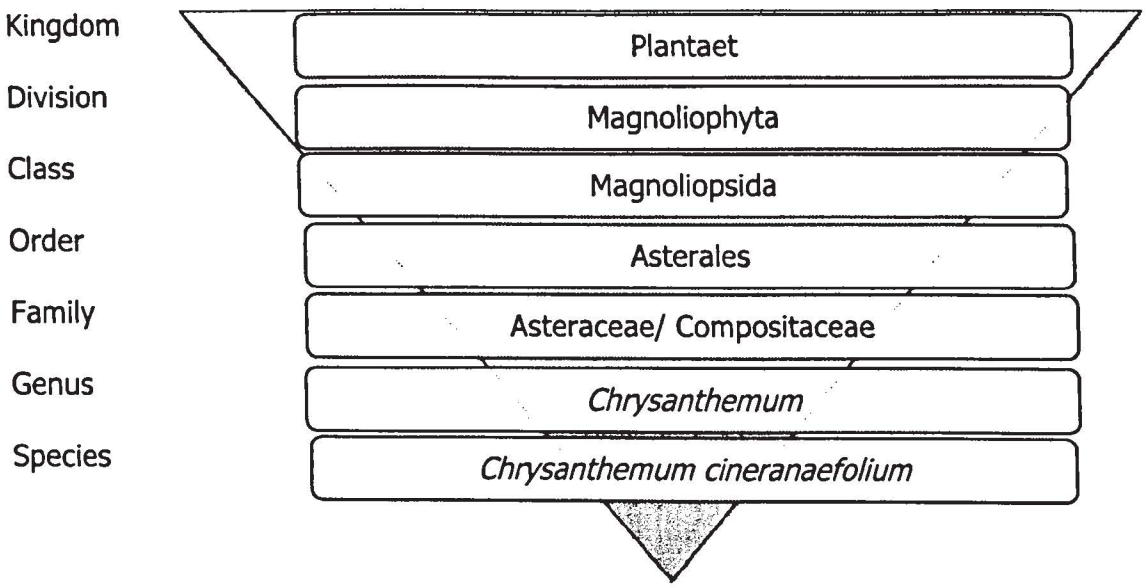


Figure 2.1 Taxanomy of *Chrysanthemum sp.*
Source: Wikipidea, 2011; and New World Encyclopedia, 2011

Chrysanthemum is one of the most important ornamental crops around the world, and it is produced as both cut flower and pot plant (Van Der Ploeg and Heuvelink, 2006). It has been in cultivation for over 2500 years (Cathey, 1969). All species of

Chrysanthemum are herbaceous perennial plants which will grow up to 50-150 cm tall. However, varying by country, generally 70-80 cm long stems are preferred in the market (Larson, 1992; Bailey and Whipker, 1998; Hayashi *et al.*, 2001; Jaime and Silva, 2003; Karlovic *et al.*, 2004). Furthermore, a way of distinguishing the different type of *Chrysanthemum* is by looking at its bloom formation. *Chrysanthemum* can be divided into 13 different classes according to the bloom formation as shown in Figure 2.2. Hence, further categorization is done based on how the cultivars are handled in production which are mainly standard, spray or pompoms. Standards are usually grown single stem with all the lateral flower buds removed to develop one large, terminal flower head. This is usually used for cut flower production. Sprays are usually grown multi-stem with only the terminal flower bud removed to allow all lateral flower buds to flower. This is usually use for pot crop production. Whereas pompoms are usually grown multi-stem with the lateral flower buds removed to develop one large, terminal flower head on each lateral. This is usually use for pot crop production. According to Anonymous (2010), the growth production of *Chrysanthemum* greatly varies according to cultivars and environmental conditions. However, it was stated that the growth of *Chrysanthemum* in local highland production was ranged within three to four months from planting to harvesting of cut flower. Thus, manipulation of photoperiod and temperature seems to play vital role in achieving growth of *Chrysanthemum* all year round.

2.4.1 Variety of *Chrysanthemum* Species

There are over 30 different types of species in the genus of *Chrysanthemum* which are native to Asia and north-eastern Europe. Namely, *Chrysanthemum Aphrodite*, *Chrysanthemum arcticum*, *Chrysanthemum argyrophyllum*, *Chrysanthemum arisanense*, *Chrysanthemum boreale*, *Chrysanthemum chalchingolicum*, *Chrysanthemum chanetii*, *Chrysanthemum cinerariaefolium*, *Chrysanthemum coronarium*, *Chrysanthemum crassum*, *Chrysanthemum glabriusculum*, *Chrysanthemum hypargyrum*, *Chrysanthemum indicum*, *Chrysanthemum japonense*, *Chrysanthemum japonicum*, *Chrysanthemum lavandulifolium*, *Chrysanthemum mawii*, *Chrysanthemum maximowiczii*, *Chrysanthemum mongolicum*, *Chrysanthemum morifolium*, *Chrysanthemum morii*, *Chrysanthemum okiense*, *Chrysanthemum oreastrum*, *Chrysanthemum ornatum*, *Chrysanthemum pacificum*, *Chrysanthemum potentilloides*, *Chrysanthemum segetum*, *Chrysanthemum shiwogiku*, *Chrysanthemum*

sinuatum, Chrysanthemum vestitum, Chrysanthemum weyrichii, Chrysanthemum yoshinaganthum, Chrysanthemum zawadskii.

2.4.2 Disbudding

Each shoot on a mum usually produces several flowers of relatively small size which is often closely pressed against each other distorting the flowers. In order to produce large, exhibition size mums of perfect form, the plants should be disbudded. As the flower buds appear on each shoot, all but the largest are removed (disbudded). The remaining single bud on each shoot will develop into a large, perfectly formed flower.

Jinny Hilderbrand (2009) stated that there are several different styles of bud removal in *Chrysanthemums*. For standard *Chrysanthemum*, the traditional style disbudding refers to as DB which involves in removal of all lateral buds and leaving the only terminal bud on each stem. Disbudding is usually done as soon as the lateral buds are formed and as close to the main stem as possible. This technique will produce one large showy blossom on each stem. On the other hand, for spray *Chrysanthemum* which has grown in popularity for both daisy and decorative types rely on a form of disbudding in which the large terminal bud is removed and the lateral buds are allowed to develop as clusters of smaller blossoms at the top of each stem.

Center Bud Removal (CBR) should be done as soon as the terminal bud separates from lateral buds and could be taken off without injuring the other lateral buds. Late CBR could result in clubby flower clusters, delays in blooming and flower size reduction. Whereas Multiple Bud Removal (MBR) is another way of bud removal style which sometimes necessary to completely resolve the clubby problem in sprays. MBR is actually a very soft second pinch of more than one bud in the terminal cluster which longer axillary breaks are established thus the flowers will not appear as clubby. MBR is performed much earlier than CBR with usually approximately at three weeks after the original pinch when small flower buds are actually can be feel.

2.4.3 Pest and Disease Problems

The leaves and flower of *Chrysanthemum* are the most at risk as it is often serves as food plants by pest such as Stalk Borer (*Papaipema nebris*), Leaf Miner (*Phyllonorycter blancardella*) larvae (NAPIS, 2010), Aphid (Myzus persicae sulzer), and the some Lepidoptera species, such as Diamond Black Moth (*Plutella xylostela Linn*) and butterfly. Two most common problem in *Chrysanthemum* production is the *Chrysanthemum* White Rust (*Puccinia horiana*) disease and Leaf Miner (*Chromatomya horticola*), which is listed in the Quarantine Act for importation of *Chrysanthemum* cut flower as a major problem to prevent spreading of disease (AQIS, 2004).

2.5 Economic Uses of *Chrysanthemum*

2.5.1 Cut Flower

Chrysanthemum is commonly grown as cut flower, potted flowering plant and even garden ornamental plant. *Chrysanthemum* can be displayed into two groups which is the Garden Hardy or Exhibition. Species like Garden Hardy mum is a new perennial which are capable of withstanding the winter in the ground and mainly in northern latitudes. Also, Garden hardy is referred to their ability to produce abundance of small blooms with only little mechanical assistance, such as staking, as well as the ability to remain in wind or rain. However, exhibition varieties on the other hand require staking, over wintering and sometime addition of night lights. But this exhibition varieties can be utilize in various plant forms such as large disbudded blooms, spray forms, and even artistically trained forms such as topiary, cascade or bonsai (Dole, 2004).

2.5.2 Culinary Use

The yellow and white *Chrysanthemum* is usually produce in a dried flower form to be boiled and serve as a herbal drink, generally called the *Chrysanthemum* Tea. It is believed to have a cooling effect to the body by reducing the internal heat.

2.5.3 Insecticidal Use

Pyrethrum (*Chrysanthemum cinerariaefolium*) is economically important as a natural source of insecticide. The flowers are pulverized, and the active components called pyrethrins, contained in the seed cases, are extracted and sold in the form of an oleoresin. This is applied as a suspension in water or oil, or as a powder. Pyrethrins attack the nervous systems of all insects, and inhibit female mosquitoes from biting. When not present in amounts fatal to insects, they still appear to have an insect repellent effect. They are harmful to fish, but are far less toxic to mammals and birds than many synthetic insecticides, except in consumer airborne backyard applications. They are non-persistent, being biodegradable and also breaking down easily on exposure to light. They are considered to be amongst the safest insecticides for use around food. Basically, pyrethroids are synthetic insecticides based on natural pyrethrum, or permethrin.

2.6 Major Factors Affecting Growth of *Chrysanthemum*

There are several growing conditions that are found to be affecting *Chrysanthemum* growth performance, which generally can be categorized into two main different lists of Abiotic factors and Biotic factors. However, commonly stated is the influence of various Abiotic factors, such as photoperiod, light intensity, temperature, light quality, relative humidity, CO_2 concentration, and also plant density (Carvalho and Heuvelink, 2001). Strictly mentioned once again that although there are various of factors affecting the growth of *Chrysanthemum*, the efforts will only be concentrating on the light duration manipulation to regulate the end flower produced, as well as other relative parameters. By other means, the light duration or daylength referred in this scientific paper is closely referred to the term photoperiod. From an application standpoint, plant morphogenesis can be influenced by an appropriate choice of lighting, which may affect photoreceptors of the plants (Anželika Kurilcik *et al.*, 2008).

Cultivars of *Chrysanthemum* X *morifolium* Ramat (Bailey, 1976) are some of the world's most popular cut flowers and potted ornamental plants. This popularity is due in part to the ability to control year-round commercial availability of the flowers by manipulating photoperiod or daylength and by providing an optimal environment for growth and floral development. Some of the major factors are temperature, irradiance,

REFERENCES

Adams, S. R., and Langton, F. A. 2005. Photoperiod and Plant Growth: A Review. *Journal of Horticultural Science and Biotechnology* **80(1)**: 2–10

Adams, S. R., Pearson, S., Hadley, P. 1998. The Effect of Temperature on Inflorescence Initiation and Subsequent Development in *Chrysanthemum* cv. Snowdon (*Chrysanthemum morifolium* Ramat). *Scientia Horticulturae* **77**: 59–72

Anonymous. 2010. Asian Info on Malaysia's Geography. Http://www.asianinfo.org/asianinfo/malaysia/pro-geography.htm. Access on 22 February 2011

Anželika Kurilcik, 1, 2, Stase Dapkuniene, 3, Genadij Kurilcik, 3, Silva Žilinskaite, 2, Arturas Žukauskas, 3, 4, Pavelas Duchovskis, 1, 4, and Sodininksyste Ir Darzininkyste. 2008. Effect of the Photoperiod Duration on the Growth of *Chrysanthemum* Plantlets *In vitro* (Abstract in English). *Annals of Botany* **27(2)**: 134-147

Apelbaum, A., Burgoon, A. C., Anderson, J. D., Solomos, T. and Lieberamn, M. 1981. Some Characteristics of the System Converting 1-aminocyclopropane-1-carboxylic acid to Ethylene. *Plant Physiology* **67**: 80-84

AQIS. 2004. Department of Agriculture, Fisheries and Forestry. Malaysian Accreditation Scheme for Flower Suppliers Http://www.aqis.gov.au/icon32/asp/ex_TopicContent.asp. Access on 3 January 2011

Atkin, R. K., Barton, C. E., and Robinson, D. K. 1973. Effect of Root on Growing Temperature on the Growth Substances in Xylem Exudate of *Zea mays*. *International Expo of Botany* **24**: 475-487

Auni, H. N., Latifah, M. N., and Khairol, M. A. 2006. The Prospect of Japanese Flower Market and The Potential of Exporting Malaysian Cut *Chrysanthemums* by Sea Shipment. *Acta Horticulturae International Society of Horticulture Science* **710**: 519-526

Bachthaler, E. and H. Jansen. 1985. The Effect of Growth Retardants and Temperature on the Flowering of *Chrysanthemum* 'Escort' (Abstract in English). *Cartenbauwissenschaft* **50**: 156-161

Bailey, D. A., and Whipker, B. E. 1998. Best Management Practices for Plant Growth Regulators Used in Floriculture. New Colorado State University Http://www.ces.ncsu.edu/depts/hort/hil/hil-529.html. Access on 3 March 2011

Bailey, L. H., and Bailey, E. Z. 1976. *Hortus*. 3rd edition. Macmillan, New York

Ben-Jaacov, J., and Langhans, W. 1971. Effect of Long Photoperiods on Flower Development of *Chrysanthemum*. *Florist's Revision* **149 (3861)**: 72–75

Bernier, C., Kinet J. M., and Sachs, R. M. 1981. *The Physiology of Flowering*. Volume 1. CRC Press, Boca Raton, Florida

Blanchard, M. G., and Runkle, E. S. 2009. Use of a Cyclic High-pressure Sodium Lamp to Inhibit Flowering of *Chrysanthemum* and Velvet Sage. *Scientia Horticulturae* **110**: 448–454

Boase, M. R., Butler, R. C. and Borst N. K., 1998. *Chrysanthemum* Cultivar-Agrobacterium Interactions Revealed by GUS Expression Time Course Experiments. *Scientia Horticulturae* **77**: 89-107

Bonaminio, V. P. and Larson, R. A. 1978. Influence of Potting Media, Temperature, and Concentration of Ancymidol on Growth of *Chrysanthemum morifolium*. *Journal of American Society of Horticultural Science* **103**: 752-756

Brunk, and Max. 1953. Facts important in selling flowers. *New York State Flower Grower's Business* **91**: 4-6

ByungJoo, L., MiKyoung, W., DongHee, L., and DongGi, S. 2001. Flowering Responses to Sequental Short Day/Long Day Exposure in *Chrysanthemum* (*Dendranthema grandiflora* 'Tzvelev'). *Korean Journal of Horticulture Science Technology* **19(4)**: 560-563

Carvalho, S. M. P. and Heuvelink, E. 2001. Influence of Greenhouse Climate and Plant Density on External Quality of *Chrysanthemum* (*Dendranthema grandiflorum* Ramat.) Kitamura: First Steps Towards a Quality Model. *Journal of Horticultural Science and Biotechnology* **76(3)**: 249–258

Cathey, H. M. 1954. *Chrysanthemum* Temperature Study Thermal Modifications of Photoperiods Previous to and After Flower Bud Initiation. *American Society of Horticulture Science* **64**: 492-498

Cathey, H. M. 1957. *Chrysanthemum* Temperature Study for The effect of Temperature upon the Critical Photoperiod Necessary for the Initiation and Development of Flowers of *Chrysanthemum morifolium*. *American Society of Horticulture Science* **69**: 485-491

Cathey, H. M. 1969. The Induction of Flowering: *Chrysanthemum morifolium* Ramat. L.T. Evans (Eds.). Cornell University Press, Ithaca, New York. Pg 268-290

Cathey, H. M., and Borthwick, H. A. 1961. Cyclic Lighting for Controlling Flowering of *Chrysanthemum*. *Journal of American Society of Horticultural Science* **78**: 545–552

Chan, A. P. 1955. Some Factors Affecting Flower Bud Development of *Chrysanthemums*. *International Horticultural Congress* **2**: 1023-1039

Cockshull, K. E. 1979. Effects of Irradiance and Temperature on Flowering of *Chrysanthemum morifolium* Ramat. In Continuous Light. *Annals of Botany* **44**: 451-460

Cockshull, K. E. and Hughes, A. P. 1972. Flower Formation in *Chrysanthemum morifolium* : The Influence of Light Level. *Journal of Horticultural Science* **47**: 113–127

Cockshull, K. E., and Hughes, A. P. 1971. The Effects of Light Intensity at Different Stages in Flower Initiation and Development of *Chrysanthemum morifolium*. *Annals of Botany* **35**: 915-926

De Jong, J. 1978. Involved Temperature of *Chrysanthemum* Plant. *Vakbl Bloemisterij* **5**: 64-65

Dole, J. M., and Wilkins, H. M. 2004. *Floriculture: Principles and Species*. 2nd edition. Prentice Hall, New Jersey

Doorenbos, J., and Kofranek, A. M. 1953. Inflorescence Initiation and Development in an Early and Late *Chrysanthemum* Variety. *Journal of American Society of Horticultural Science* **61**: 555-558

Dutta, J. P., Seemanthini, R., and Khader M. A. 1996. Improving the Quality and Yield of *Chrysanthemum* Flowers with Artifical Photoperiod. *Orissa Journal of Horticulturae* **24(1)(2)**: 1-4

Fisher, J. E. 1955. Floral Induction in Soybeans. *Botany of Gaz* **117**: 156-165

Fossum, M. T. 1955. Report of Special Conference on Problems and Research Proposals Pertaining to Grades and Standards of Floricultural Crops in the United States. *United States Department of Agriculture Marketing* **12**: 32-38

Furuta, T. 2004. Photoperiod and Flowering of *Chrysanthemum morifolium*. *American Society of Horticulture Science* **63**: 457-461

Gamalei, Y. M., Van Bel, A. J. E., Pakhomova, M. V. and Sjutkina, A. V. 1994. Effects of Temperature on the Conformation of the Endoplasmic Reticulum and on Starch Accumulation in Leaves with the Symplasmic Minor-vein Configuration. *Plant Horticulturae* **194**: 443–453

Garner, W. W., and Allard, H. A. 1920. Effect of The Relative Length of Day and Night and Other Factors of The Environment of Growth and Reproduction in Plants. *Journal of Agriculture Research* **18**: 553-606

Gaylord, F. C., and Hoxsie, C. E. 1960. *Market grades for ornamentals: Chrysanthemums and carnations*. Purdue University Research Mimeo **79(3)**: 17

Gaylord, F. C., and Hoxsie, C. E.. 1958. *Market grades for ornamentals Chrysanthemums and Carnations*. Purdue University Research *Mimeo* **79(1)**: 13-19

Goldschimdt, E. E., and Huber, S. C. 1992. Regulation of Photosynthesis by End-Product Accumulation in Leaves of Plants Storing Starch, Sucrose, and Hexose Sugars. *Plant Physiology* **99**: 1443–1448

Gregov, Z., Dubravec, K., and Pecina, M. 1995. Dynamics of Height Control in Spray *Chrysanthemums* Affected by Growth Retardants. *Acta Pharmaceutica* **2(45)**: 259-262

Hanke, H. 1996. Short Day Decreases the Risk of Later Flowering of *Chrysanthemums*. Taspo Gartenbaumagazin **5(8)**: 8-10

Hayashi, T., Heins, R. D., Cameron, A. C., and Carlson, W. H. (2001). Ethephon Influences Flowering, Height, and Branching of Several Herbaceous Perennials. *Scientia Horticulturae* **91(3-4)**: 305-324

Hidén, C. and Larsen, R. U. 1994. Predicting Flower Development in Greenhouse Grown *Chrysanthemum*. *Scientia Horticulturae* **58**: 123–138

Hopkins, W. G., and Hüner, N. P. A. 2004. *Introduction to Plant Physiology*. 3rd edition. John Wiley and Sons, Incorporation

Hughes, A. P., and Cockshull, K. E. 1972. Further Effects of Light Intensity, Carbon Dioxide Concentration, and Day Temperature on Growth of *Chrysanthemum* morifolium cv. Bright Golden Anne in Controlled Environments. *Annals of Botany* **36**: 533-550

Jaime, A., and Silva, T. 2003. *Chrysanthemum*: Advances in Tissue Culture, Cryopreservation, Postharvest Technology, Genetics and Transgenic Biotechnology. *Biotechnology of Advance* **21**: 715-766

Janick, J., 2008. *Chrysanthemum* plants. *Acta Horticulturae* **435**: 158–163

Jinny Hilderbrand. 2009. Grolink Pot *Chrysanthemum* Culture Http://www.grolink.com/pdf/Pot%20Chrysanthemum%20Culture%20for%20Website.pdf. Access on 30 January 2011

Junaidi. 20 December 2010. Sabah Local Production: *Chrysanthemum* Growth and Development. North Borneo Flower Nursery Sabah. Field supervisor

Karlovic, K., Vrsek, I., Sindrak, Z., and Zidovec, V. 2004. Influence of growth regulators on the height and number of inflorescence shoots in the *Chrysanthemum* cultivar 'Revert'. *Agriculture Conspectus Science* **69(2)(3)**: 63-66

Karlovic, K., Vrsek, I., Sindrak, Z., Zidovec, V. 2004. Influence of Growth Regulators on the Height and Number of Inflorescence Shoots in the *Chrysanthemum* Cultivar 'Revert'. Agriculture Conspectus of Science **69(2)(3)**: 63-66

Karlsson, M. G., Heins, R. D., Erwin, J. E., Berghage, R. D., Carlson, W. H., and Biernbaum, J. A. 1989. Irradiance and Temperature Effects on Time of Development and Flower Size in *Chrysanthemum*. *Scientia Horticulturae* **39**: 257-267

Korkut, A. 1990. Study on Some *Chrysanthemum* Cultivars Under the Unheated Glass Greenhouse. *5th Greenhouse Symposium Turkey* 331- 339

Kozai, T., Watanabe, K. and Jeong, B. R. 1995. Stem Elongation and Growth of *Solanum tuberosum* L. *In Vitro* in Response to Photosynthetic Photon Flux, Photoperiod and Difference in Photoperiod and Dark Period Temperatures. *Scientia Horticulturae* **64(1)(2)**: 1–9

Larsen, R. U., and Persson, L. 1999. Modelling Flower Development in Greenhouse *Chrysanthemum* Cultivars in Relation to Temperature and Response Group. *Scientia Horticulturae* **80**: 73–89

Larson, R. A. 1992. *Introduction to Floriculture.* 2nd edition. Academic Press Incorporation San Diego California

Lim, H. J., Ridzuan, M. M. S., and Hamir, N. A. 1995. Cut Flower Production in Malaysia Http://www.fao.org/docrep/005/ac452e/ac452e06.html. Access on 13 March 2011

Lu, C. W., Wang, J. C., Tang, D. B., Gai, Q. H., and Lu, S. M. 2004. Effects of Photoperiod on Inducing Initiation of Potato Microtuber *In Vitro* (Abstract in English). *Chinese Potato Journal* **23(2)**: 68–72

Mattson, N. S., and Erwin, J. E. 2005. The Impact of Photoperiod and Irradiance on Flowering of Several Herbaceous Ornamentals. *Scientia Horticulturae* **104**: 275–292

NCR. 1968. Market Grades and Standards for Carnation, *Chrysanthemum* and Roses. *Agricultural Experiment Station Bulletin* **727**: 15 -23

New World Encyclopedia. 2011. *Chrysanthemum*: Scientific Classification. Http://www.newworldencyclopedia.org/entry/*Chrysanthemum*. Access on 10 December 2010

Persson, L., and Larsen, R.U. 1998. Adapting a Prediction Model for Flower Development in *Chrysanthemum* to New Cultivars. *Acta Horticulturae International Society of Horticulture Science* **40(1)**: 142-153

Post, K. 1931. Reducing the Day Length of *Chrysanthemum* for Production of Early Blooms by Use of Black Satin Cloth. *Society of Horticulture Science* **28**: 382-388

Post, K., and Lacey, D. B. 1951. High Temperature Produces Long Day Effect on *Chrysanthemums*. *New York State Flower Growers* **76**: 4-5, 8

PTRIC. 2000. *Chrysanthemum Produce Facts: Florists Mum.* Http://postharvest.ucdavis.edu/Produce/ProduceFacts/Orn/*Chrysanthemum*.shtml. Access on 12 December 2011

Reid, M. S. 2004. Produce Facts *Chrysanthemum* Florist Mum. Postharvest Technology Research & Information Center.

RMK9. 2006. Chapter 3: 3.1.8

Roberts, R. H., and Struckmeyer, B. E. 1938. The Effects of Temperature and Other Envrinomental Factors Upon the Photoperiodic Responses of Some of the Higher Plants. *Journal Agriculture Research* **56**: 633-677

Runkle, E. 2002. Grower 101: Controlling Photoperiod. *Crop Cultivation* **30**: 90-93

Runkle, E., and Fisher, P. 2004. Photoperiod and Flowering. *Flowering Newsletter* **40**: 25-30

Runkle, E., Heins, R., Cameron, A., Carlson, W. 2001. Mini Review of Research Activity: Horticultural Flowering of Herbaceous Perennials. *Flowering Newsletter* **31**: 34–43

SAF. 1963. Society of American Florist. Market Grades and Standard for *Chrysanthemum*, Carnation and Rose. University of Illinos College of Agriculture Library. *Experiment Station Bulletin* **727**: 1-2

Schwabe, W. W. 1950. Factors Controlling Flowering in The *Chrysanthemum indicum* : The Effects of Photoperiod and Temporary Chilling. *International Botany Institute* **1**: 329-43

Teixeira Da Silva, J. A. 2004. Ornamental *Chrysanthemums*: Improvement by Biotechnology: Review of Plant Biotechnology and Applied Genetics. *Plant Cell Tissue and Organ Culture* **79**: 1–18

TNB. 2011. *Domestic Tariff Rates* Http://www.tnb.com.my/tnb/residential/pricing-and-tariff/tariff-rates.html. Access on 20 February 2011

Trotter, W. K. 1955. Problems in Marketing Florist's Crops. *Cornell University of Agriculture Engineering* **983**: 65-83, 101

Van Der Ploeg, A., and Heuvelink, E. 2006. The influence of temperature on growth and development of *Chrysanthemum* cultivars: a review. *Horticulture Science Biotechnolgy* **81(2)**: 174-182

Velmurugan, S., and Vadive, I. E. 2003. Effect of Photoperiod and Paclobutrazol on Year Round Flower Production in *Chrysanthemum*. *South Indian Horticulture* **51(16)**: 51-59

Vince Prue, D. 1975. *Photoperiodism in Plants*. McGraw-Hill Book Corporation Maidenhead, London

Vince, D. 1960. Low temperature effects on the flowering of *Chrysanthemum* morifolium Ramat. *International Horticulture Science* **35**: 161-175

Warner, D. A., Holaday, A. S., and Burke, J. J. 1995. Response of Carbon Metabolism to Night Temperature in cotton. *Agronomy Journal* **87**: 1193–1197

Wieland, C. E. 1998. *An Examination of Night Length Effects on the Difference in Floral Initiation and Floral Development of Chrysanthemum Cultivars*. Masters Thesis. University of Florida

Wikipedia. 2011. *Chrysanthemum: Scientific Classification and Taxanomic*. Http://search.yahoo.com/search/*Chrysanthemum*. Access on 10 December 2010