



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF LIGHT INTENSITY AND DAYLENGTH ON GROWTH
AND FLOWERING OF SIAM TULIP
(*CURCUMA ALISMATIFOLIA* VAR CHIANGMAI PINK)**

FLORA CHIN LEE SA

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FLORA CHIN LEE SA

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

April 2007



DEDICATION

This manuscript is especially dedicated to my parents, Anselm Chin Shu Hiun and Mary Ng Nyuk Moi, to my eldest sister and brother-in law, Monica Chin Lee Yung and Wee Thian Huat, my second sister and brother in-law, Veronica Chin Lee Ching and Allan Chiam Goh Bian, my brother, Athanasius Chin Chun Fui, my loved one, Tang Sai Hoo and also to my lovely nephew and nieces Ian, Lynn and Leah Chiam.



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

**EFFECTS OF LIGHT INTENSITY AND DAYLENGTH ON GROWTH AND
FLOWERING OF SIAM TULIP
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By

FLORA CHIN LEE SA

April 2007

Chairman: Associate Professor Thohirah Abdullah @ Lee Chin Chin, PhD

Faculty : Agriculture

Three studies were conducted to produce high quality potted and cut flowers of *Curcuma alismatifolia* var Chiangmai Pink, to develop a production protocol for the future use of commercial field growers and to introduce this species as a new ornamental crop to further enhance the lucrative floriculture industry in Malaysia. The morphological changes during flowering were characterized using scanning electron microscopy. In addition, influences of light intensity and daylength on flowering of *Curcuma alismatifolia* var Chiangmai Pink were investigated in two separate experiments.

The objectives of the first study were to study the morphology, inflorescence initiation and flower development of *C. alismatifolia* using scanning electron microscopy and also to develop a time line of flowering of the crop. The observation from this study showed that the inflorescence was a mixed inflorescence called the thyrses, the main axis was indeterminate and secondary axis was determinate. Apex of the main axis produced



primary bracts continuously. The flowers consisted of a gamosepalous calyx, three petals, a polliniferous stamen, a labellum developed from two petaloid staminodes, two lateral petaloid staminodes and a pistil. Ovary and ovules developed in a trilocular style with axial placentation. Initiation and development of the inflorescences can be best described with the number of leaves on the plant. The vegetative stage occurred at 1-4 leaves stage where as the flowering stage was at 5-6 leaves stage.

For study two, the objective was to determine the effects of shading on the growth and flower development of *Curcuma alismatifolia*. Four levels of shading consisting of T1 (0% shade, without using black net), T2 (30% shade), T3 (50% shade) and T4 (70% shade) were used. The average light intensity measured was T1 ($1108 \mu\text{mol m}^{-2}\text{s}^{-1}$), T2 ($645.32 \mu\text{mol m}^{-2}\text{s}^{-1}$), T3 ($402.08 \mu\text{mol m}^{-2}\text{s}^{-1}$) and T4 ($296.86 \mu\text{mol m}^{-2}\text{s}^{-1}$). Increasing shade levels increased plant height and flower stalk length of *C. alismatifolia*. Manipulation of shade levels in cultivation of this species is especially important where 30% shade seemed to be the most suitable for pot flower production. For cut flower production, 70% shade are more suitable with 82.70 cm tall plants and produced flower stalk of 78 cm. In terms of flower quality, plants of 30% shade were the best in the aspect of flower colour, size and more turgid peduncle. Postproduction productivity was also the longest at 43 days. Hence, production of potted and cut flowers of *Curcuma alismatifolia* using shade level of 30% for the former and 70% for the latter would hasten plants production for commercial purposes.

The objective of the last study was to study the effect of daylength on the performance of *Curcuma alismatifolia* in Malaysia. Rhizomes of *C. alismatifolia* var Chiangmai Pink were grown under five treatments of long days at 12 hour (control), 14 hour, 16 hour, 18 hour and 20 hour. Treatments were supplemental lighting with incandescent bulb of 0 hr, 2 hr, 4 hr, 6 hr and 8 hr after 1900 hr. The study showed that 16 hr photoperiod produced the best growth rate. Plants at 16 hour also gave the best quality flowers with suitable plant height as potted plants, uniform flowering and also intense flower colour. Inflorescence length of *Curcuma alismatifolia* under this treatment also was the best size with 11.85 cm. Inflorescences of control were too short with less true flowers and shorter bracts where as inflorescences of plants under 20 hour were too long and thin with smaller true flowers. Post production of *Curcuma alismatifolia* under 16 hour were at 43 days.

Introduction of this species as a new flowering potted and cut flower in Malaysia will be very promising as *Curcuma alismatifolia* is easy to grow with manipulation of shade levels and daylength. This plant species also require less maintenance as it has few pest and diseases problems. Future study on the vase life of the cut flower of *Curcuma alismatifolia* var Chiangmai Pink, the study on the dormancy, post harvest technology and storage condition for the rhizome of *Curcuma alismatifolia* should also be conducted to further enhance the growth and flowering of this species for commercial production.



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

**KESAN KEAMATAN CAHAYA DAN JANGKAMASA PANJANG KE ATAS
PERTUMBUHAN DAN PEMBUNGAAN SIAM TULIP
(*CURCUMA ALISMATIFOLIA* VAR CHIANGMAI PINK)**

Oleh

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April 2007

Pengerusi: Profesor Madya Thohirah Abdullah @ Lee Chin Chin, PhD

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Tiga kajian telah dilakukan sebagai meningkatkan pengeluaran bunga keratan dan tanaman pasuan *Curcuma alismatifolia* var Chiangmai Pink, menghasilkan sebuah protocol untuk pengeluaran komersil tanaman ini komersil dan memperkenalkan spesies ini sebagai satu tanaman baru untuk mengembangkan lagi industri florikultur Malaysia. Perubahan morfologi semasa pertumbuhan dan pembungaan diteliti menggunakan kaedah 'scanning electron microscopy'. Kesan keamatan cahaya dan jangkamasa panjang ke atas pertumbuhan dan pembungaan *Curcuma alismatifolia* var Chiangmai Pink telah ditentukan di dalam dua kajian berasingan.

Objektif kajian pertama adalah untuk mengkaji morfologi, inisiasi infloresens serta perkembangan bunga *C. alismatifolia* dan juga memperkenalkan satu jadual masa pembungaan bagi tanaman ini. Kajian ini menunjukkan bahawa infloresens adalah sejenis



campuran infloresens yang dipanggil ‘thyse’; paksi utama adalah ‘indeterminate’ dan paksi kedua adalah ‘determinate’. Apeks pada paksi utama menghasilkan brakta primer secara berterusan. Bunga *Curcuma alismatifolia* terdiri daripada ‘gamosepalous’ kaliks, tiga petal, stamen, ‘labellum’ yang terbentuk daripada dua ‘petaloid staminodes’, dua ‘lateral staminodes’ dan satu pistil. Ovari dan ovul terbentuk secara ‘trilocular’ dengan ‘axial placentation’. Inisiasi dan perkembangan infloresens boleh diterangkan secara jelas dengan menggunakan bilangan daun pada tanaman di mana fasa vegetatif terdapat 1-4 helai daun manakala semasa fasa pembungaan terdapat 5-6 helai daun.

Objektif kajian kedua adalah untuk menentukan kesan naungan terhadap pertumbuhan dan perkembangan bunga *Curcuma alismatifolia*. Empat aras naungan terdiri daripada T1 (0% naungan, tanpa menggunakan kasa hitam), T2 (30% naungan), T3 (50% naungan) dan T4 (70% naungan). Purata keamatan cahaya yang dicatatkan ialah T1 ($1108 \mu\text{mol m}^{-2}\text{s}^{-1}$), T2 ($645.32 \mu\text{mol m}^{-2}\text{s}^{-1}$), T3 ($402.08 \mu\text{mol m}^{-2}\text{s}^{-1}$) and T4 ($296.86 \mu\text{mol m}^{-2}\text{s}^{-1}$). Peningkatan aras naungan cahaya meninggikan lagi tinggi pokok dan panjang keratan bunga *C. alismatifolia*. Kesan manipulasi cahaya di dalam kajian ini adalah amat penting di mana naungan 30% menghasilkan tanaman yang sesuai untuk pengeluaran tanaman pasuan. Tinggi pokok dan panjang keratan bunga adalah 42% dan 35% lebih kurang daripada tanaman di bawah naungan 70%. Bagi pengeluaran keratan bunga, naungan pada 70% adalah amat sesuai kerana pokok adalah tinggi pada 82.70 cm dan panjang keratan bunga adalah 78 cm. Kualiti bunga pada 30% naungan adalah paling baik dari aspek warna dan saiz dan jangka hayat pada 43 hari. Dengan itu, pengeluaran tanaman

pasuan adalah disyorkan pada 30% naungan manakala untuk pengeluaran keratan bunga pula adalah pada naungan 70%.

Objektif kajian ketiga adalah untuk mengkaji kesan jangkamasa panjang terhadap pertumbuhan dan perkembangan *Curcuma alismatifolia* di Malaysia. Lima rawatan jangkamasa panjang iaitu pada 12 jam (kawalan), 14 jam, 16 jam, 18 jam dan 20 jam telah dibekalkan. Kajian ini menunjukkan bahawa tanaman pada rawatan 16 jam memberi kadar pertumbuhan yang paling baik dan tinggi yang sesuai untuk pengeluaran pokok pasuan pada tinggi 58.38 cm. Kualiti bunga juga adalah baik kerana intensiti warna yang lebih menarik dan pembungaan yang seragam pada rawatan ini. Panjang infloresen *Curcuma alismatifolia* saiz juga sesuai pada 11.85 cm. Infloresen untuk rawatan 20 jam pula adalah lebih panjang dan kurus dan bunga sebenar adalah lebih kecil. Jangkahayat untuk *Curcuma alismatifolia* pada rawatan 16 jam adalah pada 43 hari.

Pengenalan species ini sebagai satu pokok pasuan hiasan dan keratin bunga adalah amat berpotensi memandangkan *Curcuma alismatifolia* senang ditanam melalui manipulasi paras teduhan dan jangkamasa panjang. Species ini juga tidak memerlukan penjagaan yang rapi kerana mengalami kurang infestasi serangga dan serangan penyakit. Kajian pada masa akan datang terhadap jangkahayat keratan bunga, dormansi dan teknologi lepas tuai adalah perlu bagi memantapkan lagi pertumbuhan dan pembungaan *Curcuma alismatifolia* untuk pengeluaran secara komersil di Malaysia.

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I certify that an Examination Committee has met on 20th April 2007 to conduct the final examination of **Flora Chin Lee Sa** on her **Master of Agriculture Science** thesis entitled “**Floral Biology and Light Responses on Growth and Flower Development of *Curcuma alismatifolia* var Chiangmai Pink**” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

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

FLORA CHIN LEE SA

Date: 4 JUNE 2007



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CHAPTER 1

INTRODUCTION

The floriculture industry in Malaysia is a relatively recent development compared to other agricultural enterprises. It has developed into a very viable commercial enterprise from its beginning as hobbies. The industry has shown tremendous growth in the last decade with increase in production and export in response to local and foreign demands. The trend is expected to increase with the growing affluence of the local population and that of the developed importing countries as well as improved market opportunities. In the National Agricultural Policy (1992-2010), ornamentals have been identified as priority crops with good potential to generate higher income for producers. The policy has underlined the thrust for future development of the floriculture industry with aggressive pursuance of the cultivation of ornamentals in the country.

In recent years, the Malaysian floriculture industry has shown a remarkable growth promoted by urbanization and landscaping activities and has become a dynamic industry in the agricultural export sector. In 2003, export from Malaysia for temperate flowers, orchids, foliage and dried flowers were RM100.9 million (Agromedia, 2000). With that figure, Malaysia only captures 0.33% of the world market of RM 30 billion. The scenario like this showed that the Malaysian floriculture industry still has scope and potential for expansion to bring more revenue to the country as well as the industry itself. Thus, along with the Ninth Malaysian Plan, which emphasized more on the agriculture sector, the introduction of a new flowering crop is vital as it has vast potential in contributing to Malaysia's economic



development. In the quest for new variety of ornamental to further enhance the lucrative floriculture industry, ornamental Zingibers, which have long been known of their showy inflorescences, present the highest potential.

Ornamental ginger is a diverse and versatile group of plants that are gaining increased recognition as pot flowers, landscape and cut flower markets. There are 90 genera of ginger in the Zingiberaceae family. This family contains at least 1400 species and perhaps as many as 2000 species. The genera of flowering gingers include *Alpinia*, *Curcuma*, *Etingera*, *Globba*, *Hedychium*, *Kaempferia* and *Zingiber*. One of the most popular is *Curcuma alismatifolia*. *Curcuma alismatifolia* originates from northern Thailand and Cambodia where the local population usually consumes its flower as a vegetable (Tanaka, 1976; Zhang *et al.*, 1995). *Curcuma alismatifolia* with its showy inflorescence has recently been considered for commercial cultivation as floricultural crops. This plant has a high potential to enhance the lucrative floriculture industry in our country as it is becoming a favourite in the international market – as cut flower production, potted plant as well as for exterior landscapes. It is also becoming a highly demanded plant in Japan, Holland, USA, Taiwan and Israel where it is grown commercially as a cut flower. Presently, the species is grown predominantly in Thailand and China where they are the native (indigenous) to the South East Asia (Paz, 2003). Similar growing conditions here in Malaysia will be a great potential and this opportunity is presently unexploited.

Curcuma alismatifolia is a herbaceous perennial with short fleshy rhizomes and tuberous roots, often with a dormancy period (Burch *et al.* 1987). The breaking of bud dormancy on rhizomes of *C. alismatifolia* is very important as to overcome the problem of eye bud emergence and to provide an availability of the plant material throughout the year. According to Rafidah (2004), BAP at a concentration of 100mg/L is the most suitable concentration for breaking bud dormancy in rhizome of *Curcuma alismatifolia* var Pink Purple. In Thailand, rhizomes of *Curcuma* in commercial production are harvested during the 3 months dormant period for storage and distribution (Lekawatana and Pituck, 1998).

Curcuma alismatifolia also makes excellent flowering pot plants, in some cases the flowers emerged before the foliage. The characteristics that make them attractive as potted plants to the floriculture industry are ease of production in the greenhouse, unique foliage, production of many flowering stems per pot, long-lasting colourful bracts and few diseases or insect problems (Kuehny, 2001). Besides that, they are marketable for landscape purposes. Three cultivars of this species are currently available, bearing pink, red and white bracts respectively on the upper part of the inflorescence (Zhang *et al.*, 1995). In this study, *Curcuma alismatifolia* var Chiangmai Pink was chosen due to its free flowering habits, attractive flower colour and easy availability.

There is little information on the optimum production environment and cultivation practices of this species. The optimum light levels for producing *Curcuma* as flowering pot plants have not been determined (Paz *et al.*, 2001). As a tropical geophytic plant, short daylength and low temperature are two limiting environment factors for growth and