



UNIVERSITI PUTRA MALAYSIA

**POLLINATION ECOLOGY AND FRUIT DEVELOPMENT OF
Molineria rubriclavata AND *Molineria latifolia***

MOHD FIRDAUS BIN ISMAIL

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POLLINATION ECOLOGY AND FRUIT DEVELOPMENT OF
Molineria rubriclavata AND *Molineria latifolia*

By

MOHD FIRDAUS BIN ISMAIL

**Thesis Submitted to the School of Graduate Studies,
Universiti Putra Malaysia, in Fulfilment of the
Requirements for the Degree of Doctor of Philosophy**

May 2014

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Dedicated with love to

*My visionary father, **Ismail Awang,***

*My virtuous mother, **Kamarah @ Norizan Abdullah,***

*My elder sister, **Noris Norzilla** and*

*My younger sister, **Azlyнна***



Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirement for the degree of Doctor of Philosophy

**POLLINATION ECOLOGY AND FRUIT DEVELOPMENT OF *Molineria
rubriclavata* AND *Molineria latifolia***

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MOHD FIRDAUS BIN ISMAIL

May 2014

Chair: Nur Ashikin Psyquay Binti Abdullah, PhD

Faculty: Agriculture

Molineria Colla is a perennial shrub that produced fruits containing a sweet protein called curculin. Observation in the wild populations across the peninsular showed that fruit set were inconsistent. Some plants produced inflorescence with complete fruit set and some did not. Undeveloped fruits were found in irregular number and pattern on the inflorescence. Plants transplanted and maintained under the rain shelter had poor performance in term of fruit setting even though flowers were produced abundantly. However, the lack of information on the basic aspect of the plant such as the pollination ecology hinders the effort to improve the fruit setting problems in a short time. Thus a study was carried out focusing on pollination ecology and fruit development of *Molineria rubriclavata* and *Molineria latifolia* var. *megacarpa*.

Pollination ecology studies focused on flower anthesis, anther dehiscence, stigma receptivity and pollen viability. Anthesis was found to occur within one day. The flower normally started to open around 5.00 am in the morning. It was found that anthesis is heavily influenced by weather condition especially the sun light exposure period. The anthers dehisced before the flowers were open as early as 8.00 pm in the evening of the previous day of flower opening. However the stigma was fully receptive in the mid-morning around 6.00 am once the flowers were opened and started to dry up around 11.00 am. The pollen viability increased after 5 hours of anther dehiscence that started around 8.00 pm and peaked at 6-8 hours before decreasing gradually.

The next study focused on identification of pollinators and pest of *Molineria rubriclavata* and *Molineria latifolia* and how the interactions affected fruit setting. Various types of insect were recorded visiting the *Molineria* flowers for various reasons. The main pollinators for *Molineria* were identified as the ants while the most efficient were the bees however the frequency of visitations by the ants were much higher than the bees thus they were ranked as the main pollinators. The

common pest for *Molineria rubriclavata* and *Molineria latifolia* was the termite that could cause the whole plant to die. Snails were also found to forage on the flower especially the anthers.

Polymorphism on flower structure was observed among *Molineria* varieties and species. Two varieties of *Molineria latifolia* were recorded to have heterostylous flowers. Three morphs of heterostylous flowers were found. *Molineria latifolia* var. *megacarpa* was the only species that contained all three flower morphs while *Molineria latifolia* var. *rutilovenis* have two flower morphs.

The last parts of the research focused on flower and fruit development. Flower and inflorescence development were studied using microscopic techniques which were histology and Scanning Electron Microscopic. Whereas the fruit development studies were conducted to look at fruits development, fruit bunch development and also seed development. The investigations on fruit development showed that the fruits started to ripen 12 weeks after pollination while the seeds were fully developed around 6-8 weeks.

In general, it can be concluded that the most suitable time for pollination of *Molineria rubriclavata* and *Molineria latifolia* is between 6.30 am to 10.00 am. The ecological factors that affect the anthesis were rain, mucilage and position of the flower. The main pollinators for this plant were ants namely *Monomorium destructor*, *Meranoplus bicolor* and *Tapinoma sp.* The visit of the pollinator was influenced by the size of the flower. *Molineria latifolia* produced heterostylous flower to increase the number of pollen in order to ensure higher pollination success in the absence of pollinator. The growth rate of fruit length and width were at the maximum at week 2 and week 3 after pollination respectively while fruit weight is at the highest at week 12. As for the seed, the maximum growth rate for length and width were both at week 2 after pollination. The seed fresh and dry weight highest growth occurred at week 3 after pollination.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

**EKOLOGI PENDEBUNGAAN DAN PERKEMBANGAN BUAH *Molineria
rubriclavata* DAN *Molineria latifolia***

Oleh

MOHD FIRDAUS BIN ISMAIL

Mei 2014

Pengerusi: Nur Ashikin Psyquay Binti Abdullah, PhD

Fakulti: Pertanian

Molineria Colla adalah tumbuhan renek yang menghasilkan buah mengandungi sejenis protein manis dipanggil curculin. Pemerhatian terhadap populasi liar di Semenanjung Malaysia menunjukkan pembentukan buah tidak konsisten. Sesetengah pokok menghasilkan jambak bunga yang berbuah penuh manakala sesetengahnya tidak. Buah yang tidak terbentuk dijumpai dalam jumlah dan aturan yang tidak tetap pada jambak bunga. Pokok yang di pindahkan ke bawah struktur lindungan hujan mempunyai prestasi penghasilan buah yang lemah walaupun bunga dihasilkan dengan banyak. Walau bagaimanapun, kekurangan maklumat berkaitan aspek asas tumbuhan ini seperti ekologi pendebungaan menghalang usaha untuk meningkatkan pembentukan buah dalam jangkamasa yang singkat. Maka suatu kajian telah dijalankan dengan fokus terhadap ekologi pendebungaan dan perkembangan buah *Molineria rubriclavata* dan *Molineria latifolia* var. *megacarpa*.

Kajian ekologi pendebungaan fokus kepada antesis (anthesis), kematangan anter (anther dehiscence), penerimaan stigma (stigma receptivity) dan kebernasan debunga (pollen viability). Antesis didapati berlaku dalam masa satu hari. Bunga biasanya mula terbuka sekitar jam 5.00 pagi. Didapati pembukaan bunga dipengaruhi oleh keadaan cuaca terutamanya tempoh pendedahan kepada cahaya matahari. Anter matang sebelum bunga berkembang seawal jam 8.00 malam pada hari sebelumnya. Walau bagaimanapun stigma bersedia menerima debunga sepenuhnya sekitar jam 6.00 pagi setelah bunga berkembang dan mula mengering sekitar jam 11.00 pagi. Kebernasan debunga meningkat selepas 5 jam anter terbuka dan memuncak 6-8 jam sebelum merosot.

Kajian seterusnya fokus kepada pengenalpastian pendebunga dan perosak *Molineria rubriclavata* dan *Molineria latifolia* dan bagaimana interaksi ini memberi kesan kepada pembentukan buah. Pelbagai jenis serangga direkodkan melawat bunga *Molineria* dengan pelbagai sebab. Pendebunga utama *Molineria* yang dikenalpasti

adalah semut manakala pendebunga yang paling cekap adalah lebah namun frekuensi lawatan semut adalah lebih tinggi berbanding dengan lebah maka semut dikelaskan sebagai pendebunga utama. Perosak yang utama bagi *Molineria rubriclavata* dan *Molineria latifolia* adalah anai-anai yang boleh menyebabkan keseluruhan pokok mati. Siput juga dijumpai memakan bunga terutamanya anter.

Kepelbagaian struktur (polymorphism) bunga diperhatikan dikalangan varieti dan spesis *Molineria*. Dua spesis *Molineria latifolia* direkodkan mempunyai bunga heterostil (heterostylous). Tiga bentuk bunga heterostil telah dijumpai. *Molineria latifolia* var. *megacarpa* adalah satu-satunya spesis yang mempunyai ketiga-tiga bentuk bunga manakala *Molineria latifolia* var. *rutilovenis* mempunyai dua bentuk bunga.

Bahagian terakhir kajian ini fokus kepada perkembangan bunga dan buah. Perkembangan bunga dan jambak bunga dikaji menggunakan teknik mikroskopi iaitu teknik histologi dan Mikroskop Imbasan Elektron (Scanning Electron Microscope). Manakala kajian perkembangan buah dijalankan untuk melihat perkembangan buah, perkembangan jambak buah dan juga perkembangan biji. Siasatan ke atas buah menunjukkan buah mula masak selepas 12 minggu dari proses pendebunga manakala biji terbentuk sepenuhnya sekitar minggu ke 6-8.

Secara keseluruhan, dapat disimpulkan bahawa masa paling sesuai untuk pendebungaan *Molineria rubriclavata* dan *Molineria latifolia* adalah antara 8.30 pagi hingga 10.00 pagi. Faktor-faktor ekologi yang menjejaskan antesis adalah hujan, lendir dan posisi bunga. Pendebunga utama tumbuhan ini adalah *Monomorium destructor*, *Meranoplus bicolor* dan *Tapinoma sp.* Lawatan pendebunga dipengaruhi oleh saiz bunga. *Molineria latifolia* menghasilkan bunga heterostil (heterostylous) untuk meningkatkan bilangan polen bagi memastikan kejayaan pendebunga yang lebih tinggi ketika ketiadaan pendebunga. Kadar pertumbuhan panjang dan lebar buah maksimum pada minggu ke-2 dan ke-3 selepas pendebunga manakala berat buah tertinggi pada minggu ke-12. Bagi biji, kadar pertumbuhan maksimum untuk panjang dan lebar kedua-duanya pada minggu ke-2 selepas pendebunga. Kadar pertumbuhan berat basah dan kering biji tertinggi berlaku pada minggu ke-3 selepas pendebunga.

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I certify that an Examination Committee has met on **20th May 2014** to conduct the final examination of **Mohd Firdaus Bin Ismail** on his **Doctor of Philosophy** thesis entitled "**Pollination Ecology and Fruit Development of *Molineria rubriclavata* and *Molineria latifolia*** " in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Examination Committee were as follows:

Mahmud Tengku Muda Mohamed, PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Uma Rani a/p Sinniah, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Yahya Awang, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Muhammad Ashraf, PhD

Professor
Faculty of Sciences
University of Agriculture
38040 Faisalabad
Pakistan
(External Examiner)

NORITAH OMAR, PhD

Professor and 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 Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Nur Ashikin Psyquay Binti Abdullah, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Ghizan Bin Saleh, PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Maznah Binti Ismail, PhD

Professor
Faculty of Medicine and Health Sciences
University Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

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Signature: _____
Nur Ashikin Psyquay Abdullah, PhD
Associate Professor
Faculty of Agriculture and Food Sciences
Universiti Putra Malaysia
(Chairman)

Signature: _____
Ghizan Saleh, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Signature: _____
Maznah Ismail, PhD
Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

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