

UNIVERSITI PUTRA MALAYSIA

POLLINATION ECOLOGY AND FRUIT DEVELOPMENT OF Molineria rubriclavata AND Molineria latifolia

MOHD FIRDAUS BIN ISMAIL

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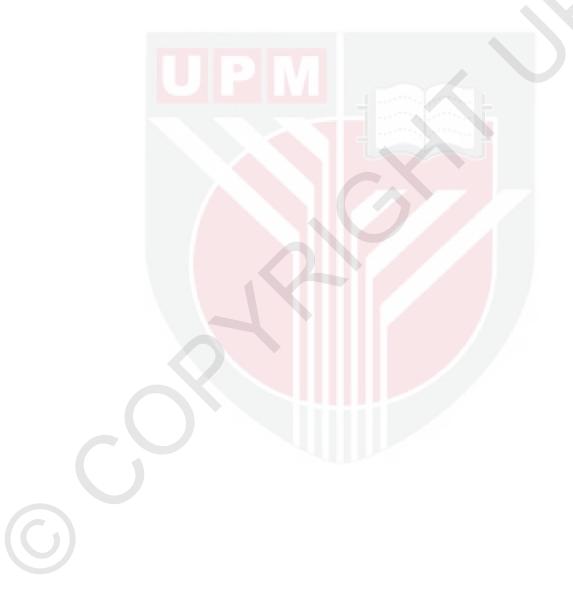
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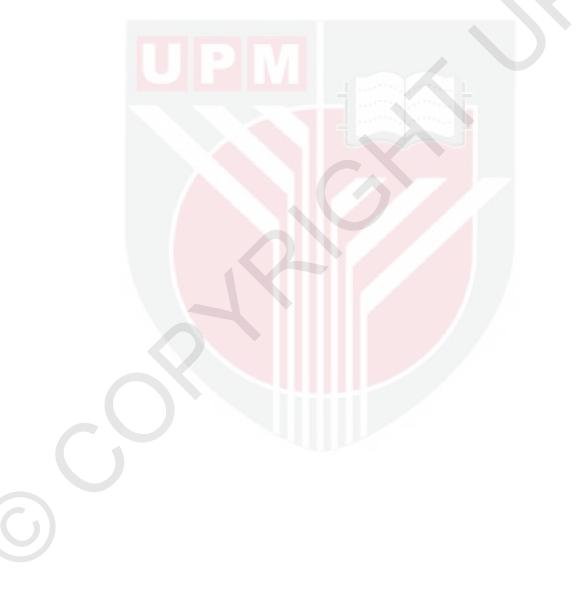
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Dedicated with love to

My visionary father, **Ismail Awang**, My virtuous mother, **Kamarah @ Norizan Abdullah**, My elder sister, **Noris Norzilla** and My younger sister, **Azlynna**



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

By

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

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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 pembentukkan 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 pendebungaan 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 pendebungaan yang lebih tinggi ketika ketiadaan pendebunga. Kadar pertumbuhan manakala berat buah maksimum pada minggu ke-2 dan ke-3 selepas pendebungaan. Kadar pertumbuhan maksimum untuk panjang dan lebar kedua-duanya pada minggu ke-2 selepas pendebungaan. Kadar pertumbuhan berat basah dan kering biji tertinggi berlaku pada minggu ke-3 selepas pendebungaan.

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