UNIVERSITI PUTRA MALAYSIA

REPRODUCTIVE BIOLOGY OF ACACIA MANGIUM WILLD. AND ACACIA AURICULIFORMIS A. CUNN. EX. BENTH.

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REPRODUCTIVE BIOLOGY OF *Acacia mangium* WILLD. AND *Acacia auriculiformis* A. CUNN. ex. BENTH.

By

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Thesis Submitted in Fulfillment of the Requirements for the Degree of Doctor Philosophy in the Faculty of Forestry, Universiti Pertanian Malaysia.

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DEDICATED

to loving memories of my late

Father

IBRAHIM ARSHAD

and

Mother

AMINAH ADIL

and

to my children

ZIZIANNA and NAZHUA ZEKHANN

for everlasting source

of inspirations

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Abstract of the thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfillment of the requirements for the Degree of Doctor of Philosophy.

Reproductive biology of *Acacia mangium* WILLD. and *Acacia auriculiformis* A. CUNN. ex BENTH.

by

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October 1991

Supervisor : Associate Professor Dr. Kamis Awang

Faculty : Forestry

A. mangium is the most widely planted plantation species in Malaysia for general utility timber and pulp and paper. The occurrence of natural hybrids between *A. mangium* and *A. auriculiformis* has created general interest in using hybrids in the plantation programme.

This study looks into the reproductive biology of *A. mangium* and *A. auriculiformis* and compares the performance of hybrid progenies and progenies of their parental species.

Morphologically, the inflorescences and flowers of *A. mangium* and *A. auriculiformis* are similar. The inflorescence of both species consists of numerous flowers borne on a loose spike. The flowers are small and brightly coloured. The main difference between the flowers of the two species is the colour, creamy white in *A. mangium* and bright yellow in *A. auriculiformis*. Andromonoecy is also observed in both species.

Both species flower throughout the year with a distinct peak season occurring between June to July. During peak flowering, it is synchronised between trees of a species. Between the two species, there is some overlapping in flowering time.

Anthesis in *A. mangium* and *A. auriculiformis* flowers is nocturnal and homogamous. Both species are generally outcrossers, by being partially self-incompatible. Flowers of *A. mangium* and *A. auriculiformis* are entomorphilic where *Trigona* and *Apis* spp. are the consistent pollen vectors.

The hybridization potential was found to be greater when *A. auriculiformis* functions as the female parent than *A. mangium*. Verifying the hybrid progenies using the isozyme technique gives fast, reliable and consistent results. Using peroxidase as the enzyme gives clear distinctive bands to differentiate between the hybrids and the parental species.

The hybrid progenies showed significant height growth over the progenies of parental species. However, biomass and root nodule production between the hybrid progenies and progenies of parental species showed no significant difference.

Future research areas are identified and a breeding strategy for *A. mangium* and *A. auriculiformis*, incorporating a hybridization programme, are proposed.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia bagi memenuhi syarat untuk memperolehi Ijazah Doktor Falsafah.

Biologi pembiakan *Acacia mangium* WILLD. dan *Acacia auriculiformis* A. CUNN. ex BENTH.

oleh

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Oktober 1991

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A. *mangium* adalah sejenis spesis pokok yang ditanam secara besar-besaran di ladang hutan di Malaysia bagi pengeluaran bahan kayu kegunaan am dan pulpa dan kertas. Kewujudan hibrid semulajadi **A. *mangium*** dan **A. *auriculiformis*** telah menimbulkan minat untuk menggunakan hybrid sebagai bahan tanaman projek perladangan.

Kajian ini meneliti ke atas biologi pembiakan **A. *mangium*** dan **A. *auriculiformis*** dan membanding keupayaan ketumbuhan anak-anak benih hibrid dengan anak-anak benih spesis induk.

Dari sudut morfologi, jambak bunga dan bunga *A. mangium* dan *A. auriculiformis* adalah sama. Jambak bunga kedua-dua spesis ini merupakan spika yang mengandungi banyak bunga. Bunganya kecil dan mempunyai warna yang cerah. Perbezaan utama di antara bunga kedua-dua spesis ini ialah pada warna. *A. mangium* mempunyai bunga berwarna putih kekuningan dan *A. auriculiformis* kuning cerah. Juga terdapat "andromonoecy" di kedua-dua spesis ini.

Kedua spesis ini berbunga sepanjang tahun tetapi terdapat satu musim bunga lebat yang berlaku diantara bulan Jun dan Julai. Semasa musim bunga lebat pembungaan diantara pokok didalam sesuatu spesis adalah selaras. Diantara spesis musim bunga adalah bertaut.

Bunga *A. mangium* dan *A. auriculiformis* adalah bunga malaman dan homogami. Kedua-dua spesis pada lazimnya adalah spesis pembiakbakaan luar kerana terdapat ketakserasian sapara. Bunga *A. mangium* dan *A. auriculiformis* entomophili di mana spesis *Trigona* dan *Apis* vektor pendebugaan yang utama.

Didapati potensi penghibridan adalah tinggi sekiranya *A. auriculiformis* berfunsi sebagai induk betina jika dibandingkan dengan *A. mangium* sebagai induk betina. Pengesahan anak benih hibrid dengan menggunakan teknik isoenzim adalah lebih cepat, yakin dan memberi hasil yang selaras. Menggunakan peroxidase

sebagai enzim menghasilkan jalur yang jelas bagi membezakan di antara hibrid dengan spesis induk.

Progeni hibrid menunjukkan ketumbuhan tinggi yang bererti jika dibandingkan dengan progeni spesis induk. Walau bagaimanapun pengeluaran biojisim dan nodul di antara progeni hibrid dan progeni spesis induk tidak memberi berbezaan bererti.

Arah penyelidikan masa depan dikenalpasti dan strategi pembiakan *A. mangium* dan *A. auriculiformis*, yang mempunyai rancangan penghibridan, dicadangkan.

CHAPTER 1

INTRODUCTION

Acacia mangium and *Acacia auriculiformis*

A. mangium Willd. and *A. auriculiformis* A. Cunn. ex Benth., which were classified under the genus *Acacia* have been reclassified under a new genus *Racosperma* (Pedley, 1987). The genus *Racosperma* contains about 850 species found in Australia, New Guinea, Madagascar, Indonesia, Philippines, Fiji, Taiwan and Hawaii. Generally, the species of this genus are pioneer and fast-growing species which play significant role in secondary succession through nutrient conservation, replacement and redistribution (Adams and Attiwill, 1984a; 1984b).

Throughout the dissertation, the author addresses the genus *Acacia* as synonymous to *Racosperma*.

Both *A. mangium* and *A. auriculiformis* belong to the genus *Acacia*, under sub-genus *Phyllodineae*, and under section *Juliflorea*. *A. mangium* grows naturally in northern Queensland, Australia, and extends through the Western Province of Papua New Guinea into the Indonesian Provinces of Irian Jaya and Maluku (Doran and Skelton, 1982). Natural stands of *A. auriculiformis* are widespread in Queensland, Australia, western and southern part of Papua New Guinea and extend into Irian Jaya and the Kei Islands of Indonesia (Turnbull *et al.*, 1986).

Both *A. mangium* and *A. auriculiformis* are described as fast-growing trees that can grow up to 30 *m* tall (Turnbull *et al.*, 1986).

In *A. mangium*, the outer bark is rough with longitudinal furrows and pale gray-brown to brown in colour. Mature phyllodes can measure up to 25 *cm* in length and 5-10 *cm* in width and are characterized by four conspicuous longitudinal main nerves with faint secondary nerves. The flowers, borne as loose spikes, are creamy white in colour. The seed pods are linear and coiled when ripe measuring from 7-8 *cm* long and 3-5 *mm* wide. The seeds are shiny black, ovate to oblong (measuring 3-5 by 2-3 *mm*) with an orange funicle folded to form an oily, fleshy aril beneath each seed.

The bark of *A. auriculiformis* is rough and fissured. The phyllodes are 10-16 *cm* in length and 1.5-2.5 *cm* in width with three prominent longitudinal nerves and with many fine crowded secondary nerves. The flowers are in spikes and are conspicuously bright yellow in colour. The pods are flat and twisted with irregular spirals when mature (measuring 6.5 by 1.5 *cm*). The seeds are black, ovate to elliptical up to 4-6 *mm* long and 3-4 *mm* wide. A long red or orange funicle encircles the seed.

Both *A. mangium* and *A. auriculiformis* have a wide range of uses which include timber, fodder and fuelwood. They are

often planted as ornamental or shade trees and widely used to rehabilitate wastelands (Turnbull *et al.*, 1986; NAS, 1983).

Acacia in Malaysia

Acacia spp. are exotic to Malaysia. The species planted include *A. auriculiformis*, *A. richii* A. Gray, *A. confusa* Merr., *A. cincinnata* F. Muell., *A. holosericea* A. Cunn. ex Benth., *A. aulacocarpa* A. Cunn. ex Benth., *A. farnesiana* Willd., *A. podalyriifolia* A. Cunn. ex G. Don and *A. mangium* Willd. (Barnard and Beveridge, 1957; Mitchell, 1964; Tham, 1979; Selvaraj and Mohammad, 1980; Anuar, 1986; Corner, 1953). Among these species, *A. auriculiformis* and *A. mangium* are the most extensively planted.

A. auriculiformis was first introduced to Peninsular Malaysia in 1931 (Barnard and Beveridge, 1957) and to Sabah in 1953 (Nicholson, 1965). It is commonly planted in gardens and parks, and along roadsides. The species is known to grow well under poor soil conditions and is a promising species for improving soils in tin-tailing areas. Although its bole form is poor, its timber is suitable for pulpwood (Phillips *et al.*, 1979) and its bark is a source of tannin (Abdul Razak *et al.*, 1981).

A. mangium was first introduced to Sabah in 1966 as fire-breaks for the pine plantations (Tham, 1976). It was subsequently introduced to Peninsular Malaysia in 1979 from