UNIVERSITI PUTRA MALAYSIA

THE BRANCHING BEHAVIOUR AND SILVICULTURAL POTENTIAL OF *PTEROCARPUS INDICUS* USING SMALL CUTTINGS

LOK ENG HAI

THE BRANCHING BEHAVIOUR AND SILVICULTURAL POTENTIAL OF *PTEROCARPUS INDICUS* USING SMALL CUTTINGS

By

LOK ENG HAI

Thesis submitted in Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Science and Environmental Studies, Universiti Pertanian Malaysia

December 1996

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude and thanks to Professor Dr. Ruth Kiew for her guidance, critiques, advice and endless patience throughout the course of this study.

I wish also to thank my supervisory committee members, Associate Professor Dr. Saberi Othman and Associate Professor Dr. Lim Meng Tsai for their interest, support, cooperation and encouragement throughout this study.

I would also like to express my sincere gratitude to the Forest Research Institute of Malaysia (FRIM) for financial support and the opportunity to undertake this course. My thanks also to the Director-General of FRIM, Dato' Dr. Salleh Mohd Nor for his belief and trust in my abilities.

I am grateful to the Department of Biology, Universiti Pertanian Malaysia (UPM) for the use of the Anatomy Laboratory and to Miss Suleka Madhavan for her expert technical assistance and cooperation during my laboratory work. I would also like to thank all my colleagues in FRIM who have assisted me in one way or another, in particular Miss Fauzidah Ahmad for her assistance and guidance in using statistical packages for my data analysis; Dr. Baskaran Krisnapillay for his kind cooperation in allowing me to share his laboratory equipment; M. Markandan, for his technical assistance and as a wonderful colleague, and foresters, Abdul Molok Ghani and Ariffin Shahbandar for their assistance in the field.

Finally, but not least, my deepest appreciation to my parent, sisters and dear wife, Doris Loh for their constant prayers, support, understanding, sacrifices and patience, and to my son, Vince Lok, who has given me the strength and inspiration to complete this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the degree of Master of Science.

THE BRANCHING BEHAVIOUR AND SILVICULTURAL POTENTIAL OF *PTEROCARPUS INDICUS* USING SMALL CUTTINGS

By

LOK ENG HAI

December 1996

Chairman : Professor Dr. Ruth Kiew

Faculty : Science and Environmental Studies

Although angsana is commonly planted as a roadside tree by large cuttings, little research has been conducted either on a trial basis or in plantations. A study was initiated to evaluate its branching behaviour and subsequently to recommend proper pruning regimes with respect to maximisation of the branch growth; anatomical features; and silvicultural potential using small cuttings.

The branching behaviour in angsana showed that the trees in UPM produced more coppicing branches and a higher level of branch orders as compared to Kuala Lumpur trees. A range of one to five coppicing branches and one to three branch orders were obtained in UPM trees while in Kuala Lumpur, one to five and one to three respectively were obtained. These trees attain bigger diameter and length in coppicing branches, ranging from one to three, and branch orders ranging from one to five, thus producing

higher timber volume. In Kuala Lumpur the average main stem diameter was 39.2cm with a clear bole height of 2.4m while in UPM the average stem diameter was 73.5cm. The optimum pruning regime of three coppice branches on the main stem with three to five branch orders is recommended as it gives higher timber volume. However, the six sites in Kuala Lumpur showed that there is a significant difference in branch sizes between sites.

Stems of angsana have high capabilities to sprout and root regardless of the small size used in the experiment. Sprouting and rooting in these small cuttings were observed to take place between 3 to 15 weeks although rooting may take a shorter period. Rooting hormone is not necessary although treatment (hormone) and age of the stem significantly affects leaf number, weight and area produced. The capabilities of the stem to root and sprout have great potential for the species to produce vegetatively. Stems of angsana have abundant parenchyma tissues available with developed meristematic tissues. The meristematic activity takes place within two weeks with shoot development occurring at Week 7. A completely differentiated branch is formed by the tenth week. However, weak anatomical tissues present in the stem such as having discontinuous fibres, less lignified vessels and cell walls and abundant cellulose fibres were observed to have contributed to branch breakage.

Abstrak tesis ini dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan untuk mendapatkan ijazah Master Sains

CORAK PENCABANGAN DAN SILVIKULTUR *PTEROCARPUS INDICUS* DENGAN MENGGUNAKAN KERATAN KECIL

Oleh

LOK ENG HAI

Disember 1996

Pengerusi : Professor Dr. Ruth Kiew

Fakulti : Sains dan Pengajian Alam Sekitar

Pokok angsana yang biasa ditanam melalui keratan amat sesuai ditanam sebagai pokok tedungan dan boleh didapati dengan meluasnya di sepanjang jalanraya. Namum demikian, kerja penyelidikan yang dijalankan kurang memberikan tumpuan terhadap spesis ini secara keseluruhannya maupun dalam petak percubaan atau perladangan hutan. Memandangan potensi pokok ini, satu kajian asas terhadap corak pencabangan dan seterusnya mensyorkan satu regim pangkasan, sifat-sifat anatomi dan potensi silvikultur dengan menggunakan keratan kecil dijalankan.

Corak pencabangan angsana di UPM didapati menghasilkan dahan tunas dan dahan susunan yang lebih tinggi dibanding dengan pokok di Kuala Lumpur. Julat antara satu hingga lima (dahan tunas) dan satu hingga lapan (dahan susunan) boleh didapati di UPM berbanding dengan satu hingga lima (dahan tunas) dan satu hingga tiga di Kuala Lumpur.

Tetapi corak pencabangan ini menghasilkan saiz perepang, panjang dahan dan isipadu yang lebih tinggi pada dahan tunas yang mempunyai julat dahan tunas satu hingga tiga dan dahan susunan satu hingga lima. Di Kuala Lumpur, purata perepang batang pokok ialah 39.2cm dengan batang bersih setinggi 2.4m sementara purata perepang di UPM ialah 73.5cm. Corak pencabangan dengan tiga dahan tunas dan tiga hingga lima dahan susunan adalah disyorkan dalam regim pangkasan yang optimum. Bagaimanapun, saiz tumbesaran dahan pokok yang terdapat di antara enam lokasi di Kuala Lumpur menunjukkan adanya perbezaan.

Batang pada pokok angsana mempunyai daya untuk menunas dan mengeluarkan akar tanpa kira saiz keratan yang digunakan. Masa mengeluarkan mata tunas dan akar adalah didapati antara 3 hingga 15 minggu walaupun pengeluaran akar mengambil masa yang lebih pendik. Penggunaan hormon adalah tidak perlu walaupun hormon dan umur keratan mempengaruhi pengeluaran bilangan, muatan dan keluasan daun. Daya kebolehan ini menjadikan ia sebagai satu spesis pokok yang mempunyai potensi untuk membiak secara tampang. Batang angsana mempunyai bilangan tisu parenkima yang banyak dengan tisu meristem yang kembang. Aktiviti meristem ini mula dalam masa dua minggu dengan perkembangan tunas kelihatan setelah minggu ketujuh. Perkembangan dahan dapat dibezakan dalam minggu kesepuluh. Bagaimanapun, sifat kelemahan tisu yang terdapat pada sesuatu dahan seperti gentian yang tidak berterusan, salur dan dinding sel yang kurang 'lignified' dan gentian yang selulos menyumbangkan kepada patahnya dahan pokok.

CHAPTER I

INTRODUCTION

Pterocarpus indicus Willd. is a well-known timber and roadside tree found throughout the Indo-Malesian and Pacific region. It is commonly known as angsana or sena in Malaysia and Singapore, narra in the Philippines, sonokembang in Indonesia and pradoo in Thailand. In Malaysia, it has been used as a shade tree for at least 100 years (Corner, 1988). Although the species appears to have inherent qualities desirable in a reforestation crop, growth data are lacking. Nevertheless, the tree has not done well in experimental trials (Browne, 1955; Cherrington, 1958; NAS, 1979; Srivastava, 1979; Wong, 1982; Corner, 1988). Growth data are restricted to early reports from Philippine reforestation projects (Assidao and Cerna, 1960; NAS, 1979; Sardina, 1951) and individual amenity trees in Singapore (Wong, 1982). Under favourable conditions *P. indicus* growth is very rapid, leading to mean annual diameter and height increment greater than 4 cm and 1.5 m respectively (Foxworthy, 1927). The red sap and young leaves are also believed to have traditional medicinal value (Burkill, 1935). In the Philippines, it is the national tree and has been widely used in reforestation projects since 1910 (Nas, 1979).

Angsana propagates easily from seeds and by cuttings. Propagation by cuttings, however, is commonly used especially in ornamental and roadside trees to provide 'instant shade' and greenery. Large cuttings of more than 3 m long and 5 to 8 cm

diameter are normally used as they are found to propagate fairly easily (Browne, 1955; Wong, 1982). It is estimated that these trees can be harvested within 15 -20 years and that the future source of timber would come from these roadsides trees (Ng, 1989). In experimental trials carried out in Peninsular Malaysia, trees have not done well and the results obtained are conflicting. Watson (1933) reported a high survival rate from cuttings while other trial plots that were left untended show high mortality rates (Burkill, 1935; Ang, 1988; Appanah and Weinland, 1993). Nevertheless, angsana is known to thrive well on deep fertile, well-drained soils at an elevation of less than 600 m in areas with an annual rainfall of at least 1,500 mm.

Angsana is widely considered as a fairly disease and pest resistant tree. The most serious disease was that recorded from 1875 to 1925, which was suggested to be caused by a virus spread by leafhoppers (Furtado, 1935) or according to Corner (1988) it was akin to Dutch elm disease. Other known diseases caused by fungi and insects are *Fusarium* disease, leaf miners and leaf spot (Furtado, 1935; Illustriaimo and Clinte, 1936; Clavejo, 1977; Corner, 1988; Fong, 1991 - *pers. comm.* and Tay, 1991 - *pers. comm.*). Angsana is also known to be a wind-firm tree. However, there are reported incidences of branch breakage due to mechanical failure though these are not rampant (Khairul, 1991; Simon, 1991, and Kiew, 1994 - *pers. comm.*). In Malaysia, trials of angsana are still on-going. Serious attention is now given to the planting of angsana trees due to its potential and demand as a high quality timber for fine furniture, cabinet making, panelling and easy workability of the wood (Sim, 1988). However, the major

inhibiting factor in the widespread use of the species is the early branching behaviour which causes the main stem to fork resulting in shorter clear bole length and reduced timber volume production. Hence, there is a need to understand the natural branching behaviour of the species and its silvicultural requirements so that proper management and utilization of the species can be carried out.

Objectives of the Study

This study was undertaken with the following objectives:

(i) To follow and characterise the natural branching behaviour of angsana trees grown from cuttings and to recommend a proper pruning regime with respect to the maximisation of timber production.

(ii) To assess whether this pruning regime affects branch growth rate.

(iii) To determine anatomical features with respect to shoot development and branch breakage.

(iv) To assess growth performance of small angsana cuttings.

The information gathered from this study should provide a better understanding of angsana tree behaviour that will assist both foresters and urban planners to utilise and manage this species more productively.

CHAPTER II

LITERATURE REVIEW

Distribution and Ecology

The genus *Pterocarpus* comprises 20 species, which are widely distributed throughout the tropics (Rojo, 1977). Nine species, which include *P. indicus*, are commercially valuable though none is extensively cultivated (Table 1). *P. indicus* has a wide geographical range, from South Burma to the Philippines and throughout the Malay Archipelago to Papua New Guinea and the Solomon Islands. There is considerable morphological and ecological variation throughout its range. However, due to extensive clonal propagation, angsana planted at any given locality tends to be uniform.

In Peninsular Malaysia, it occurs wild in various localities but is generally rare except for some old and isolated trees which are planted and are still growing along the roadsides in Penang, Melaka, Johore, Port Dickson (Plate 1 and 2), Rompin and Taiping (Ridley, 1922; Browne, 1955; NAS, 1979; Wong, 1982; Wong, 1983, and Corner, 1988). In the Moluccas, four varieties are locally recognised, which between them occupy a range of habitats from the coastal to submontane forest and seasonal swamps (Rojo, 1977).

Table 1

Species of *Pterocarpus* that Produce High Quality Furniture Wood

Species	Distribution	Common Name	Notes
ASIA:			
indicus	SE Asia	Angsana, Narra	Classic Furniture Wood
dalbergiodes	S. Asia	Andaman Padauk	Most Sought-After Hardwood
macrocarpus	Burma, Thailand	Burma Padauk	Luxury Wood
marsupium	India, Sri Lanka	-	Important Timber After Teak
santalinus	India	Red Sandalwood	Fragrant Sandalwood
AFRICA:			
angolensis	Southern Africa	Muninga	Dry, Open Woodland Trees
erinaceus	Senegal	-	Savanna Trees
osun and *soyauxii*	Nigeria to Zaire	African Padauk	Furniture and Decorative Wood

(Source: NAS, 1979).

Plate 1: Row of Old Angsana Trees Planted Along the Roadsides in Port Dickson, Negeri Sembilan

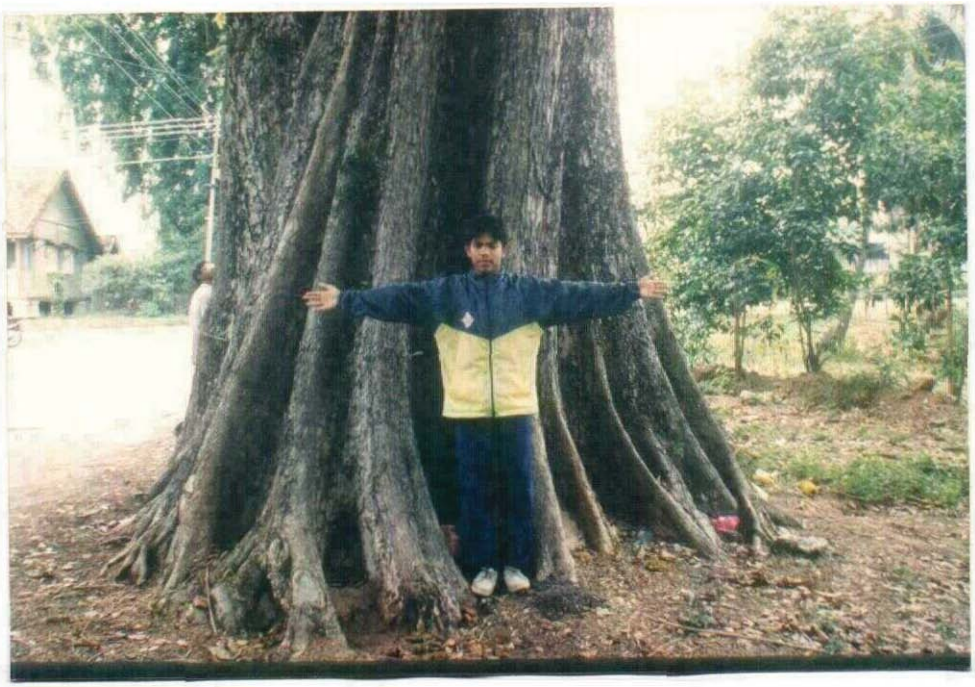

Plate 2: An Old Angsana Tree with Large Diameter Size and Buttresses in Port Dickson, Negeri Sembilan

Botanical Description

Angsana belongs to subfamily Papilionatae of the Leguminosae. It is a large deciduous tree, growing up to 33 m tall and a diameter of 7.5 m at breast height. The bole is short, with very small thick buttresses and a spreading crown with drooping twigs and foliage. Large buttresses, however, sometimes occur. The bark is smooth, pale grey on young trees, later becoming rough, dark brownish grey and longitudinally cracked, about 1 cm thick, the inner bark yellowish tinged with pink and exuding watery, dark red sap.

Its leaves are pinnate with 6-12 alternate leaflets. The leaflets range from 7 x 3.5 to 11 x 5.5 cm, are ovate to elliptic with a pronounced acuminate tip. In areas with seasonal climate, angsana is noted for its gregarious flowering. This is stimulated by a sudden drop in temperature caused by a heavy storm on a hot day (Holttum, 1954; Wong, 1982 and Corner, 1988). This synchronous pattern of flowering ensures good cross-pollination. The flowers are yellow, fragrant and borne in large axillary panicles. The samara takes about 3-4 months to mature. It is disc-shaped with a central woody-corky bulge containing 1-3 seeds. Unlike most legumes, the fruit is indehiscent and is dispersed by wind and water. For silvicultural purposes, the seeds are difficult to extract from the fruit but they readily germinate through weaknesses in the fruit wall.

A good description of the species is given by Claveria (1952); Assidao and Nastor (1961); NAS (1979); Fraser (1985) and Corner (1988).

Silvicultural Potential of Using Angsana Poles

Growth

Angsana grows like a pioneer species and is shade intolerant. Growth of seedlings is slower than cuttings and exhibits considerable variation in vigour. Rooted cuttings can be established readily on nearly all kinds of soil from coastal sands to inland clays and in both urban and garden conditions (Claveria, 1950; Assidao and Nastor, 1961 and Wong, 1982). However, trials established locally in plantations showed mixed results (Table 2). Available information on a 60- year plantation trial in FRIM initially showed a very high mortality rate of more than 90% with surviving trees having a clear bole height of 7.1 m and mean diameter of 48.6 cm (Ang, 1988). The reason for the high mortality rate is not clear but there are strong indications that it may have been due to neglect. There is a need for selection of individuals with a straight bole and maximisation of timber from these branches.

Vegetative Propagation by Cuttings

Angsana is unique among the big timber trees in its capacity to root from stem cuttings. It is well known as an 'instant tree' in Singapore and the Philippines. For urban and reforestation planting large trees grown rapidly from cuttings are transplanted. A high survival rate of 90% was obtained from these cuttings (Sardina, 1961; Claveria, 1952; Assidao and Cerna, 1960; and Wong, 1982). Cuttings were also used because they propagate and survive well in any soil type. It is also the surest way of perpetuating desirable characters as in the case of the drooping variety which is desirable and suitable for park planting.

Table 2

Angsana Growth Rates Recorded Either as Individuals or Plantation Grown

				MAI/YR	
Author	Age	Total Ht (m)	Bole Ht (m)	Gbh (m)	Diam. (cm)
Foxworthy (1927)	-	-	>1.5	>4	-
Browne (1955)	-	36.4	-	3.6	12.6
NAS (1979)	5	8	-	0.3	-
Nwoboshi (1982)	-	-	-	1.0-1.6	2.4-4.4
Wong (1982)	100	27	-	4.6	-
Troup (1986)	-	15.2	-	-	-
Corner (1988)	-	30.3	-	-	-
Ang (1991)	60	7.1	-	0.5	-

Materials selected for cuttings must be procured from straight, sound branches and can be obtained from any part of the branch. Bigger branches produce more sprouts in a shorter time than smaller branches. The part of the branch from which the cuttings was obtained has no appreciable effect on subsequent growth and development of the tree. Treatment using creosote is needed to protect the wounded parts at the distal end and the bark (Hartamann and Kester, 1983). Rooting hormone is also required to encourage early rooting (Buenaventura, 1932; Nastor, 1957; and Sardina, 1961). Various suitable planting sizes have been recommended for reforestation projects ranging from diameter sizes of 7-12 cm and lengths of 60-100 cm. Average shoot height increment of 266 cm

per year can be obtained (Assidao and Nastor, 1961). For urban planting, Wong (1982) recommended stakes with 4-5 cm diameter and 2 m length. Such stakes can produce up to 10 radiating shoots distally forming a symmetrical crown above pedestrian height within 1-2 years.

Problems In Planting From Cuttings

The popularity of angsana lies in its ease of propagation, its fast growth rate and ease of management, which account for its success as an 'instant tree'. The success of transplanted cuttings from the nursery depends on the size of the stakes or poles used. For instance, in Singapore it is the practice to transplant these 'instant trees' with girth of not more than 60 cm to ensure successful establishment and good growth rate.

In general, angsana is relatively wind-firm as it is able to grow well under a wide range of habitats and has a strong root system which undergoes anastomosis (Wong, 1982). Nevertheless, angsana commonly suffers from branch break if high frequency of pruning or pollarding is not done. This may be due to mechanical weakness at the point of shoot initiation.

Silviculture Requirements

Adequate Stem Size

Though stem cuttings can be taken from trees of any age and size, material should be carefully selected to ensure a high percentage of survival. Branches that are too old or