UNIVERSITI PUTRA MALAYSIA

RESPONSE OF THREE SHADE TREE SPECIES TO GRASS AND WOODCHIP MULCHING

JOHN TASAN

FH 2002 10

RESPONSE OF THREE SHADE TREE SPECIES TO GRASS AND WOODCHIP MULCHING

By

JOHN TASAN

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

2002

Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirements for the degree of Master of Science

RESPONSE OF THREE SHADE TREE SPECIES TO GRASS AND WOODCHIP MULCHING

By

JOHN TASAN

April 2002

Chairman : Zakaria Abdullah, M.Sc.
Faculty : Forestry

The tree loss in urban areas is of major concern because they represent shortfalls in the management objectives and waste money for replanting programmes. Mulching is considered as the best alternative for enhancing tree growth and to rehabilitate degraded urban soil. This study was carried out to examine the relative growth of 180 transplanted seedlings of *Cinnamomum iners*, *Hopea odorata* and *Mimusops elengi* in response to grass, woodchip and control mulching after 28 months. The data on collar diameter, height, volume, and fine root biomass was analysed using two-way analyses of variance, including comparison of mean values.

The results showed that *Cinnamomum iners*, *Hopea odorata* and *Mimusops elengi* showed better diameter, height, volume and fine root growths when treated with the various mulch treatments ($P \leq 0.05$). The reasons for these results are discussed. Generally, it was found that *Hopea odorata* and *Cinnamomum iners* have better growth when treated with the grass mulch, while *Mimusops elengi* showed better growth when treated with the woodchip mulch.

This study strongly supports that mulching is beneficial in enhancing tree growth, as it will eliminate competition from other vegetation for growing resources such as growing space, light, water and nutrients. It also creates a favourable environment for fine root production, as these roots could help the trees to absorb additional water and nutrients from the soil.

Local governments and other parties in making the urban reforestation project successful can apply information gained from this study. In addition, further research on urban forestry is still needed and has been proposed as Malaysia aspires to be a "Garden Nation" by 2005.

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

**RESPONS TIGA SPESIS POKOK TEDUHAN
TERHADAP SUNGKUPAN RUMPUT DAN KAYU SERPAI**

Oleh

JOHN TASAN

April 2002

Pengerusi : Zakaria Abdullah, M.Sc.
Fakulti : Perhutanan

Kehilangan pokok di kawasan bandaran telah mendapat perhatian kerana ia gagal mencapai matlamat pengurusan serta membazirkan wang bagi rancangan penanaman semula. Sungkupan dilihat sebagai cara terbaik bagi menggalakkan tumbesaran pokok serta memulihara tanah di kawasan bandaran yang kurang subur. Kajian ini telah dijalankan bagi mendapatkan tumbesaran bandingan pada 180 anak pokok *Cinnamomum iners*, *Hopea odorata* dan *Mimusops elengi* yang telah ditanam semula terhadap sungkupan rumput, kayu serpai serta kawalan selepas 28 bulan. Data berkaitan diameter, tinggi, isipadu dan biojisim akar rerambut telah dianalisa dengan menggunakan analisa varians dua hala, termasuk perbandingan nilai min.

Keputusan menunjukkan bahawa *Cinnamomum iners*, *Hopea odorata* dan *Mimusops elengi* telah mempamerkan tumbesaran yang baik bagi diameter, tinggi, isipadu dan biojisim akar rerambut apabila dirawat dengan sungkupan yang pelbagai ($P \leq 0.05$). Sebab-musabab yang menyumbang kepada keputusan tersebut telah dibincangkan. Secara amnya, adalah didapati bahawa *Hopea odorata* dan *Cinnamomum iners* mempunyai tumbesaran yang baik apabila dirawat dengan sungkupan rumput,

manakala *Mimusops elengi* mempunyai tumbesaran yang baik apabila dirawat dengan sungkupan kayu serpai.

Kajian ini menyokong penuh bahawa sungkupan adalah berfaedah dalam mempertingkatkan tumbesaran pokok memandangkan ia mampu mengurangkan saingan daripada tumbuhan lain bagi mendapatkan sumber-sumber tumbesaran seperti ruang, cahaya, air dan nutrien. Ia juga menyediakan persekitaran yang menggalakkan bagi penghasilan akar rerambut, yang mana akar-akar tersebut mampu membantu pokok-pokok untuk menyerap lebih banyak air dan nutrien dari dalam tanah.

Maklumat yang diperolehi daripada kajian ini akan dapat dimanfaatkan oleh pihak-pihak berkuasa tempatan serta lain-lain yang berminat di dalam menjayakan projek perhutanan semula di kawasan bandaran. Selanjutnya, kajian mendalam berkenaan dengan perhutanan bandar juga perlu dan telah dicadangkan kerana Malaysia berazam untuk menjadi "Negara Taman" menjelang 2005.

To my beloved grandfathers:

Mr. Goper Anak Mawing (Bai Beka);
Mr. Jehong Anak Sinjak (Bai Jenet);
and
Mr. Mejat Anak Sipan (Bai Nyindau).

These are the Bidayuh BiBunuk master gardeners
who have taught me basic agriculture during my childhood days.

There is hope for a tree that has been cut down;
it can come back to life and sprout.
Even though its roots grow old, and its stump dies in the ground,
with water it will sprout like a young plant ~ Job 14:7-9

ACKNOWLEDGEMENTS

Praise to the Lord and all His angels and saints for giving me strength and courage that finally enable me to accomplish my graduate studies.

It is of my great pleasure to extend my deepest appreciation and sincerest thanks to Mr. Zakaria Abdullah, head of my supervisory committee, who has persuaded me to carry out this tree mulching study. Special thanks are also extended to my supervisory committee members - Associate Professor Dr. Lim Meng Tsai, Dr. Siti Rubiah Zainudin and Mr. Amat Ramsa Yaman. They have contributed so much efforts in guiding me through the entire course of this study, by giving invaluable constructive criticisms and suggestions, through supervision, encouragement and support, of which made this study a success.

Thanks to my sponsor, The Tunku Abdul Rahman Scholarship Foundation of Sarawak, for financial assistance during my graduate studies in UPM. This also includes short-term grant from IRPA 1221 for provision made in this study.

I am greatly indebted to my uncle, Dr. Geri Kibe Ak. Gopir of UKM, who has been my role model and mentor, and supports me in pursuing higher education. To Dr. Jugah Kadir of UPM, I would like to express my special gratitude for his personal encouragement and support.

Special appreciations are dedicated to my loved ones for their patience and understanding. They are Nancy Ambulusius; parents - Mr. Tasan Ak. Mejat and Mdm. Miner ak. Jehong; brother - Palance Dess Ak. Tasan; sisters - Philomena and

Fiona Ak. Tasan; the Ambulusius' family; grandparents; uncles, aunts, cousins, nephews, nieces, relatives, and other family members, for their support and that have always been my source of inspiration and encouragement throughout they study period.

Again, I would like to express my deepest appreciation and thanks to all my friends for their kindest support and friendship, whom are also firm believers in information sharing in this ICT age. They are Roland Kueh Jui Heng, Sundai Silang, Geoffrey James Gerusu, John Keen Chubo, Boyd Sun Fatt, Shirley Bakansing, Griffin Akeng, Ong Kian Huat, Liew Kang Chang, Noor Fiqoh, Dr. Wong Ee Ding, Endela Tipot, Malcom Demice, the James Rentar brothers, Gabriel Michael Tomi, George Akam, Bigger Gayu, Gedrin Geno, Jennifer Milland, Simon Sidep, Nachaeloas Midin, Loddy Akam Singeu, Uno Kechendai, Frederick Satang, Juil Soriyun, Osnan Daud, James Dohe, Liam Dibor, Richard Wellis Sinyem, Saad Nyan, Susan Juhin, David Joseph Pereira, Fr. Christopher Wee and also to my fellow brothers and sisters in the CSSUPM.

Special gratitude is also given to my former colleagues at the APAFRI-Tree Link Secretariat - Mr. Edward Raymond Sutherland, Mr. Alias Abdul Jalil, Ms. Ingrid Rennbald, Ms. Yeang Nyet Poi and Ms. Noridah Osman, for which I was able to participate in the Kuala Lumpur XXI IUFRO World Congress in August 2000. Many thanks are also expressed to all staff at the Faculty of Forestry and the School of Graduate Studies, UPM, including UPM librarians for providing an excellent source of e-information, the Tree CD software.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirements for the degree of Master of Science.

AINI IDERIS, Ph.D.
Professor/Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 08 AUG 2002

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND UNITS

ABA	=	Abscisic Acid
ANOVA	=	Analysis of Variance
APAFRI	=	Asia Pacific Association of Forestry Research Institutions
Anova SS	=	Analysis of Variance Sum of Squares
Ca	=	Calcium
cm	=	centimetre(s)
C/N	=	denotes "Carbon-Nitrogen ratio"
CRD	=	Completely Randomised Design
CSSUPM	=	Catholic Students' Society of Universiti Putra Malaysia
C.V.	=	Co-Variance
DF	=	Degrees of Freedom
e.g.	=	*exempli gratia* (for example)
et al.	=	*et alii* (and others)
etc.	=	*et cetera* (and other similar things)
F	=	denotes "theoretical sampling distribution"
g	=	gramme(s)
ha	=	hectare(s)
hr	=	hour(s)
ICT	=	Information and Communication Technology
IRPA	=	Intensified Research on Priority Areas
IUFRO	=	International Union of Forestry Research Organisations
JPBD	=	Jabatan Perancangan Bandar dan Desa (Department of Town and Country Planning)
K	=	Kalium
LSD	=	Least Significant Difference
m	=	metre(s)
m^2	=	square metre
MARDI	=	Malaysia Agricultural Research and Development Institute
MJm^{-2}	=	Mega Joule per square metre
mm	=	millimetre(s)
MMS	=	Malaysia Meteorological Service
Mn	=	Manganese
MSE	=	Mean Square Error
m.s.l.	=	mean sea level
N	=	Nitrogen
N-P-K	=	Nitrogen-Phosphorus-Kalium
N-P-K-Mg	=	Nitrogen-Phosphorus-Kalium-Magnesium
NPP	=	Net Primary Productivity
P	=	Phosphorus
pH	=	a measure of the acidity or alkalinity of a solution
Pr	=	Probability
SD	=	Standard Deviation
Tree CD	=	Tree Compact Disk (a software on forestry related subjects)
UKM	=	Universiti Kebangsaan Malaysia
UPM	=	Universiti Putra Malaysia

CHAPTER I

INTRODUCTION

General Background

Urban forests constitute a valuable component of the urban environment and provide a wide range of important benefits to urbanites. These benefits ranged from environment that is more pleasant, healthy and comfortable to live, work and play in, to substantial improvements in individual and community well being (Dwyer *et al.*, 1992).

We should not underestimate the role of urban forests in safeguarding the urban ecosystem. Lawrence *et al.* (1993) noted that urban forests performed many valuable functions such as air purification, soil stabilisation, minimising soil erosion, provision of shade and protection from wind. They also mentioned that the presence of trees might influence weather patterns as well as enhance the aesthetics of the landscape and its surrounding architecture. The other functions are to reduce noise and glare, provide wildlife habitat, increase property values and impart a sense of well being. A single tree may take many years to grow to its full stature and potential and, in so doing, may provide a significant historical link with the past.

However, there is a major concern for environmental degradation because of high development activities and rapid growth of population in urban areas. Nowadays, urban forests are rapidly declining in both extent and quality despite their important ecological roles. The expansion of industrialisation and settlement areas, inflow of

urban migration, creation of new urban infrastructures and so on are the major causes that irrevocably upset the natural environment. In addition, air pollution caused by industrialisation might affect tree growth in the urban areas. Detailed information on effect of air pollution on tree growth can be found in Gholz and Lima (1997).

Another important issue that needs to be addressed is how shall we have a more lasting urban forestry programme. Gilman (1997) suggested that a mix of tree species should be planted together to prevent major devastating disaster caused by pests and diseases. In so doing, it might require more work and creativity, which is quite challenging and complex. However, such changes must be done if we are to develop sustainable urban forests, including a more lasting urban forestry programme throughout the country.

Justification

At present, post-planting care for trees and landscape plants in urban areas is not given its due importance due to various reasons. One of the reasons is the lack of budget allocation for such purposes. Consequently, minimal and often improper maintenance has caused high mortality in plant growth.

This study emphasises on the importance of organic mulch to be used as part of the cost effective post-planting care of trees and other landscape plants. Organic mulching is considered as the best alternative to enhance growth of trees and rehabilitate degraded urban soil. Organic mulches have been used for a long time as soil cover and/or conditioner (as composted materials) and as it decomposes, it provides the essential nutrients required for plant growth.

New information derived from this study is hopefully applicable for establishment of young trees in the local urban landscape, with the purpose lising and managing organic wastes.

Research Objective and Scope of the Study

This study examined the response of *Cinnamomum iners*, *Hopea odorata* and *Mimusops elengi* trees to grass and woodchip mulches (including a control treatment) after 10, from 10 to 28 and after 28 months.

Scope of the study focused on growths of diameter, height, volume and fine root production of the trees to determine whether mulching has any effect on such growth within the study period.

CHAPTER II

LITERATURE REVIEW

Urban Forestry at a Glance

The Dictionary of Forestry defines "urban forestry" as the art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic and aesthetic benefits that trees provide to the society (Helms, 1998).

It is important to know what urban forestry is all about. The concept of urban forestry was introduced at the University of Toronto in 1965 (Jorgensen, 1970). Jorgensen (1970 and 1986), who invented the phrase noted that urban forestry involves mainly tree management in the entire area that is influenced and utilised by the urban population and it is not solely based on city trees nor concerned with single tree management.

Urban forestry has been recognised as one of the forestry opportunities in the Asia Pacific region and a powerful tool for conservation management in urban areas (DiNicola *et al.*, 1998). Grey (1996) also gives further information about the kinds of services and opportunities offered by urban forests.

Generally, it refers to the management of a large group of trees in urban areas rather than on an individual basis (Harris, 1983). Hibberd (1989) further noted that it embraces trees grown in and close to urban areas for landscape beautification and

aesthetics and for recreation purposes. Such management also includes trees in streets, avenues, urban parks, land reclaimed from previous industrial use, as well as those in urban woodlands and gardens.

Miller (1997) noted that the concept of urban forestry is developed through three stages in relation to urbanisation process. First, urban centres expanded and interfaced with rural woodlands because of massive migration of people into cities. Second, social values exert a strong influence on the management of rural land to reflect urban living. Third, the urbanisation processes continuously have a negative impact on vegetation within cities, at the urban/rural interface and rural forests.

Urban forestry, however, is not just planting of trees and other vegetation in urban areas, although its primary concern is to ameliorate the harsh environment. To extend the definition of urban forestry, Helms (1998) provides us with other terminologies. Among others, the "urban and community forestry" that is widely practised in the United States involves information dissemination, technical assistance, grants to local government and networking of resources among various levels of government. The "urban forestry maintenance programme" is a programme that takes care of trees within a community and includes tree pruning, fertilisation, removal of individual trees, thinning, exotic species eradication and improvement of trees and stands under public ownership in and around communities. A legal document known as "urban tree ordinance" is also in use at the local level to identify who has authority to manage trees on public lands within communities and what standard of care will be expected.

In Malaysia, however, we are still far behind in having our own "standard procedures" with regards to urban and community forestry. It is a hope that in the near future, we can emulate our Western counterparts by having and implementing these programmes and by-law(s) that are applicable and relevant to our needs. Moreover, relevant expertise and sources of information on the development of Malaysian urban forestry are also abundant (Tho *et al.*, 1983; Mohd. Basri *et al.*, 1983; Chee and Ridwan, 1984; Justice, 1986; Anon., 1988; Ng, 1988; Yap, 1988; Khuzaimah, 1989; Zakariya and Ahmad Ainuddin, 1989; Salleh *et al.*, 1990; Zakariya, 1990; Ng, 1991 and 1992; JPBD, 1995; Maripa, 1996; New Straits Times, 1997; Siti Rubiah, 2000).

The Real Concern

Tree loss from lack of proper maintenance is a major concern in every urban tree planting programme, as it not only represents failure to meet the management objectives but it is requires additional public funds to replace the dead trees (Bradshaw *et al.*, 1995).

It has been found that more than 80% of the tree failure in urban areas are due to below ground problems (Patterson *et al.*, 1980). Tree longevity in urban landscape is greatly influenced by the performance of the root system in the root zone environment (Hamilton, 1979; Fayle, 1978; Grene, 1978).

Improper planting technique of trees such as deep planting also contributes to such problem, thus affecting the ability of trees to establish and grow properly. The weakened tree may decline as a direct result of aggravated root loss or from secondary disorders such as cankers or borers, which can lead to premature death (Funk, 1992).

Craul (1985) noted that one of the primary reasons for this poor survival rate is the adverse rooting environment in many urban sites. The planting area is often limited in rooting space; the soils are compacted with restricted aeration, drainage is poor and the soils are nutrient deficit. The evidence is clear that maintenance requirements are greater for urban trees because of stress-inducing factors in the urban environment.

The performance of tree root system in urban landscapes is important as root growth/development decreases in compacted and hard to penetrate soils (Perry, 1982). Kozlowski and Davies (1975) suggested that planting hole preparation is important in ensuring the transplanting success. Corley (1984) noted that a favourable environment through preparation of large planting hole with quality soil is needed to accommodate root regeneration at the early stages of development. Moreover, previous studies reported that mulches incorporated into the soil helps in modifying the soil environment and increase vegetation growth (Black *et al.*, 1994; Slick and Curtis, 1985).

Therefore, concerted efforts in rehabilitating the urban soils are much needed to facilitate growth of tree roots in a modified, good rooting environment. This will help trees to grow in a healthy way and meet the management objectives in a short time.

Nature of Tree Growth and Yields

Tree growth is the increment made in girth, diameter, basal area, height, volume, quality or value of individual trees (Ford-Robertson, 1971). Such growth takes place simultaneously and independently in different parts of a tree (Philip, 1994). Rate of growth is an increase in size made during a given period (Ford-Robertson, 1971).