



**UNIVERSITI PUTRA MALAYSIA**

**STORAGE OF SEEDLINGS OF THREE RECALCITRANT  
DIPTEROCARP SPECIES BY SLOW GROWTH TECHNIQUES**

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**STORAGE OF SEEDLINGS OF THREE RECALCITRANT  
DIPTEROCARP SPECIES BY SLOW GROWTH TECHNIQUES**

**By**

**TSAN FUI YING**

**Thesis Submitted in Fulfilment of the Requirements for the  
Doctor of Philosophy in the Faculty of Forestry  
Universiti Putra Malaysia**

**February 2000**



Dedicated to my beloved parents,  
husband and daughter



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

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**Chairman: Jamaluddin Basharuiddin, Ph.D.**

**Faculty: Forestry**

Most dipterocarp species are erratic seed bearers and produce recalcitrant seeds. This study was designed to explore the possibility of storing their seeds as slow growing seedlings for the continuous supply of planting materials for various planting programmes.

*Shorea ovalis* seedlings showed suspended growth while *Shorea leprosula* could be stored as slow growing seedlings at 150  $\mu\text{mol}/\text{m}^2/\text{s}$  PPFD for twelve months. Storage at a density of 700 seedlings/ $\text{m}^2$  on the forest floor under this low radiation condition, however, resulted in mortality rate of above 20% due to herbivory of cotyledons, broken branches from the trees above, damping off and intraspecific competition. *Hopea odorata* were free from damping off when maintained at a slow growth phase for the same length of period on the forest floor at densities of 300, 500 and 700 seedlings/ $\text{m}^2$ . The other factors as



mentioned, however, resulted in mortality rate of above 20% also in these seedlings.

*S. ovalis* and *S. leprosula* showed a survival rate of above 80% when maintained at the same density of 700 seedlings/m<sup>2</sup> for three months at 16°C combined with 5 µmol/m<sup>2</sup>/s PPFD in the growth chamber. *H. odorata*, on the other hand, could be held in this growth chamber for up to six months at a suspended growth state irrespective of application of Hoagland solution. These cold stored seedlings, however, were physiologically less active than those grown for the same duration on the forest floor.

*H. odorata* could also grow slowly in the nursery for up to nine months following up to two applications of paclobutrazol at rates of 0.5 and 1 g/l. Treatment with this growth regulator could be done at an interval of three months when the seedlings were four-month old and upwards. These seedlings stored in the nursery were more robust than those held on the forest floor or in the cold chamber.

When retrieved from storage condition for recovery under normal growth condition, *H. odorata* seedlings subjected to treatments with paclobutrazol as mentioned could fully recover from the slow growth phase within three months. They were comparable to the paclobutrazol free control seedlings maintained for the same duration in terms of growth performance. The seedlings following the



other storage treatments generally could not gain comparable physiological performance as the control seedlings within the studied recovery duration.

*S. ovalis*, *S. leprosula* and *H. odorata* stored as slow growing seedlings under any of the approaches mentioned generally showed lag growth at the storage of nine months (nine-month old). The lag growth even continued during the recovery period of three months in the nursery.



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**PENYIMPANAN ANAK BENIH TIGA SPESIS DIPTEROKAP  
REKALSITRAN DENGAN TEKNIK PERTUMBUHAN  
SECARA PERLAHAN-LAHAN**

Oleh

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**Februari 2000**

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Kebanyakan spesies dipterokap berbuah tidak tentu masa dan menghasilkan biji benih rekalsitran. Kajian ini bertujuan meninjau kemungkinan penyimpanan biji benih mereka sebagai anak benih dalam keadaan pertumbuhan perlahan-lahan untuk bekalan bahan tanaman secara berterusan bagi berbagai program penanaman.

Anak benih *Shorea ovalis* menunjukkan pertumbuhan tergantung manakala *Shorea leprosula* boleh disimpan sebagai anak benih dalam keadaan pertumbuhan perlahan-lahan pada  $150 \mu\text{mol}/\text{m}^2/\text{s}$  PPFD selama dua belas bulan. Walau bagaimanapun, penyimpanan pada kepadatan  $700$  anak benih/ $\text{m}^2$  di lantai hutan bawah keadaan keamatan cahaya yang rendah ini menyebabkan kadar kematian melebihi  $20\%$  akibat kotiledon dimakan, dahan patah yang terjatuh dari atas pokok, masalah melecur dan persaingan intraspesifik. *Hopea odorata* adalah



bebas daripada masalah melecur apabila disimpan pada fasa pertumbuhan perlahan-lahan untuk tempoh yang sama di lantai hutan pada kepadatan 300, 500 and 700 anak benih/m<sup>2</sup>. Akan tetapi, faktor-faktor lain tersebut juga menyebabkan kadar kematian melebihi 20% untuk anak benih ini.

*S. ovalis* and *S. leprosula* menunjukkan kadar kemandirian melebihi 80% apabila disimpan pada kepadatan yang sama pada 700 anak benih/m<sup>2</sup> selama tiga bulan pada gabungan suasana suhu 16°C dan cahaya 5  $\mu\text{mol/m}^2/\text{s}$  PPFD dalam kebuk pertumbuhan. *H. odorata* boleh disimpan dalam kebuk pertumbuhan tersebut sehingga enam bulan pada keadaan pertumbuhan tergantung tanpa mengambil kira aplikasi larutan Hoagland. Walau bagaimanapun, anak benih disimpan sejuk ini didapati kurang aktif dari segi fisiologi berbanding dengan mereka yang tumbuh untuk jangka waktu yang sama di lantai hutan.

*H. odorata* juga boleh tumbuh secara perlahan-lahan di tapak semaian selama sembilan bulan berikutan sehingga dua aplikasi paclobutrazol pada kadar 0.5 dan 1 g/l. Rawatan dengan bahan mengawal pertumbuhan ini boleh dilakukan pada selang masa tiga bulan semasa anak benih berumur empat bulan ke atas. Anak benih yang disimpan di tapak semaian adalah lebih besar daripada mereka yang disimpan di lantai hutan atau dalam kebuk pertumbuhan yang sejuk.

Apabila dialihkan daripada keadaan penyimpanan untuk pemulihan bawah keadaan pertumbuhan normal, hanya anak benih *H. odorata* yang dirawat dengan paclobutrazol tersebut dapat memulih sepenuhnya daripada fasa



pertumbuhan perlahan-lahan dalam tempoh tiga bulan. Mereka adalah setanding dengan anak benih kawalan yang bebas daripada aplikasi paclobutrazol yang disimpan untuk jangka masa yang sama dari segi prestasi pertumbuhan. Kebanyakan anak benih yang mengikuti rawatan penyimpanan yang lain tidak dapat memperolehi prestasi fisiologi yang setanding dengan anak benih kawalan dalam tempoh pemulihan yang dikaji.

Kebanyakan anak benih *S. ovalis*, *S. leprosula* dan *H. odorata* yang disimpan dalam keadaan pertumbuhan secara perlahan-lahan melalui mana-mana teknik tersebut menunjukkan pertumbuhan “lag” pada penyimpanan sembilan bulan (umur sembilan bulan). Pertumbuhan “lag” ini berterusan semasa tempoh pemulihan selama tiga bulan di tapak semaian.

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## LIST OF ABBREVIATIONS

DMF	N,N-dimethyl formamide
FRIM	Forest Research Institute Malaysia
PAR	Photosynthetic active radiation
PPFD	Photosynthetic photon flux density
R/Fr	Red to far-red
SPAC	Soil-plant-atmosphere-continuum
UPM	Universiti Putra Malaysia



# CHAPTER I

## INTRODUCTION

### Need for the Study

The forest in Peninsular Malaysia is represented by tropical rain forest with a dominance by the family Dipterocarpaceae which produces the bulk of the commercially valuable timbers. Increasing agricultural development has in recent years resulted in a substantial part of the forests being lost from timber production, especially in lowland forests with high productivity of timbers. It is projected that the timber production in Malaysia will decline by the turn of the century (Yap, 1991).

According to the law of nature of plant succession, the forest dominated by dipterocarps can be regenerated naturally in exploited relic stands in tropical rain forest zones. Nevertheless, natural regeneration of dipterocarps, especially in the hill dipterocarp forests, is generally poor and normally confined to a narrow belt on the ridges (Tang and Wadley, 1976). Man must intervene in the forest ecosystem to accelerate the dipterocarp succession stages (Sato, 1979). An example of the acceleration of dipterocarp succession is artificial planting of these species. Forest plantation of fast-growing as well as high quality dipterocarps has an important role to play to supplement and to compliment the timber supply from