



**UNIVERSITI PUTRA MALAYSIA**

***SELECTION OF CLONES FOR CANOPY REPLACEMENT IN  
REHABILITATION OF VASCULAR STREAK DIEBACK IN MATURE  
COCOA (*Theobroma cacao* L.) IN MALAYSIA***

**ROZITA OSMAN**

**ITA 2013 1**



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**DOCTOR OF PHILOSOPHY  
UNIVERSITI PUTRA MALAYSIA**

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COCOA (*Theobroma cacao L.*) IN MALAYSIA**

By

**ROZITA OSMAN**

**Thesis Submitted to the School of Graduate Studies,  
Universiti Putra Malaysia, in Fulfillment of the  
Requirements for the Degree of  
Doctor of Philosophy**

**May 2013**

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## DEDICATION

I dedicated this precious effort, the fruit of my thoughts and study to my affectionate mother, brothers and sisters, husband Radzuan and children Muhammad Irfan Zikry, Muhammad Imran, Muhammad Iman Zafri and Nur Sarah Aisyah who inspired me to the higher destiny of life.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

**SELECTION OF CLONES FOR CANOPY REPLACEMENT IN  
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By

**ROZITA OSMAN**

May 2013

**Chairman : Professor Mohd. Razi Ismail**

**Faculty : Institute of Tropical Agriculture**

Vascular streak dieback (VSD) caused by the fungus *Oncobasidium theobromae* Talbot & Keane is a major disease of cocoa in Malaysia. In existing cocoa areas, canopy replacement using tolerant clones can be practiced for VSD control. The general objective of this study was to develop suitable canopy replacement technique for rehabilitation of VSD infected mature cocoa. Screening of VSD tolerant clones were carried out on ten selected clones and non-grafted seedling was used as the control. Based on visual observations and biochemical analysis, four clones: PBC123, KKM25, MCBC1 and QH1003 showed tolerant to VSD. These clones were low in proline content (0.99 - 1.19  $\mu\text{mol g}^{-1}$  fresh weight), low in total polyphenols content (1.42 - 1.72 mg GAE  $\text{g}^{-1}$  fresh weight) and high in peroxidase activity especially PBC123 (0.58 U mg protein<sup>-1</sup>) compared susceptible clones (proline content - 1.31 - 1.60  $\mu\text{mol g}^{-1}$  fresh weight, total

polyphenols content - 3.71 - 3.95 mg GAE g<sup>-1</sup> fresh weight, peroxidase activity - 0.20 U mg protein<sup>-1</sup>). These clones were selected for subsequent study. The graft compatibility between PBC130 and selected clones was observed and evaluated. The observations and anatomical study of four clones revealed that four selected clones: KKM25, QH1003, PBC123 and MCBC1 were compatible to be grafted to PBC130 although it was already grafted to hybrid rootstock. The possible duration required for cocoa clones graft union formation was about 40 days. These four clones were subsequently used for study in the third experiment where they were grafted to mature PBC130 at four grafting distances and four grafting points under field conditions. The VSD DSI was higher (1.432) at 1.5m grafting distances, girth of the grafted branches was smallest in 2m grafting distance (8.73 cm) and 5 grafting points (9.49 cm), stomatal conductance was higher at 1.5 m grafting distance (47.24 mmol m<sup>-2</sup>s<sup>-1</sup>), proline content and peroxidase activity were higher at 1.0 m grafting distance (1.71 μmol g<sup>-1</sup> fresh weight and 16.84 U mg protein<sup>-1</sup>, respectively) and total polyphenols content was higher at 1.5 m grafting distance. After successful canopy replacement, cocoa production yield had increased significantly (12.75 - 18.54 pods per tree per year) compared to before its implementation (5.50 - 10 pods per tree per year). After taking few factors into considerations, it was found that grafting at 1.5m grafting distance with 3 to 4 grafting points per tree can rehabilitated VSD infected mature cocoa trees and increase cocoa production.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan Ijazah Doktor Falfasah

**PEMILIHAN KLON-KLON UNTUK PENGGANTIAN KANOPI DALAM  
PEMULIHAN PENYAKIT MATIROSOT JEJALUR VASKULAR BAGI  
POKOK KOKO DEWASA ( *THEOBROMA CACAO* L.) DI MALAYSIA**

Oleh

**ROZITA OSMAN**

**Mei 2013**

**Pengerusi : Profesor Mohd Razi Ismail**

**Fakulti : Institut Pertanian Tropika**

Matirosot jejalur vaskular (VSD) yang disebabkan oleh kulat *Oncobasidium theobromae* Talbot & Keane adalah penyakit utama pada tanaman koko di Malaysia. Dalam kawasan koko yang sedia ada, kaedah penggantian kanopi boleh dipraktikkan untuk kawalan penyakit VSD. Objektif am kajian ini adalah untuk membangunkan teknik penggantian kanopi yang sesuai untuk pemulihan koko dewasa yang dijangkiti VSD. Saringan klon yang toleran VSD dijalankan ke atas sepuluh klon terpilih dan anak benih koko tidak bercantum sebagai kawalan. Berdasarkan pemerhatian dan analisa biokimia, empat klon: PBC123, KKM25, MCBC1 dan QH1003 menunjukkan toleran terhadap VSD. Klon-klon ini rendah kandungan prolin ( $0.99 - 1.19 \mu\text{mol g}^{-1}$  berat basah), rendah kandungan polifenol ( $1.42 - 1.72 \text{ mg GAE g}^{-1}$  berat basah) dan tinggi aktiviti peroksida terutamanya PBC123 ( $0.58 \text{ U mg protein}^{-1}$ ) berbanding klon-



klon yang rentan (kandungan prolin - 1.31 - 1.60  $\mu\text{mol g}^{-1}$  berat basah, kandungan polifenol - 3.71 - 3.95 mg GAE  $\text{g}^{-1}$  berat basah, aktiviti peroksida - 0.20 U mg protein $^{-1}$ ). Klon-klon ini dipilih untuk kajian seterusnya. Keserasian cantuman di antara PBC130 dan klon yang dipilih telah diperhati dan dinilai. Pemerhatian serta kajian anatomi pada klon telah menunjukkan bahawa empat klon: KKM25, QH1003, PBC123 and MCBC1 adalah serasi untuk dicantum kepada PBC130 walaupun ia telah dicantum terlebih dahulu kepada pokok penanti hibrid. Tempoh masa yang diperlukan untuk pembentukan penyatuan cantuman adalah kira-kira 40 hari. Keempat-empat klon ini kemudiannya digunakan untuk kajian dalam percubaan yang ketiga di mana klon dicantum pada PBC130 yang matang pada empat jarak cantuman dan empat bahagian cantuman sepokok di lapangan. VSD DSI tinggi (1.432) pada jarak cantuman 1.5m, ukur lilit dahan cantum paling kecil pada jarak cantuman 2m (8.73 cm) dan lima tempat cantuman (9.49 cm), konduktan stomata paling tinggi pada jarak cantuman 1.5 m (47.24  $\text{mmol m}^{-2}\text{s}^{-1}$ ), kandungan prolin dan aktiviti peroksida paling tinggi pada jarak cantuman 1.0 m (masing-masing 1.71  $\mu\text{mol g}^{-1}$  berat basah dan 16.84 U mg protein $^{-1}$ ) dan kandungan polifenol paling tinggi pada jarak cantuman 1.5 m. Selepas kejayaan penggantian kanopi, pengeluaran hasil koko meningkat dengan bererti (12.75 - 18.54 bilangan buah sepokok setahun) berbanding dengan sebelum pengantiannya (5.50 - 10 bilangan buah sepokok setahun). Setelah mengambil kira beberapa faktor, didapati cantuman pada jarak 1.5 m daripada tanah dengan 3 hingga 4 cantuman sepokok dapat

memulihkan pokok koko dewasa yang dijangkiti VSD dan meningkatkan pengeluaran koko.



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I certify that a Thesis Examination Committee has met on 23<sup>rd</sup> May 2013 to conduct the final examination of Rozita Osman on her thesis entitled "Physiological and Biochemical Changes during Canopy Replacement Using Selected Clones for Rehabilitation of Vascular Streak Dieback (VSD) Disease in Mature Cocoa (*Theobroma cacao L.*)" in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Doctor of Philosophy.

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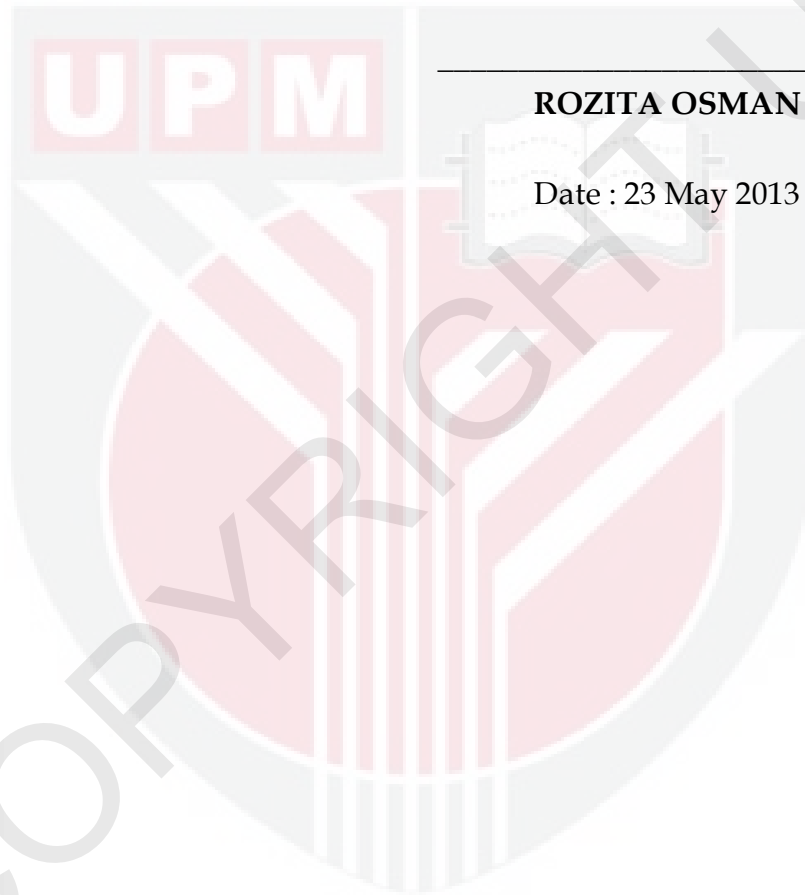
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## DECLARATION

I hereby declare that the thesis is my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.



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