



UNIVERSITI PUTRA MALAYSIA

***GROWTH, PHYSIOLOGICAL RESPONSES, AND ENZYMATIC ACTIVITIES IN
IMMATURE STAGES OF FIVE HEVEA BRASILIENSIS WILLD CLONES UNDER
WATER STRESS***

NOORLIANA MOHD ZAN

ITA 2013 4



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NOORLIANA MOHD ZAN

**MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA**

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By

NOORLIANA MOHD ZAN

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

June 2013

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Abstract of thesis presented to the Senate of University Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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NOORLIANA MOHD ZAN

June 2013

Chairman: Professor Mohd Razi Bin Ismail, PhD

Institute: Institute Tropical of Agriculture

The effects of water stress treatment through variation in the duration of stress applied (i.e 7, 14, 21, 28 days) on growth and physiological responses of immature *Hevea brasiliensis* clones were investigated under glasshouse condition in comparison with a unstressed. 5 clones were found to have similar responses under a well-watered control condition. Water stress significantly ($p \leq 0.05$) reduces soil moisture, biomass partitioning, specific leaf area, leaf area ratio and leaf weight ratio. Similarly, gas exchange in stressed *Hevea* clones had a significant effect on the net photosynthesis, stomata conductance, leaf water potential and transpiration rate. In contrast, the increase of water stress duration increased the root shoot ratio (R:S) and water use efficiency (WUE). On the other hand, in terms of clones, RRIM 3001, RRIM 2002 and RRIM 929 exhibited characteristics of maintained photosynthesis, stomata conductance, leaf water potential under water deficit by maintaining high plant water status through prompt

stomata regulation (high water use efficiency), as compared to RRIM 2008 and RRIM 2014 that were sensitive to water deficit.

Additionally, significant linear relationships were found between leaf water potential, stomata conductance and net photosynthesis. A significant relationship on net photosynthesis and leaf water potential was also obtained. These relationships show an ability to adapt and maintain root to shoot communication under a water stress condition that supports the gas exchange findings. Water stress of *Hevea* plants could decrease the level of chlorophyll a, chlorophyll b, total chlorophyll content and maximum quantum efficiency of photosystem II (PS II). However, in this study chlorophyll a, chlorophyll b and total chlorophyll content were not significantly affected by water stress. The decrease of maximum quantum efficiency of photosystem II was due to the impairment of net photosynthesis which limits the availability of CO₂ concentration. Moreover, water stress had rapidly increased biochemical constituents, such as ascorbate peroxidase (APX), guaiacol peroxidase (GPOX) and catalase (CAT) which exhibited progressive scavenging of reactive oxygen species (ROS) formation to prevent photooxidation or oxidative stress. On the other hand, RRIM 3001 had the ability to maintain carbon dioxide (CO₂) concentration and better scavenging defense mechanism for ROS as compared to RRIM 2014 under stressed condition. Overall results revealed that RRIM 3001 clone had the most similar water stress tolerance characteristic and suggest that water stress applied to immature *Hevea* clones will gradually affect their growth, physiology and trigger enzymatic antioxidants to overcome formation of ROS molecules.

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

**PERTUMBUHAN, RESPON FISIOLOGI DAN AKTIVITI ENZIM DI
PERINGKAT BELUM MATANG KE ATAS LIMA KLON *Hevea brasiliensis*
Willd DI BAWAH TEGASAN AIR**

Oleh

NOORLIANA MOHD ZAN

Jun 2013

Pengerusi : Professor Mohd Razi Bin Ismail, PhD

Institut : Institut Pertanian Tropika

Kesan rawatan tegasan air pada hari ke (7, 14, 21, 28) yang diberikan untuk melihat kesannya ke atas pertumbuhan dan tindak balas fisiologi *Hevea brasiliensis* di peringkat tidak matang yang dibandingkan terhadap rawatan kawalan dan di jalankan di dalam rumah hijau. Lima klon menunjukkan tindak balas yang seragam di bawah keadaan tiada tegasan air. Tegasan air menunjukkan ($p \leq 0.05$) pengurangan yang signifikan terhadap kelembapan tanah, pembahagian biojisim, luas daun spesifik, nisbah luas daun dan nisbah berat daun. Begitu juga, kadar pertukaran gas, kadar fotosintesis bersih, konduktans stomata, potensi air daun dan kadar transpirasi yang menunjukkan kesan signifikan terhadap tegasan air. Sebaliknya, peningkatan tegasan air terhadap hari akan meningkatkan nisbah akar pucuk (R:S) dan kecekapan penggunaan air (WUE). Sebaliknya, dari segi klon, RRIM 3001, RRIM 2002 dan RRIM 929 menunjukkan ciri pengekalan fotosintesis bersih, konduktans stomata, potensi air daun di bawah pengaruh kekurangan air dengan mengekalkan kandungan air yang tinggi melalui pengawalan

stomata (kecekapan penggunaan air yang tinggi), berbanding dengan klon RRIM 2008 dan RRIM 2014.

Tambahan lagi, terdapat hubungan linear antara potensi air daun, konduktans stomata dan fotosintesis bersih. Selain itu, fotosintesis bersih juga menunjukkan hubungan yang signifikan terhadap potensi air daun. Hubungan ini menunjukkan keupayaan untuk menyesuaikan diri dan mengekalkan komunikasi di antara akar dan pucuk di bawah keadaan tegasan air bagi menyokong dapatan bagi kadar pertukaran gas. Tegasan air pada *Hevea* menyebabkan penurunan tahap klorofil a, klorofil b, jumlah kandungan klorofil dan kecekapan maksimum kuantum photosistem II (PS II). Penurunan kecekapan maksimum kuantum photosistem II disebabkan oleh kemerosotan fotosintesis bersih yang menghadkan ketersediaan kepekatan CO₂. Selain itu, tegasan air menunjukkan peningkatan yang ketara terhadap komponen biokimia, seperti ascorbate peroxidase (APX), guaiacol peroxidase (GPOX) dan catalase (CAT) yang menunjukkan tindak balas progresif terhadap pembentukan spesies oksigen reaktif (ROS) untuk mencegah pengoksidaan foto atau tekanan oksidatif. RRIM 3001 menunjukkan keupayaan untuk mengekalkan kepekatan karbon dioksida dan mekanisme pertahanan berbanding yang baik berbanding RRIM 2014 di bawah keadaan tegasan air. Keputusan keseluruhan menunjukkan bahawa RRIM 3001 memberikan ciri ketahanan terhadap tegasan air dan mencadangkan bahawa tegasan air yang dikenakan ke atas *Hevea* tidak matang memberi kesan terhadap pertumbuhan, fisiologi dan mencetuskan enzim antioksidan untuk melawan dan menyeimbangkan pembentukan molekul ROS.

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I certify that a Thesis Examination Committee has met on 17th June 2013 to conduct the final examination of Noorliana binti Mohd Zan on her thesis entitled "**Growth, Physiological Responses, and Enzymatic Activities in Immature Stages of Five *Hevea brasiliensis* Willd Clones under Water Stress**" in accordance with the Universities and University Colleges 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 Master of Science.

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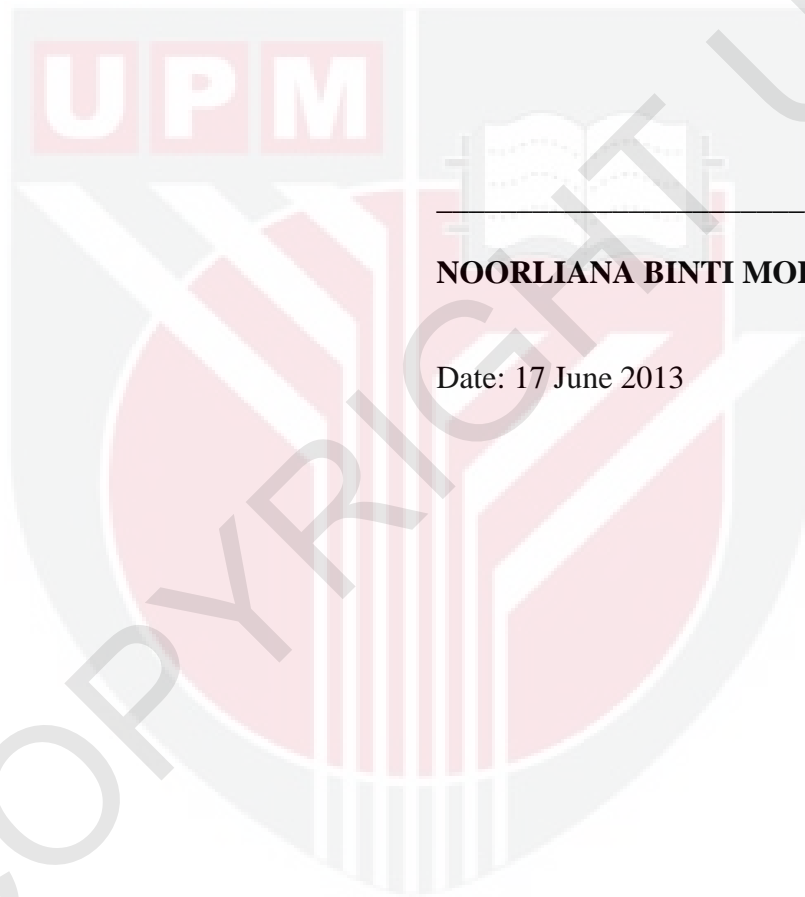
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DECLARATION

I declare that the thesis is my original work except for quotations and citations 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 at any other institution.



NOORLIANA BINTI MOHD ZAN

Date: 17 June 2013



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