UNIVERSITI PUTRA MALAYSIA

ULTRASONIC CHARACTERISATION OF OIL PALM TRUNK INFECTED BY *GANODERMA BONINENSE* DISEASE

MOHD KHAIRUL NAJMIE BIN MAMAT

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ULTRASONIC CHARACTERISATION OF OIL PALM TRUNK INFECTED BY *GANODERMA BONINENSE* DISEASE

By

MOHD KHAIRUL NAJMIE BIN MAMAT

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

April 2011

I dedicated this thesis to

My Parent, My Wife, My Son and Family Members

Whose prayers, support and love

Blessed my heart and sustained me in the years of life.

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

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Chairman : Professor Haji Kaida Khalid, PhD

Faculty : Science

The ultrasonic characteristics for oil palm trunk which have been infected by *Ganoderma boninense* disease has been studied by using the ultrasonic commercial equipment at frequency 54 kHz. Among the physical characteristics that identifiable in oil palm tree that infected by *Ganoderma boninense* disease was by appearance a mature *Ganoderma* basidiocarp at the stem, lower fronds of an oil palm tree were dead and fractured. An oil palm tree of 30 years old has been used in this study.

The measurement method used in this study was direct transmission method. The study of ultrasonic properties of oil palm trunk was infected with *Ganoderma boninense* disease were made in two stages; where in the first stage, measurement are made at standing oil palm tree and in the second stage; measurement was done in the cut trunk of stem centre to blocks size measuring $5 \times 10 \times 10$ cm^3. The number of samples used is 27 and consist of 3 sections namely: inner zone, central zone and peripheral zone.

Results for standing oil palm tree showed that the ultrasonic velocity in the infected with *Ganoderma boninense* disease sample is between 350 – 600 ms^{-1} while healthy trunk the velocity was exceeding 700 ms^{-1}.

Measurement on the sample cut found that the trunk density of the sample infected decreased as much as 50% of the healthy stem. Percentage of moisture contents the infected areas also higher than the healthy areas. This affects the ultrasonic velocity through radial direction, tangential direction, and longitudinal direction for infected by *Ganoderma boninense* disease area which was consistently lower than healthy stem area. For the 10 cm thickness samples, the ultrasonic velocity for all transit directions was in the range of 260 – 750 ms^{-1} for the infected sample whereas for healthy samples was in the range of 460 – 900 ms^{-1}.

While, result of elasticity constant for the infected sample was between 0.2 – 8.5 (10^8 Nm^{-2}) for all directions while the healthy area which was between 1.3 – 32.1 (10^8 Nm^{-2}) for all directions. These results are very useful for the detection and identification of the location which has been affected by the disease.

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

PENCIRIAN ULTRASONIK BATANG KELAPA SAWIT YANG DIJANGKITI PENYAKIT *GANODERMA BONINENSE*

Oleh

MOHD KHAIRUL NAJMIE BIN MAMAT

April 2011

Pengerusi : Professor Haji Kaida Khalid, PhD

Fakulti : Sains

Ciri-ciri ultrasonik untuk batang kelapa sawit yang dijangkiti oleh penyakit *Ganoderma boninense* telah dikaji dengan menggunakan alat ultrasonik komersial berfrekuensi 54 kHz. Antara ciri-ciri fizikal dikenalpasti pada pokok kelapa sawit yang dijangkiti penyakit *Ganoderma boninense* ialah dengan kemunculan basidiokarpa *Ganoderma* yang matang pada batang, manakala pelepahnya patah dan mati. Sebatang pokok kelapa sawit berusia 30 tahun telah digunakan dalam kajian ini.

Kaedah pengukuran yang digunakan dalam kajian adalah kaedah penghantaran terus. Proses pengukuran dibuat dalam dua peringkat; dimana peringkat pertama, pengukuran dibuat pada pokok yang hidup dan peringkat kedua; pengukuran pada batang kelapa sawit selepas ditebang dimana batang tersebut dipotong dalam bentuk blok bersaiz 5 ×

10×10 cm^3. Bilangan sampel yang digunakan sebanyak 27 sampel dan ditanda kepada tiga bahagian iaitu zon dalam, zon tengah dan zon periferi (pinggiran).

Keputusan pada pokok hidup menunjukkan halaju ultrasonik yang dijangkiti oleh penyakit *Ganoderma boninense* diantara 350 – 600 ms^{-1} berbanding pokok sihat melebihi 700 ms^{-1}.

Pengukuran untuk batang selepas ditebang didapati ketumpatan batang yang dijangkiti oleh penyakit *Ganoderma boninense* berkurangan sebanyak 50% berbanding dengan batang yang sihat. Peratusan kelengasan untuk batang yang dijangkiti juga lebih tinggi berbanding batang sihat. Dari kesan ini masa transit untuk gelombang ultrasonik merambat melalui arah jejarian, arah tangen, dan arah membujur lebih tinggi untuk kawasan dijangkiti penyakit *Ganoderma boninense* berbanding kawasan batang sihat. Untuk sampel ketebalan 10 cm, halaju ultrasonik untuk semua arah ialah kira-kira 260 – 750 ms^{-1} untuk batang dijangkiti oleh penyakit *Ganoderma boninense* manakala untuk sampel sihat ialah kira-kira 460 – 900 ms^{-1}.

Manakala keputusan pemalar kekenyalan pula menunjukkan bahawa kawasan yang dijangkiti penyakit *Ganoderma boninense* adalah di antara 0.2 – 8.5 (10^8 Nm^{-2}) setiap arah. Pemalar kekenyalan untuk kawasan yang sihat pula di antara 1.3 – 32.1 (10^8 Nm^{-2}) untuk setiap arah. Keputusan ini sangat berguna untuk pengesanan kawasan yang mana telah terjejas oleh penyakit itu.

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Appreciation also given to my colleagues and my senior, Mr Ashry Bin Jusoh and staff members in the Applied Microwave Lab, Mr Roslim, Mr Zulambiar from past and present, for their guidance, help and support.

I certify that a Thesis Examination Committee has met on 14 April 2011 to conduct the final examination of Mohd Khairul Najmie Bin Mamat on his thesis entitled "Ultrasonic Characterisation of Oil Palm Trunk Infected by *Ganoderma Boninense* Disease" 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 degree of Master of Science.

Members of the Thesis Examination Committee were as follows:

Azmi bin Zakaria, PhD
Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Mohd Maarof bin Hj Abd Moksin, PhD
Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Halimah binti Mohamed Kamari, PhD
Lecturer
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Ibrahim Abu Talib, PhD
Professor
Faculty of Science and Technology
Universiti Kebangsaan Malaysia
(External Examiner)

NORITAH OMAR, PhD
Associate Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 23 August 2011

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Haji Kaida Khalid, PhD
Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Haji Sidek Abdul Aziz, PhD
Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

Faridah Abdullah, PhD
Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

_____
HASANAH MOHD GHAZALI, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

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.

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MOHD KHAIRUL NAJMIE BIN MAMAT

Date: 14 April 2011

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