UNIVERSITI PUTRA MALAYSIA

EFFECTS OF ARBUSCULAR MYCORRHIZAL FUNGI AND *Trichoderma harzianum* ON GROWTH AND BASAL STEM ROT DISEASE SUPPRESSION IN OIL PALM

MOHD NAZIF SAIFUDDIN BIN ABD MALIK

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By

MOHD NAZIF SAIFUDDIN BIN ABD MALIK

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

March 2012

DEDICATIONS

اللهم صلى على محمد وعلى ال محمد

This thesis is dedicated to my beloved parents, sisters, family and friends.

&

Al-Fatihah to Allahyarhamah Professor Dr. Faridah Abdullah.....

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

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Chairman : Associate Professor Radziah Othman, PhD

Faculty : Science

The Malaysian oil palm industry is a major sector that plays an important role in supporting Malaysia's economy. This industry faced huge challenges to increase oil palm yields due to the limited land area for oil palm cultivation and the basal stem rot (BSR) disease that attacks oil palm. Chemical fertilizers and chemical fungicides have been used to overcome these problems, but the results have not been satisfactory. Thus, biological approaches using beneficial microorganism such as arbuscular mycorrhiza and *Trichoderma harzianum*, could be another alternative to complement the role of conventional fertilizers and fungicides. Arbuscular mycorrhiza (AM) and *T. harzianum* have been well known as plant growth enhancer and protector against diseases in various plant species. Therefore, both of these fungi were used in the present study to determine their effects on oil palm. The objectives of this study were: i) to compare the effects of AM and *T. harzianum* (isolate FA 1132) as single and mixed inoculums on oil palm growth in nursery trial, ii) to

compare the effects of AM and *T. harzianum* (isolate FA 1132) as single and mixed inoculums on growth of oil palms in the field, and iii) to compare the effects of AM and *T. harzianum* (isolate FA 1132) as single and mixed inoculums to suppress basal stem rot (BSR) disease in oil palm seedlings. Three different studies were conducted to fulfill these objectives. Experiment 1 was conducted in a nursery trial with seven treatments, which were single AM species (SAM), multiple AM species (MAM), *Trichoderma harzianum* (isolate FA 1132) infused-compost (TC), mixture of SAM with TC (SAM+TC), mixture of MAM with TC (MAM+TC), chemical fertilizers (F) and the control (C). Oil palm vegetative parameters were observed six times over 24 weeks. Leaf and soil samples were analyzed for chemical nutrients. Experiment 2 was conducted under field conditions at Mungka plantation, Segamat, Johore. There were five treatments, which were MAM, TC, MAM+TC, F and C. Vegetative growth parameters were observed every six weeks until week 30. Leaf and soil samples were also analyzed for chemical nutrients. Experiment 3, the disease resistance study, was conducted in a glasshouse with oil palms artificially infected with *Ganoderma boninense*. Seven treatments as in Experiment 1 were given after the artificial infection. *Trichoderma harzianum* (isolate FA 1132) infused-compost (TC) oil palms showed the best overall growth performance in Experiment 1. Oil palms receiving TC had the highest mean shoot dry weight (15.74 g), leaf area (1181.65 cm^2) and potassium (K) content (2.68 %). Oil palms receiving TC, SAM+TC and MAM+TC also had higher stem girth and frond numbers compared to other treatments. Higher chlorophyll a (2.51 mg g^{-1}), chlorophyll b (0.84 mg g^{-1}) and total chlorophyll (3.35 mg g^{-1}) were also recorded in TC treated oil palms. Application of TC also increased the mean pinnae number (15.30) better than in F and control oil palms. Oil palms treated with TC had higher nitrogen, N (3.79 %) and

phosphorus, P (0.14 %) contents. Overall, the performance of the treatments in decreasing order of growth performance in the nursery trial was TC > SAM+TC > MAM+TC > MAM > SAM > F > C. The results of the field trial (Experiment 2) were similar to Experiment 1, and TC treatments gave the best overall growth performance. Oil palms receiving the TC treatment had the best stem girth (80.2 cm), frond length (193.50 cm), pinnae number (112.3) and fruit bunch number (1.90). Higher frond numbers (20.3), chlorophyll a (3.70 mg g^{-1}), chlorophyll b (1.72 mg g^{-1}) and total chlorophyll (5.42 mg g^{-1}) contents were recorded in TC treated oil palms. The contents of N (3.12 %), P (0.26 %), K (2.39 %) and calcium, Ca (0.65 %) recorded were also higher in TC treated oil palms. Overall, the performance of the treatments in decreasing order of growth performance in the field trial was TC > MAM+TC > MAM > F > C. Results of Experiment 3 showed that BSR disease was reduced by 100.00 % in TC treated oil palms, while the reduction was 91.17 % in SAM+TC and MAM+TC oil palms. However, oil palms treated with MAM (50.00 %) and SAM (43.75 %) had higher percentage of disease severity compared to the oil palms treated with chemical fertilizers (33.30 %). Application of TC and the mixture of AM and TC showed satisfactory results in suppressing BSR disease in oil palms compared to AM inoculum alone. In conclusion, oil palms treated with *Trichoderma harzianum* (isolate FA 1132) showed the best growth performance both in the nursery and field trials. *Trichoderma harzianum* (isolate FA 1132) was also an effective antagonist against *Ganoderma boninense* that causes BSR disease in oil palm seedlings.

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

KESAN-KESAN KULAT MIKORIZA ARBUSKUL DAN *Trichoderma harzianum* TERHADAP PERTUMBUHAN DAN PENINDASAN PENYAKIT REPUT PANGKAL BATANG DALAM KELAPA SAWIT

Oleh

MOHD NAZIF SAIFUDDIN BIN ABD MALIK

Mac 2012

Pengerusi : Profesor Madya Radziah Othman, PhD

Fakulti : Sains

Industri kelapa sawit Malaysia merupakan sektor utama yang memainkan peranan penting dalam menyokong ekonomi Malaysia. Industri ini berhadapan cabaran besar untuk meningkatkan hasil kelapa sawit kerana kawasan tanah yang terhad bagi penanaman kelapa sawit dan penyakit reput pangkal batang (RPB) yang menyerang kelapa sawit. Baja kimia dan racun kulat kimia telah digunakan untuk mengatasi masalah-masalah ini, tetapi keputusannya tidak memuaskan. Oleh itu, pendekatan biologi menggunakan mikroorganisma bermanfaat seperti mikoriza arbuskul dan *Trichoderma harzianum*, boleh menjadi alternatif lain bagi melengkapkan peranan baja dan racun kulat konvesional. Mikoriza arbuskul (AM) dan *Trichoderma harzianum* telah dikenali sebagai peningkat pertumbuhan pokok dan pelindung terhadap penyakit dalam pelbagai spesies tumbuhan. Oleh itu, kedua-dua kulat ini telah digunakan dalam kajian ini untuk menentukan kesan-kesan mereka terhadap kelapa sawit. Objektif-objektif kajian ini adalah i) untuk membandingkan kesan-

kesan AM dan *T. harzianum* (isolat FA 1132) sebagai inokulum tunggal dan campuran terhadap pertumbuhan kelapa sawit dalam percubaan nurseri, ii) untuk membandingkan kesan-kesan AM dan *T. harzianum* (isolat FA 1132) sebagai inokulum tunggal dan campuran terhadap pertumbuhan kelapa sawit di lapangan, dan iii) untuk membandingkan kesan AM dan *T. harzianum* (isolat FA 1132) sebagai inokulum tunggal dan campuran untuk menindas penyakit reput pangkal batang (RPB) dalam anak pokok kelapa sawit. Tiga kajian berbeza telah dilaksanakan untuk memenuhi objektif-objektif ini. Eksperimen 1 telah dilaksanakan dalam percubaan nurseri dengan tujuh rawatan, iaitu satu spesies AM (SAM), pelbagai spesies AM (MAM), *Trichoderma harzianum* (isolat FA 1132) terapan-kompos (TC), campuran SAM dengan TC (SAM+TC), campuran MAM dengan TC (MAM+TC), baja kimia (F) dan kawalan (C). Parameter vegetatif kelapa sawit telah diperhatikan enam kali dalam 24 minggu. Sampel daun dan tanah telah dianalisis untuk nutrien kimia. Eksperimen 2 telah dilaksanakan di bawah kondisi lapangan di ladang Mungka, Segamat, Johor. Terdapat lima rawatan, iaitu MAM, TC, MAM+TC, F dan C. Parameter pertumbuhan vegetatif telah diperhatikan setiap enam minggu sehingga minggu ke-30. Sampel daun dan tanah telah juga dianalisis untuk nutrien kimia. Eksperimen 3, kajian rintangan penyakit, telah dilaksanakan di dalam sebuah rumah kaca dengan menjangkitkan kelapa sawit dengan *Ganoderma boninense* secara buatan. Tujuh rawatan seperti dalam eksperimen 1 telah diberikan selepas jangkitan secara buatan. Kelapa sawit *Trichoderma harzianum* (isolat FA 1132) terapan-kompos (TC) menunjukkan prestasi pertumbuhan keseluruhan yang terbaik dalam Eksperimen 1. Kelapa sawit yang menerima TC mempunyai min berat kering pucuk (15.74 g), luas daun (1181.65 cm^2) dan kandungan kalium, K (2.68 %) yang tertinggi. Kelapa sawit yang menerima TC, SAM+TC dan MAM+TC juga

mempunyai lilitan batang dan bilangan pelepah yang lebih tinggi berbanding dengan rawatan lain. Klorofil a (2.51 mg g^{-1}), klorofil b (0.84 mg g^{-1}), jumlah klorofil (3.35 mg g^{-1}) yang lebih tinggi juga telah direkodkan dalam kelapa sawit dirawat dengan TC. Aplikasi TC juga meningkatkan min bilangan pinnae (15.30) lebih baik daripada kelapa sawit F dan kawalan. Kelapa sawit yang dirawat dengan TC mempunyai kandungan nitrogen, N (3.79 %), dan fosforus, P (0.14 %) yang lebih tinggi. Secara keseluruhan, prestasi rawatan-rawatan dalam turutan menurun bagi prestasi pertumbuhan dalam percubaan nurseri adalah TC > SAM+TC > MAM+TC > MAM > SAM > F > C. Keputusan percubaan lapangan (Eksperimen 2) adalah sama dengan Eksperimen 1, dan rawatan TC memberikan prestasi pertumbuhan keseluruhan yang terbaik. Kelapa sawit yang menerima rawatan TC mempunyai lilitan batang (80.2 cm), panjang pelepah (193.50 cm), bilangan pinnae (112.3) dan bilangan tandan buah (1.90) yang terbaik. Bilangan pelepah (20.3), kandungan klorofil a (3.70 mg g^{-1}), klorofil b (1.72 mg g^{-1}) dan jumlah klorofil (5.42 mg g^{-1}) yang lebih tinggi dicatatkan dalam kelapa sawit dirawat dengan TC. Kandungan N (3.12 %), P (0.26 %), K (2.39 %) dan kalsium, Ca (0.65 %) yang direkodkan juga lebih tinggi dalam kelapa sawit dirawat dengan TC. Secara keseluruhan, prestasi rawatan-rawatan dalam turutan menurun bagi prestasi pertumbuhan dalam percubaan lapangan adalah TC > MAM+TC > MAM > F > C. Keputusan dalam Eksperimen 3 menunjukkan penyakit RPB telah dikurangkan sebanyak 100.00 % dalam kelapa sawit yang dirawat dengan TC, manakala pengurangan sebanyak 91.17 % dalam kelapa sawit SAM+TC dan MAM+TC. Walau bagaimanapun, kelapa sawit yang dirawat dengan MAM (50.00 %) dan SAM (43.75 %) mempunyai peratusan keparahan penyakit yang lebih tinggi berbanding kelapa sawit yang dirawat dengan baja kimia (33.30 %). Aplikasi TC dan campuran AM and TC telah menunjukkan keputusan memuaskan dalam menindas

penyakit RPB dalam kelapa sawit berbanding inokulasi AM sendirian. Kesimpulannya, kelapa sawit yang dirawat dengan *Trichoderma harzianum* (isolat FA 1132) telah menunjukkan prestasi pertumbuhan terbaik dalam kedua-dua percubaan nurseri dan lapangan. *Trichoderma harzianum* (isolat FA 1132) juga merupakan antagonis yang berkesan terhadap *G. boninense* yang menyebabkan penyakit RPB dalam anak pokok kelapa sawit.

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Thank you...!

I certify that a Thesis Examination Committee has met on 6th March 2012 to conduct the final examination of Mohd Nazif Saifuddin bin Abd Malik on his thesis entitled "Effects of Arbuscular Mycorrhizal Fungi and *Trichoderma harzianum* on Growth and Basal Stem Rot Disease Suppression in Oil Palm" 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.

Members of the Examination Committee were as follows:

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Date: 23 July 2012

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

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(Member)

_____
BUJANG BIN KIM HUAT, 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 NAZIF SAIFUDDIN BIN ABD MALIK

Date: 6th March 2012

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