UNIVERSITI PUTRA MALAYSIA

EFFECTS OF EMPTY FRUIT BUNCHES APPLICATION ON OIL PALM ROOT DISTRIBUTION, PROLIFERATION AND NUTRIENT UPTAKE

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FP 2008 20

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DOCTOR OF PHILOSOPHY

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2008

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by

LIEW VOON KHEONG

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

July 2008

Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for Doctor of Philosophy

EFFECTS OF EMPTY FRUIT BUNCHES APPLICATION ON OIL PALM ROOT DISTRIBUTION, PROLIFERATION AND NUTRIENT UPTAKE

By

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July 2008

Chairman : **Professor Zaharah Abdul Rahman, PhD**

Faculty : **Agriculture**

Fertilizer losses due to environmental factors and doubt about the amount of fertilizers applied actually taken up by the palm increases the cost of Fresh Fruit Bunch (FFB) production. This study investigates the use of Empty Fruit Bunch (EFB) to better manage oil palm roots so that more nutrients from the applied fertilizers are absorbed rather than lost to the environment. The investigation studied the impact of EFB alone and supplemented with 0kg (N0), 1.5kg (N1) and 3kg (N2) of ammonium sulphate (AS), 0kg (K0), 1.5kg (K1) and 3kg (K2) of muriate of potash (MOP), and 0kg (P0) and 1kg (P1) of Christmas Island Rock Phosphate (CIRP) on root proliferation and soil chemical properties. Application of EFB alone increases roots mass and an increased in P, K, Ca and Mg levels in the soil. However, application of EFB supplemented with fertilizer combinations of N2P1 suppresses root proliferation while fertilizers at

either N2 or P1 alone, encourage root proliferation when compared to control, N0P0. The study explored the importance of new roots in relation to older roots in absorbing nutrients. Isotopes ^{32}P or ^{86}Rb were used as tracers to study nutrient absorption by the roots. Results show that proliferation of new roots is important because the new roots, which are creamy white in color, were significantly ($p < 0.05$) more active in absorbing nutrients compared to older brown colored roots. The use of EFB with inorganic fertilizers to prolong root life span was also included in this study. Applying EFB with a supplement of AS and CIRP at 1.5kg/palm and 1kg/palm respectively, maintained root mass for a significantly longer period ($p < 0.05$) of six months compared to EFB with no fertilizer supplements. The impact of root loss on nutrient uptake was another aspect of this study. Roots were severed at 0, 25 and 50% of total root mass to simulate drought or other causes of root damage and the impact of such damage on nutrient uptake by the remaining living roots was determined. The rate of nutrient uptake by remaining surviving roots did not increase when 25 or 50% of roots were severed. However, removing 50% of root mass seems to impair the ability of the palm to produce more roots as indicated by the KN ratio in the frond. The KN ratio was significantly higher than control when 25% of roots were severed. The KN ratio was not significantly more ($p > 0.05$) than control when 50% of roots were severed suggesting the palms inability to adapt to the damage. The impact of increasing the amount of EFB applied was investigated. It was found that increasing the amount of EFB to more than 100kg/palm does not improve palm's nutritional status particularly when its nutrient status is already at optimum. This study shows that application of 100kg EFB/palm supplemented with 1.5 kg AS/palm (N1) and 1 kg CIRP/palm (P1) can be used to increase the amount of new roots and to maintain them for six months. This finding is of much importance because it shows how fertilizer application and the subsequent nutrient acquisition by oil palm roots can be improved.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk mendapat Ijazah Kedoktoran

KESAN APLIKASI TANDAN KOSONG PADA TABURAN,

PERTUMBUHAN DAN PENYERAPAN NUTRIEN

OLEH AKAR POKOK KELAPA SAWIT

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Kerugian baja akibat faktor persekitaran dan ketidakpastian tentang penyerapan baja daripada jumlah yang ditabur meningkatkan kos pengeluaran buah sawit FFB). Kajian ini menyelidik tentang penggunaan tandan kosong sawit (EFB) untuk pengurusan akar kelapa sawit yang lebih baik supaya baja yang ditabur banyak diserap daripada hilang ke persekitaran. Penyelidikan in mengkaji kesan kesan tandan kosong dan tandan kosong ditambah dengan 11kg (N0), 1.5kg (N1) dan 3kg (N2) ammonium sulfat (AS), 0kg (K0), 1.5kg (K1) dan 3kg (K2) muriate of potash (MOP), dan 0kg (P0) dan 1kg (P1) daripada batu fostat Christmas Island (CIRP) ke atas pengeluaran akar dan sifat kimia tanah dijalankan. Aplikasi tandan kosong meningkatkan jisim akar dan aras P,K, Ca dan

Mg dalam tanah. Aplikasi tandan kosong ditambah dengan kombinasi baja N2P1 merencatkan pengeluaran akar sementara baja N2 dan P1 sahaja menggalakkan pengeluaran akar berbanding dengan kawalan, N0P0. Penyelidikan ini juga mengkaji kepentingan akar baru berbanding dengan akar lama dalam penyerapan nutrien. Bahan isotop ^{32}P atau ^{86}Rb diguna untuk mengkaji cara penyerapan nutrien oleh akar. Kajian menunjukkan pembentukan akar baru yang berwarna putih susu adalah penting kerana ia secara signifikan ($p < 0.05$) lebih aktif dalam penyerapan nutrien berbanding dengan akar tua yang berwarna perang. Penyelidikan juga mengkaji kegunaan tandan kosong ditambahkan baja inorganik dalam memanjangkan jangka hayat akar. Penggunaan tandan kosong ditambah dengan AS dan CIRP pada aras N1 dan P1 masing-masing secara signifikan ($p < 0.05$) dapat mengekalkan jisim akar untuk masa yang lebih panjang selama 6 bulan berbanding dengan tanpa baja tambahan. Kesan kerosakan akar terhadap penyerapan nutrien juga dikaji. Akar dipangkas pada 0%, 25% dan 50% daripada jumlah jisim untuk simulasi kekontangan dan kerosakan akar atas sebab lain dan kesan kerosakan ini terhadap penyerapan nutrien oleh akar-akar yang masih hidup juga ditentukan. Kadar penyerapan nutrien oleh akar lain tidak bertambah dengan pangkasan 25% atau 50%. Akan tetapi pangkasan 50% daripada jisim akar melemahkan kebolehan pokok untuk mengeluarkan lebih banyak akar seperti yang ditunjukkan oleh nisbah nutrien KN dalam pelepah sawit. Nisbah KN dalam pelepah secara signifikan lebih tinggi daripada kawalan apabila 25% akar dipangkas. Nisbah KN ini tidak signifikan ($p > 0.05$) daripada kawalan apabila 50% akar dipangkas mencadangkan bahawa pokok tidak dapat menyesuaikan diri hasil kerosakan ini. Kesan menambahkan jumlah tandan kosong terhadap tahap nutrien juga dikaji. Peningkatan amaun tandan kosong kepada 100g/pokok tidak meningkatkan tahap nutrien pokok terutama sekali apabila paras nutriennya telah mencapai paras optima. Kajian ini menunjukkan penggunaan 100kg EFB/pokok ditambah dengan 1.5kg AS/pokok (N1) dan 1kg CIRP/pokok (P1) boleh digunakan untuk meningkatkan jumlah akar dan untuk mengekalkan mereka untuk 6 bulan. Dapatan kajian ini penting kerana ia menunjukkan bagaimana aplikasi baja dan kesannya terhadap penyerapan nutrien oleh akar sawit boleh diperbaiki.

ACKNOWLEDGEMENTS

Working on this project was an exciting journey with its challenges and discoveries. I would like to thank Professor Dr. Zaharah Abdul Rahman, Professor Dr. Hanafi Musa and Professor Madya Dr. Aminuddin Husin for their support and guidance in conducting this study. A big thank you goes to my wife, Kooi Lai Ping, and both my children, Liew Li Wei and Liew Tien Qing, for their support, patience and understanding. My deep appreciation goes to Puan Zabedah for her encouragement, help and support in carrying out a number of experiments involving isotopes. I would like to thank the estate manager, En. Azhaza, who provided valuable assistance and logistical support. A big thank you to En. Sharuddin, Mr. Subramaniam and Mr. Mani from the Oil Palm Research Department who did much of the 'digging'. Much thanks also to Encik Shaiful Affandi Musa, Cik Juliawati bt Abdullah, Cik. Ruhidawati and Mr. Jeevananthan from Extension Services for their support in many of the tedious lab and field work. I gratefully acknowledge Kumpulan Guthrie Bhd. for allowing me the time and opportunity to complete this study.

I certify that an Examination Committee has met on the 22 July 2008 to conduct the final examination of Liew Voon Kheong on his Doctor of Philosophy thesis entitled “Effects of Empty Fruit Bunches Application on Oil Palm Root Distribution, Proliferation and Nutrient Uptake” in accordance with Universiti Pertanian Malaysia (Higher Degree) Regulations 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the Doctor of Philosophy.

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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.

Liew Voon Kheong

Date: 24 September 2008

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LIST OF ABBREVIATION

AS	Ammonium Sulphate
AAS	Atomic absorption spectrometer
BSR	Basal stem rot
Cec	Cation exchange capacity
CIRP	Christmas Island Rock Phosphate
Cpm	Counts per minute
EFB	Empty fruit bunch
FFB	Fresh fruit bunch
IAEA	International Atomic and Energy Agency
MINT	Malaysian Institute for Nuclear Technology
MOP	Muriate of Potash
SAS	Statistical Analytical System

CHAPTER 1

INTRODUCTION

There are fundamental reasons why oils from the mesocarp and kernel extracted from oil palm became an important commodity. On a per hectare basis, the oil palm produces more oil than any other oil seed crops (Corley and Tinker, 2003). The palm is also less susceptible to pests and diseases compared to other perennial tree crops, such as rubber, cocoa or fruit trees. In addition, intensive research has developed numerous ways and means for the oils and the tree itself to be utilized to form many end products. With so many positive attributes, the potential of the oil palm as a source of vegetable oils and lately as biodiesel became known throughout the world. This led to more and more land being planted with the palm. Given such advantages, the oil palm is now the main perennial crop for Malaysia.

Unfortunately, the large area planted with oil palm included marginal land, i.e. areas where the soil or terrain is less suitable for oil palm cultivation. This led to stagnating fresh fruit bunch (FFB) and oil production. Such situation has occurred over the last 20 years with the national average oil per hectare stagnating at about 3.6 tons/hectare (Tinker, 2000).

To overcome this stagnated production, much effort was spent on fertilizer research. Despite all efforts in this area of research, the effectiveness of fertilizer in raising yield was still not satisfactory. One