



**UNIVERSITI PUTRA MALAYSIA**

**EFFECTS OF EMPTY FRUIT BUNCH COMPOST AND ARBUSCULAR  
MYCORRHIZA ON NUTRIENT UPTAKE AND GROWTH OF GRAIN  
MAIZE**

**NORAINI MD JAAFAR**

**FP 2007 30**



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MAIZE**

**By**

**NORAINI MD JAAFAR**

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

**October 2007**



## DEDICATION

**To my beloved father and mother**

***Tn. Haji Md Jaafar @ Ahmad Jaafar Hj Din***

***Pn. Hajjah Azima Abdul Aziz***

**To my dearest husband and daughter**

***Mohd Hanafiah Bin Omar***

***Ainin Sofiya Bt Mohd Hanafiah***

**To dearly missed my late grandmother,**

***Mariam Bt Abdullah @ Koong Gooi Too***

**To my mother in law and my family**



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

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**October 2007**

**Chairman : Associate Professor Radziah Othman, PhD**

**Faculty : Agriculture**

The current interest in reducing the application of chemical fertilizer and increasing demand for combined effects of beneficial fungi and organic compost can have great impact on crop production and sustainable agriculture. Laboratory and glasshouse experiments were conducted to determine the effects of different rates of empty fruit bunch (EFB) compost and arbuscular mycorrhizal (AM) activity on plant growth, nutrient uptake, soil chemical and microbiological properties. An incubation experiment was conducted under laboratory condition to determine the effects of different rate of empty fruit bunch compost (EFBC) on nutrient release, changes in soil chemical properties and microbial population. Unsterilized Serdang series soil was amended with 0, 2.5 and 7.5% EFBC and soil was sampled at 3, 7, 14, 28, 56 and 84 day. Results showed that increasing rate of EFBC had significantly ( $P < 0.05$ ) improved the soil chemical properties in which higher soil pH, total N, ammonium-N and nitrate-N, soil available P, C, K, Ca and Mg was found in soil amended with



7.5% EFBC. Higher rate of EFB significantly ( $P < 0.05$ ) resulted in higher populations of soil fungi, bacteria and actinomycetes. This study indicated that addition of EFBC to soil may be an alternative method in improving the nutrients availability in highly weathered soils such as Serdang series soil. Applying EFBC as organic amendment in highly weathered soils, however, may require addition of effective or beneficial microorganisms such as AM to fully benefit the soil.

A glasshouse experiment was then conducted to assess the effects of combined application of EFBC and AM on the performance of AM in improving growth of grain maize and soil properties. Soil was treated with 3 rates of EFBC (0, 2.5 and 7.5% EFBC) with and without AM. Plants and soil were sampled at 7, 14, 28 and 56 days after planting (DAP) and analyzed for plant growth, nutrient uptake, soil chemical and microbiological properties. Growth of grain maize was significantly ( $P < 0.05$ ) affected by EFBC and AM application. Plants inoculated with AM were able to absorb more nutrients released from EFBC than the nonmycorrhizal plants. Mycorrhizal plants also showed lower requirement of EFBC than nonmycorrhizal plants. Application of 2.5% EFBC with AM gave better ( $P < 0.05$ ) shoot maize biomass and root biomass than nonmycorrhizal plants. After 56 DAP, AM inoculation increase in maize plant biomass by 60% compared to plants without AM. Inoculation with AM and application of EFBC also increased the uptake of N, P, K, Ca and Mg by maize. Application of EFBC stimulated AM development throughout 56 DAP.



There was 60% spore production in soils with EFBC than the control soil. Application of EFBC also improved soil nutrients and enhanced microbial activities which may induce the mycorrhizal symbiosis with plant roots. This can be observed in increasing mycorrhizal spore production with increasing EFBC rate. However, the highest root infections in 7.5% EFBC+M was observed to be insignificantly ( $P>0.05$ ) different to that in 2.5% EFBC+M and did not result in the highest plant growth. Lower rate of EFBC (2.5% EFBC) having intermediate values of AM spores production (300 spores  $10\text{ g soil}^{-1}$ ) and percentage of infection (69.68%) promoted highest plant growth at 56 DAP. Application of 2.5% EFBC was sufficient for mycorrhizal plants to attain the highest growth compared to the highest EFBC application rate of 7.5% EFBC required by nonmycorrhizal plants. The results suggest that lower compost rate was sufficient to stimulate plant growth when AM is being inoculated into soil. Inoculation of beneficial AM helps to reduce the optimum rate of compost application and the production cost. The study also showed that combined application of AM and EFBC have the potential to be applied for improved maize production in highly weathered soil.





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

**KESAN KOMPOS TANDAN BUAH KOSONG DAN MIKORIZA ARBUSKUL  
TERHADAP PENGAMBILAN NUTRIEN DAN PERTUMBUHAN JAGUNG  
BIJIRIN**

Oleh

**NORAINI MD JAAFAR**

**Oktober 2007**

**Pengerusi : Profesor Madya Radziah Othman, PhD**

**Fakulti : Pertanian**

Minat masa kini dalam mengurangkan penggunaan racun kimia dan permintaan meningkat untuk gabungan kesan kulat berguna dan kompos organik boleh memberi kesan pada pengeluaran tanaman dan pertanian lestari. Kajian makmal dan rumah kaca telah dijalankan untuk mengenalpasti kesan-kesan kadar kompos tandan buah kosong (KTBK) yang berbeza serta aktiviti mikoriza arbuskul (MA) terhadap pertumbuhan pokok, pengambilan nutrien, sifat kimia dan mikrobiologi tanah. Kajian pengeraman dijalankan dalam keadaan makmal untuk mengenalpasti kesan kadar KTBK terhadap pembebasan nutrien perubahan kimia dan populasi mikrob tanah. Tanah siri Serdang yang tidak disteril digaulkan dengan 0%, 2.5% dan 7.5% KTBK dan tanah disampel pada hari ke-3, 7, 14, 28, 56 dan 84. Keputusan mendapati peningkatan kadar KTBK memperbaiki ( $P < 0.05$ ) keadaan kimia tanah di mana nilai pH tanah, nitrogen, ammonium-N, nitrat-N, fosforus, karbon, K, Ca serta Mg tanah



yang lebih tinggi dijumpai dalam tanah yang digaulkan dengan 7.5% KTBK. Peningkatan paras KTBK juga meningkatkan populasi kulat, bakteria dan aktinomisit dalam tanah. Kajian ini mendapati penambahan KTBK kepada tanah mungkin merupakan kaedah alternatif dalam memperbaiki kedapatan nutrien dalam tanah terluluhawa seperti tanah Siri Serdang. Bagaimanapun, penambahan KTBK kepada tanah tinggi luluhawa mungkin memerlukan penambahan mikroorganisma berkesan atau berguna seperti MA untuk memberi manfaat sepenuhnya pada tanah.

Kajian rumah kaca dijalankan untuk mengenalpasti kesan-kesan kombinasi KTBK dan kulat MA terhadap keupayaan MA dalam meningkatkan pertumbuhan pokok dan sifat tanah. Tanah dirawat dengan 3 kadar KTBK (0%, 2.5% dan 7.5% KTBK), dengan MA atau tanpa inokulasi MA. Pokok jagung dan tanah disampel pada 7, 14, 28 dan 56 hari selepas ditanam (HST) dan dianalisa untuk pertumbuhan pokok, pengambilan nutrien, sifat kimia dan mikrobiologi tanah. Pertumbuhan pokok jagung dipengaruhi secara beerti ( $P < 0.05$ ) oleh aplikasi KTBK dan MA. Pokok yang diinokulasi dengan MA dapat menyerap lebih nutrien yang dibebaskan dari KTBK berbanding pokok tidak bermikoriza. Pokok bermikoriza juga menunjukkan keperluan KTBK yang lebih rendah berbanding pokok tanpa mikroriza. Aplikasi 2.5% KTBK dan AM memberikan nilai tertinggi biomas bahagian atas dan akar pokok jagung yang lebih baik berbanding pokok tidak bermikoriza. Selepas 56 hari ditanam, inokulasi MA meningkatkan 60% biomas pokok jagung berbanding pokok

tanpa MA. Inokulasi MA dan aplikasi KTBK turut meningkatkan pengambilan nutrisi N, P, K, Ca dan Mg oleh pokok jagung. Aplikasi KTBK merangsang pertumbuhan MA sepanjang 56 HST. Terdapat 60% penghasilan spora di dalam tanah mengandung KTBK berbanding kawalan. Aplikasi KTBK juga memperbaiki nutrisi tanah dan meningkatkan aktiviti mikroba tanah yang mungkin mendorong simbiosis mikoriza dengan akar pokok. Ini dapat dilihat dalam peningkatan pengeluaran spora kulat mikoriza dengan peningkatan kadar KTBK. Bagaimanapun, jangkitan pada kadar yang tertinggi dalam 7.5% KTBK+M didapati tidak berbeza secara beerti ( $P > 0.05$ ) dengan yang terdapat pada 2.5% KTBK+M serta tidak memberikan pertumbuhan pokok tertinggi. Kadar KTBK yang lebih rendah (2.5% KTBK) yang mempunyai nilai sederhana dalam penghasilan spora MA (300 spora 10 g tanah<sup>-1</sup>) dan peratus jangkitan (69.68%) memberikan pertumbuhan pokok tertinggi pada 56 HST. Aplikasi 2.5% KTBK adalah mencukupi untuk tumbuhan bermikoriza mencapai pertumbuhan tertinggi berbanding kadar KTBK yang lebih tinggi (7.5% KTBK) yang diperlukan oleh pokok tanpa mikoriza. Kajian menunjukkan yang kadar kompos yang lebih rendah adalah mencukupi untuk merangsang pertumbuhan pokok apabila MA diinokulasi pada tanah. Inokulasi kulat berguna MA menolong mengurangkan kadar optimum kompos yang diberikan dan kos pengeluaran. Kajian juga mendapati kombinasi KTBK dan MA mempunyai potensi diaplikasikan pada tanah untuk meningkatkan pengeluaran tanaman jagung pada tanah yang tinggi luluhawa.

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I certify that an Examination committee has met on 4<sup>th</sup> October 2007 to conduct the final examination of Noraini Md Jaafar on her Master of Science thesis entitled “Effects of Empty Fruit Bunch Compost and Arbuscular Mycorrhiza on Nutrient Uptake and Growth of Grain Maize” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the Master of Science.

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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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Date: 21 February 2008



## 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 degree at Universiti Putra Malaysia or at any other institution.

---

**NORAINI MD JAAFAR**

Date: 7 January 2008





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**LIST OF ABBREVIATIONS**

ALP	Alkaline Phosphatase
AM	Arbuscular Mycorrhiza
AMF	Arbuscular Mycorrhiza Fungi
ANOVA	Analysis of Variance
CEC	Cation Exchange Capacity
Cfu	Colony Forming unit
C:N	Carbon to Nitrogen ratio
CRD	Completely Randomized Design
DOA	Department of Agriculture
DRMT	Duncan's Multiple Range Test
ECEC	Effective cation exchange capacity
EFB	Empty Fruit Bunches
EFBC	Empty Fruit Bunch Compost
FFB	Fresh Fruit Bunches
MARDI	Malaysian Agriculture Research and Development Institute
MINT	Malaysian Institute of Nuclear Technology
MPOB	Malaysian Palm Oil Board
POME	Palm Oil Mill Effluent
R:S	Root to Shoot ratio
SAS	Statistical Analysis System