UNIVERSITI PUTRA MALAYSIA

EFFECTS OF SUGAR CANE FILTER CAKE COMPOST ON SELECTED CHARACTERISTICS OF BRIS SOILS AND GROWTH OF MAIZE

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By

YOSSIF SALAMA MOHAMED OMAR

Thesis submitted to the school of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

July 2009

DEDICATION

To

My LOVELY WIFE

AND

DAUGHTERS

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

EFFECTS OF SUGAR CANE FILTER CAKE COMPOST ON SELECTED CHARACTERISTICS OF BRIS SOILS AND GROWTH OF MAIZE

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July 2009

Chairman: Anuar Abd Rahim, PhD

Faculty: Agriculture

Beach Ridges Interspersed with Swales (BRIS) soil usually poses a great challenge for water and nutrients management due to the relatively low water holding and nutrient retention capacities. Besides, high hydraulic conductivity, such soils can also contribute to high leaching. Addition of organic wastes to BRIS soil has beneficial effects upon soil structure and properties related to it. Incubation study and field lysimeter experiments were conducted to investigate the effect of sugar cane filter cake compost on selected physical, chemical and biological properties of BRIS soil and its effect on growth and yield of maize. In both incubation and field experiments, the BRIS soil was amended with 0, 3, 6, 8, 12 tonnes ha^{-1} of filter cake compost, arranged in completely randomized and lattice square designs, respectively.

The amounts of OC, N, P, K, Ca and Mg in filter cake compost were 13.60%, 1.10%, 1.00%, 0.20%, 7.00%, 0.80%, respectively. The incubation study showed that the release of different nutrients varied according to treatments and the mean range of nutrients released at the end of incubation period were; 0.012-0.035 % N, 0.42-0.55 % OC, 33.80-60.20 ppm NO^-_3, 20.40-66.97 ppm NH_4^+ , 0.06-3.19 cmol kg^{-1} Ca and 0.03-0.08 cmol kg^{-1} Mg. Addition of 12 ton ha^{-1} of the filter cake compost significantly increased the total N and NH_4^+contents of the soil compared with unamended control. The soil OC content responded as $y = 0.42+0.01x$ ($P = 0.036$, $R^2 = 0.96$). The soil OC showed linear increase with increasing rates of filter cake compost. Field study conducted for two consecutive seasons showed that the addition of the filter cake compost yielded no significant impact on the soil pH for the first season, but in the second season a significantly higher soil pH was obtained with addition of 12 t ha^{-1} of filter cake compost compared to the control and 3 t ha^{-1} treatments. Soil pH responded as quadratic relationship where $y = 7.13 + 0.19x - 0.008x^2$ ($P = 0.0144$, R^2=0.99). The available soil water responded as $y = 2.08 - 0.17x + 0.03x^2$ ($P = 0.00436$, $R^2 = 0.96$) in the first season and $y = 2.5+ 0.12x$ ($P = 0.0254$, $R^2 = 0.85$) in the second season. In the first season, soil N responded as linear relationship, where $y = 0.022 +0.004x$ ($P=0.0449$, R^2=0.78) up to 12 t ha^{-1}, while in the second season, it responded as linear relationship, where $y = 0.04 + 0.0003x$ ($P=0.0452$, R^2=0.78) with the increment rate of filter cake compost up to 12 t ha^{-1}. The soil Ca responded as $y = 0.013 + 0.03x – 0.001x^2$ ($P = 0.0148$, $R^2 = 0.98$) and $y = 0.04 x – 0.002x^2$ ($P = 0.0009$, $R^2 = 0.99$) during first and second season, respectively. Maximum Ca content was attained at 0.13 cmol kg^{-1} in the first season and 0.21 cmol kg^{-1} for season two due to filter cake compost rates at 10.50 and 10 t ha^{-1}, respectively. There was no significant increase in microbial activity due to low fresh carbon sources in the compost. Although applying filter cake compost increases the physical and chemical condition of BRIS soil, further investigation on the economic implication of such organic amendment should be conducted.

Keywords: Sugar canes filter cake compost, sandy soils, soil amendment, and plant growth.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia bagi memenuhi keperluan untuk Ijazah Master Sains.

KESAN KOMPOS SISA TEBU TERHADAP CIRI-CIRI TERPILIH TANAH BRIS DAN PERTUMBUHAN JAGUNG

Oleh

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Tanah BRIS (Beach Ridges Interspersed with Swale) menghadapi cabaran yang besar dalam pengurusan air dan nutrien disebabkan oleh daya pegangan air dan penyimpanan nutrient yang lemah. Selain daripada itu daya hidrolik yang tinggi juga menyumbang kepada jumlah larut lesap yang tinggi. Penambahan sisa organik ke atas tanah pasir memberikan kesan yang baik ke atas struktur dan ciri-ciri tanah. Kajian pengeraman dan eksperimen lysimeter di ladang dijalankan bagi mengetahui kesan kompos sisa gula tebu (Sugar Cane Filter Cake Compost, FCC) terhadap ciri-ciri fizik, kimia dan biologi terpilih tanah BRIS dan kesannya terhadap pertumbuhan dan hasil jagung. Pada kedua-dua eksperimen, lapangan dan lysimeter tanah BRIS telah ditambah dengan 0, 3, 6, 8

dan 12 tan ha^{-1} FCC, masing-masing disusun dalam rekabentuk rawak lengkap dan segiempat latin. Jumlah karbon organik (OC), N, P, K, Ca dan Mg yang terkandung dalam FCC adalah masing-masing 13.60%, 1.10%, 1.00%, 0.20%, 7.00% dan 0.80%. Kajian pengeraman menunjukkan pembebasan nutrien yang berbeza mengikut rawatan dan julat min bagi setiap nutrien yang terbebas di akhir tempoh pengeraman adalah; 0.012-0.035 % N, 0.42-0.55 % karbon organik (OC), 33.80-60.20 ppm NO^-_3, 20.40-66.97 ppm NH_4^+, 0.06-3.19 cmol kg^{-1} Ca dan 0.03-0.08 cmol kg^{-1} Mg. Penambahan sebanyak 12 tan ha^{-1} kompos menunjukkan peningkatan bererti terhadap kandungan total N and NH_4^+ dalam tanah berbanding dengan tanpa rawatan. Kandungan karbon organik tanah menunjukkan hubungan, $y = 0.42+0.01x$ ($P = 0.036$, $R^2 = 0.96$). Karbon organik tanah menunjukkan peningkatan linear dengan peningkatan kadar FCC. Kajian lapangan yang dijalankan pada dua musim berturut-turut menunjukkan penambahan FCC tidak memberikan impak yang bererti terhadap pH tanah pada musim yang pertama, tetapi pada musim yang kedua pH tanah menunjukkan peningkatan yang bererti dengan penambahan 12 tan ha^{-1} FCC berbanding kawalan dan 3 tan ha^{-1} rawatan. pH tanah menunjukkan hubungan kuadratik di mana $y = 7.13 + 0.19x – 0.008x^2$ ($P = 0.0144$, $R^2 = 0.99$). Air tanah tersedia menunjukkan interaksi sebagai $y = 2.08 – 0.17x + 0.03x^2$ ($P = 0.00436$, $R^2 = 0.96$) pada musim pertama dan $y = 2.5 + 0.12x$ ($P = 0.0254$, $R^2 = 0.85$) pada musim kedua. Pada musim pertama, N dalam tanah bertindakbalas secara linear, dimana $y = 0.022 + 0.004x$ ($P = 0.0449$, $R^2 = 0.78$) sehingga 12 tan ha^{-1}, manakala pada musim kedua, ia menunjukkan hubungan linear dimana $y = 0.04 + 0.0003x$ ($P = 0.0452$, $R^2 = 0.78$) dengan peningkatan kadar FCC sehingga 12 tan ha^{-1}. Ca dalam tanah bertindakbalas sebagai $y = 0.013 + 0.03x – 0.001x^2$ ($P = 0.0148$, $R^2 = 0.98$) dan $y = 0.04x – 0.002x^2$ ($P = 0.0009$, $R^2 = 0.99$) masing-masing pada musim pertama

dan kedua. Kandungan Ca yang maksimum didapati pada 0.13 cmol kg^{-1} pada musim pertama dan 0.21 cmol kg^{-1} untuk musim kedua masing-masing pada kadar FCC 10.5 dan 10 tan ha^{-1}. Tiada peningkatan bererti terhadap aktiviti mikrobial berpunca pada sumber karbon yang rendah dalam kompos. Walaupun penambahan FCC meningkatkan ciri-ciri fizik dan kimia pada tanah BRIS, penyelidikan lanjut ke atas implikasi ekonomi terhadap penambahan bahan organik perlu dijalankan.

Kata kunci: Kompos sisa tebu, tanah pasir, bahan pembaikan tanah dan pertumbuhan pokok.

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I certify that an Examination Committee has met on 1st July 2009 to conduct the final examination of Yossif Salama Mohamed Omar on his master thesis entitled "Effects of Sugar Cane Filter Cake compost on selected characteristics of Bris Soils Growth Of Maize " in accordance with Unversities and Unversitity Colleges Act 1971 and the Constitution of the Unversiti Pertanian Malaysia[P.U.(A) 106] 15 March 1998. The committee recommends that the student 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 fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date: 11 September 2009

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 Unversiti Putra Malaysia or at any other institution.

(Signature)

YOSSIF SALAM MOHAMED OMAR

Date: 23 July 2009

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
$ASWC^1$	Available soil water content in first season
$ASWC^2$	Available soil water content in second season
BD^1	Bulk density in first season
BD^2	Bulk density in second season
BRIS	Beach ridges interspersed with swales
C:N	Carbon nitrogen ratio
Ca^L	Calcium in the leaves
Ca^s	Calcium in the soil
CEC	Cation exchange capacity
CEC^1 (cmol(+)kg^{-1}	Soil Cation exchange capacity in the first season
CEC^2 cmol(+)kg^{-1}	Soil Cation exchange capacity in the second season
CRD	Complete Randomized Design
EFB	Empty fruit bunches
FCC	Compost sugarcane filter cake
Fe^L	Iron in the leaves
Fe^s	Iron in the soil
K^L	Potassium in the leaves
K^S	Potassium in the soil
MARDI	Malaysian Agricultural Research and Development Institute
Mg^L	Magnesium in the leaves
Mg^s	Magnesium in the soil

N^L	Nitrogen in the leaves
N^S	Nitrogen in the soil
ns	Not significant at ($p<0.05$) probability level
OM	organic material
pH^1	Soil pH in the first season
pH^2	Soil pH in the second season
P^L	Phosphorus in the leaves
P^S	Phosphorus in the soil
POME	Palm oil mill effluent
SOM	Soil organic material
UiTM	Universiti Teknologi Mara
UPM	Universiti Putra Malaysia
WRB	World reference base

CHAPTER 1

INTRODUCTION

1.1 Background

Sandy soils are characterized by less than 18% clay and more than 65% sand in the first 100 cm of the solum (ISSS Working Group, 1998). Sandy soils are weakly developed soils with only weak profile horizon formation because of the slow chemical weathering in these normally dry and hot soils. Physical weathering predominates in response to extreme variations in temperature. The absence of vegetation cover results in an extremely low production of organic material which leads to the very low organic matter contents.

One of the primary interests of agriculturalists is the use of soil as a medium for plant production. Many crop management decisions are aimed at improving the soil to maximize production of food and fiber. Beach Ridges Interspersed with Swales (BRIS) soils, which are types of sandy soils usually pose particular challenge to water and nutrient management due to low water and nutrient retention capacity. High hydraulic conductivity also leads to loss of water beyond rooting zone of plant. Sandy soils require lots of irrigation water and fertilizers (Pathan *et al.*, 2003).