UNIVERSITI PUTRA MALAYSIA

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Nutrient recycling has been seen as a viable way to return nutrient both to the soil and plant. Recycling of organic wastes such as plant residues reduces the amount of wastes that enter the landfills. Vermicomposting has been widely accepted as an efficient, rapid and cost effective way in managing organic waste. The current study investigated the efficiency of earthworms *Eudrilus eugeniae* and *Perionyx excavatus* in vermicomposting rice straw. Vermicompost derived by *P. excavatus* was found to contain higher concentrations of total N, P, K and Mg. Available P, K and Mg was also higher in *P. excavatus* vermicompost. However *E. eugeniae* vermicompost was found to contain higher total and available Ca. Humic acid content was also found to be higher in *E. eugeniae* vermicompost. The experiment showed *E. eugeniae* took 134 days while *P. excavatus* took 171 days to complete vermicomposting. Though *Perionyx excavatus* vermicompost contains higher total and available plant nutrient, the rate of vermicompost generation by this species was relatively low compared to *E. eugeniae*. Subsequent experiment was conducted by comparing plant nutrient

availabilities and humic acids content in vermicompost generated from different plant residues; grass clippings (GC), sago waste (SW) and rice straw (RS) using *E. eugeniae* as vermicomposting agent. Total P was lower in vermicomposts as compared to the controls, however, highest extractable P was found in RS vermicompost (0.33 ± 0.00 g/kg). SW vermicompost contained highest total Ca (22.79 ± 0.01 g/kg) compared to the GC (1.39 ± 0.01 g/kg) and RS (8.22 ± 0.06 g/kg) vermicompost. Significant positive correlations between nutrient contents in raw plant residues and vermicompost were observed for total N (r = 0.779), K (r = 0.998) and Ca (r = 0.997). The study showed that nutrient in initial wastes material affects the nutrient contents of vermicompost. This suggests that among the plant residues studied, vermicomposting of rice straw produced vermicompost with the highest plant extractable nutrient contents. The effect of storage on the enzymatic action and microbial activity in the vermicompost was also determined. RS vermicompost was stored for 6 months and samples were taken every month to analyse the microbial and enzymatic activity in the vermicompost. Microbial and enzyme activities (protease and phosphatase) in vermicompost were found to be relatively active indicating that application of vermicompost after 6 months post harvest may still stimulate N and P nutrient cycling in agricultural land. RS vermicompost was found to contain high amount of plant extractable nutrients which could be easily taken up by plants. Nevertheless when compared to inorganic fertilizers the nutrient content in vermicompost is still relatively lower. Therefore, an attempt was made to further improve the extractable nutrient in RS vermicompost by adding rock phosphate (RP) during vermicomposting. The extractable P was 24% higher in vermicompost with the addition of rock phosphate. In addition, extractable macronutrients N and K were found to be significantly higher in the final product of vermicomposting with the

addition of rock phosphate. The research studied the various aspects that influence the quality of vermicompost. Based on the results obtained, an improvement in the macronutrient content in vermicompost has also successfully achieved. As an overall, the evidences raised for the current study proved that vermicomposting can be a viable technology in recycling organic wastes such as rice straw in Malaysia. This will benefit the farmers economically and contribute significantly in reducing open burning activity, thus creating a cleaner environment.

Abstrak thesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

AKTIVITI ENZIM DAN PENAMBAHANBAIKAN KANDUNGAN NUTRIEN TUMBUHAN DALAM VERMI KOMPOS

Oleh

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Kitaran semula nutrien dilihat berkesan untuk mengembalikan nutrien ke dalam tanah dan tumbuhan. Penggunaan semula sisa organik seperti sisa tumbuhan dapat mengurangkan jumlah bahan buangan ke tapak pelupusan. Pengkomposan-vermi (pengkomposan dengan menggunakan cacing tanah) telah diterima sebagai cara yang efisien, pantas dan murah dalam pengurusan sisa organik. Kajian ini telah dilakukan untuk menilai keberkesanan cacing tanah *Eudrilus eugeniae* dan *Perionyx excavatus* dalam pengkomposan-vermi jerami padi. Vermikompos yang dihasilkan oleh *P. excavatus* menunjukkan komposisi nutrien N, P, K dan Mg yang lebih tinggi. Ia juga mengandungi P, K dan Mg tersedia dalam kepekatan yang lebih tinggi. Tetapi, vermikompos *E. eugeniae* menunjukkan komposisi Ca, Ca tersedia dan asid humik dalam kepekatan yang lebih tinggi. Kajian juga menunjukkan *E. eugeniae* mengambil masa 134 hari bagi melengkapkan proses pengkomposan jerami padi manakala *P. excavatus* pula mengambil 171 hari. Walaupun vermikompos *P.*

excavatus menunjukkan kepekatan nutrien yang lebih tinggi namun, peratus penjanaan vermikompos oleh spesies ini adalah lebih rendah berbanding dengan vermikompos *E. eugeniae.* Seterusnya, kajian ini turut membandingkan kandungan nutrien dan asid humik dalam vermikompos keratan rumput (GC), sisa sagu (SW) dan jerami padi (RS). Kandungan nutrien tumbuhan dan asid humik dalam vermikompos menggunakan *E. eugeniae* sebagai agen pengkomposan telah dianalisa. Kandungan P menunjukkan kepekatan yang lebih rendah dalam vermikompos berbanding dengan kawalan, walau bagaimanapun, vermikompos RS menunjukkan kepekatan P tersedia paling tinggi (0.33 + 0.00 g/kg). Vermikompos SW mengandungi kepekatan Ca yang paling tinggi (22.79 + 0.01 g/kg) berbanding dengan vermikompos GC (1.39 + 0.01 g/kg) dan RS (8.22 + 0.06 g/kg). Kandungan N (r=0.779), K (r=0.998) dan Ca (r=0.997) menunjukkan korelasi positif yang bererti antara bahan asas (sisa organik) dan kandungan nutrien dalam vermikompos. Vermikompos jerami padi mempunyai kandungan nutrien tersedia yang paling tinggi. Kesan penyimpanan vermikompos ke atas aktiviti enzim dan mikroorganisma dalam vermikompos turut dikaji. Vermikompos RS telah disimpan selama 6 bulan dan sampel diambil setiap bulan bagi analisa aktiviti enzim dan mikroorganisma. Aktiviti mikroorganisma dan enzim (*protease* dan *phosphatase*) dalam vermikompos didapati masih aktif sepanjang tempoh kajian. Justeru, aplikasi vermikompos walau setelah 6 bulan dituai adalah masih efektif serta dapat merangsangkan kitaran nutrien N dan P dalam tanah pertanian. Vermikompos RS mengandungi nutrien tersedia yang paling tinggi dan mudah diserap oleh tumbuhan. Namun begitu, kandungan nutrien dalam vermikompos secara relatif masih rendah jika dibandingkan dengan baja bukan organik. Oleh yang demikian, kajian telah dilakukan dengan menambahkan '*rock phosphate*' (RP) dalam proses pengkomposan-vermi. Hasil

daripada penambahan '*rock phosphate*', kandungan P tersedia didapati meningkat sebanyak 24% berbanding dengan vermikompos yang dihasilkan tanpa penambahan '*rock phosphate*'. Kandungan makronutrien N dan K tersedia vermikompos turut menunjukkan peningkatan dengan penambahan '*rock phosphate*'. Kajian ini menyimpulkan pengkomposan-vermi merupakan teknologi yang berkesan dalam mengitar semula sisa organik seperti jerami padi di Malaysia kepada produk vermikompos yang berkualiti tinggi. Ini secara tidak langsung membawa faedah ekonomi kepada para petani di samping menurunkan pembakaran terbuka seterusnya mewujudkan persekitaran yang lebih bersih.

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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 Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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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.

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YAN YI WEI

Date: 14th January 2013

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
C	Carbon
Ca	Calcium
CD	Cow dung
CFU	Colony forming unit
CIRP	Christmas island rock phosphate
D	Diameter
EE	*Eudrilus eugeniae*
GC	Grass clippings
H	Height
ICP	Induction coupled plasma
K	Potassium
Mg	Magnesium
N	Nitrogen
NBRIP	National botanical research phosphate growth media
P	Phosphorus
PE	*Perionyx excavatus*
PSB	Phosphate solubilising bacteria
RP	Rock phosphate
RS	Rice straw
SPSS	Statistical package for social package
SW	Sago waste

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