



UNIVERSITI PUTRA MALAYSIA

**OIL PALM WASTES AND SEWAGE SLUDGE COMPOSTS AS
POTTING MEDIA FOR CHRYSANTHEMUM**

KALA DEVI RAMAHSAMAY

FP 2004 54

**OIL PALM WASTES AND SEWAGE SLUDGE COMPOSTS AS
POTTING MEDIA FOR CHRYSANTHEMUM**

KALA DEVI RAMAHSAMAY

**MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA
2004**



**OIL PALM WASTES AND SEWAGE SLUDGE COMPOSTS
AS POTTING MEDIA FOR CHRYSANTHEMUM**

By:

KALA DEVI RAMAHSAMAY

**Thesis Submitted in Fulfillment of the Requirement for the Degree
of Master of Science in the Faculty of Agriculture
UNIVERSITI PUTRA MALAYSIA**

JULY 2004



SPECIALLY DEDICATED TO :-

*My Beloved Grandparents, Eswaran,
Kavitha, Nerimala, Siva & Ramu*



ACKNOWLEDGEMENTS

This project paper is specially dedicated to my beloved parents, who gave all the necessary strength and support through thick and thin from young till now, in order for me to embark upon and complete my Master of Science.

I wish to thank my project supervisor, **Prof. Madya Dr. Rosenani Abu Bakar**, for providing the proper guidance and advise but most of all her understanding and patience which enabled me to successfully complete this project paper. My heartiest gratitude is also extended to **Prof. Siti Hajar, Dr. Che Fauziah** and **Prof. Madya Dr. Thohirah Lee** for their valuable information and comments on the project. I also wish to thank all the UPM staff in Makmal Kimia Tanah II, Department of Land Management especially Puan Faridah, Puan Umi, Puan Rusnah, and Sabri who assisted me in my hour of need. Not forgetting my dearest friend, Susilawati for her intellectual ideas and assistance.

Last but not least, a special thanks to my dearest fiancé, A. Eswaran who kept motivating me throughout my stay in campus.



TABLE OF CONTENTS

	Page
DEDICATION	
ABSTRACT	
ABSTRAK	
ACKNOWLEDGEMENTS	
APROVAL SHEETS	
LIST OF TABLES	
LIST OF FIGURES	
LIST OF PLATES	
 CHAPTER	
1 GENERAL INTRODUCTION	
2 REVIEW OF LITERATURE	
2.1 Soilless Potting Media	
2.2 Composts As Potting Media	
2.3 Composting	
2.3.1 Composting Process	
2.3.2 Factors Affecting Composting	
2.3.2.1 Particle size	
2.3.2.2 C/N ratio	
2.3.2.3 Temperature	
2.3.2.4 Moisture	
2.3.2.5 Aeration or oxygen supply	
2.3.2.6 Turnings	
2.3.2.7 pH	
2.3.2.8 Compost heap and dimension	
2.3.2.9 Additives	
2.3.3 Compost Maturity	
2.4 Materials Used in Soilless Potting Media	
2.4.1 Coconut coir dust	
2.4.2 Peat	
2.4.3 Compost	
2.4.3.1 Plant Nutrient Availability in Compost	
2.5 Oil Palm Wastes	
2.6 Sewage Sludge	
2.7 Chrysanthemums	
2.7.1 Factors Influencing Growth of Chrysanthemums	
2.7.1.1 Light	
2.7.1.2 Daylength	
2.7.1.3 Temperature	
2.7.1.4 Fertilizers	



2.7.2 Growth performance and plant/flowers quality of chrysanthemum

3 CHEMICAL CHARACTERISATION OF SEWAGE SLUDGES

3.1 Introduction

3.2 Materials and Methods

3.2.1 Sewage sludge samples

3.2.2 Chemical Analyses of Sewage Sludge

3.2.2.1 pH (H₂O) Sewage sludge

3.2.2.2 Organic carbon

3.2.2.3 Total nitrogen

3.2.2.4 Heavy metals and macronutrients

3.2.3 Experimental design and data analysis

3.3 Results and Discussion

3.3.1 pH

3.3.2 Organic Carbon and C/N ratio

3.3.3 Macronutrient (N, P, K, Ca, Mg)

3.3.4 Heavy Metals

3.4 Conclusions

4 COMPOSTING OIL PALM WASTES WITH SEWAGE SLUDGE FOR POTTING MEDIA IN HORTICULTURE

4.1 Introduction

4.2 Materials and Methods

4.2.1 Experimental design

4.2.2 Composting materials

4.2.3 Method of composting

4.2.4 Monitoring for Compost Maturity

4.2.4.1 Colour and odour

4.2.4.2 Moisture content (%)

4.2.4.3 Temperature

4.2.4.4 Volume reduction

4.2.5 Chemical analyses of compost

4.2.5.1 pH (H₂O)

4.2.5.2 Organic carbon

4.2.5.3 Total nitrogen

4.2.5.4 Mineral N {NH₄⁺- N and NO₃⁻- N + NO₂⁻-N}

4.2.5.5 Heavy metals and macronutrients

4.3 Results and Discussion

4.3.1 Composting Performance

4.3.1.1 Odour

4.3.1.2 Colour

4.3.1.3 Temperature

4.3.1.4 C/N ratio

4.3.1.5 Mineral N {NH₄⁺- N and NO₃⁻- N + NO₂⁻-N}

4.3.2 Characteristics of composts produced after 12 weeks of composting

4.3.2.1 Physical appearance

4.3.2.2 Volume reduction



- 4.3.2.3 pH
 - 4.3.2.4 C/N ratio
 - 4.3.2.5 Total mineral N {NH₄⁺-N and NO₃⁻-N + NO₂⁻-N}
 - 4.3.2.6 Total macronutrient content
 - 4.3.2.6.1 Total N
 - 4.3.2.6.2 Phosphorus
 - 4.3.2.6.3 Potassium
 - 4.3.2.6.4 Calcium
 - 4.3.2.6.5 Magnesium
 - 4.3.2.7 Heavy Metals Content
- 4.4 Conclusions
- 5 USE OF OIL PALM TRUNK AND SEWAGE SLUDGE COMPOST AS A SOILLESS MEDIUM FOR CHRYSANTHEMUM**
- 5.1 Introduction
 - 5.2 Materials and Methods
 - 5.2.1 Treatments and Experimental Design
 - 5.2.2 Planting Procedures
 - 5.2.3 Maintenance
 - 5.2.4 Parameters Measured during Growth
 - 5.2.4.1 Plant height
 - 5.2.4.2 Diameter:height ratio
 - 5.2.4.3 Number of days to first visible bud
 - 5.2.4.4 Number of days to first bloom
 - 5.2.4.5 Number of bloomed flowers/pot
 - 5.2.4.6 Flower diameter
 - 5.2.5 Parameters Measured at Harvest
 - 5.2.5.1 Total leaf areas
 - 5.2.5.2 Plant dry matter weight (DMW)
 - 5.2.6 Chemical Analyses of the Plant Tissue (foliar)
 - 5.2.6.1 Leave sampling and samples preparation
 - 5.2.6.2 Total element analyses
 - 5.3 Results and Discussion
 - 5.3.1 Growth Responses of Chrysanthemum Plant
 - 5.3.1.1 Plant height
 - 5.3.1.2 Diameter:height ratio
 - 5.3.1.3 Number of days to first visible bud
 - 5.3.1.4 Number of days to first visible flower
 - 5.3.1.5 Number of bloomed flowers/pot
 - 5.3.1.6 Flower diameter
 - 5.3.1.7 Total leaf areas
 - 5.3.1.8 Plant dry matter weight (DMW)
 - 5.3.1.8.1 Top dry matter weight
 - 5.3.1.8.2 Root dry matter weight
 - 5.3.2 Foliar Macronutrient Contents
 - 5.3.2.1 Nitrogen
 - 5.3.2.2 Phosphorus
 - 5.3.2.3 Potassium

	5.3.2.4 Calcium	104
	5.3.2.5 Magnesium	104
5.3.3	Foliar Micronutrient Contents	107
5.4	Conclusions	111
6	GENERAL CONCLUSION	112
	REFERENCES	114
	BIODATA OF THE AUTHOR	129



LIST OF TABLES

Table	Page
1 C/N ratio of various wastes .	
2 Dry weight of oil palm wastes produced per hectare	
3 Source and types of sewage sludge studied.	
4 pH and nutrient content of 10 selected sewage sludges taken from different wastewater treatment plants (n=3). Mean with different letters within column indicate significant differences ($p<0.05$) using Duncan's multiple range test.	
5 Heavy metals content of 10 selected sewage sludges taken from different wastewater treatment plants (n=3). Mean with different letters within column indicate significant differences ($p<0.05$) using Duncan's multiple range test.	
6 Maximum values for metal concentrations in sewage sludge and in agriculture soils according to the Commission of the European Communities guidelines (CEC, 1986).	
7 Composting treatments with various blends of oil palm wastes and sewage sludge in different ratios.	
8 Chemical composition of the oil palm wastes and sewage sludge used in the experiment (n=3). Mean with different letters within row indicate significant differences ($p<0.05$) using Duncan's multiple range test.	
9 Council of European Communities (CEC) Physical and Chemical Parameters for Compost (CEC, 1986).	
10 Treatments comparing three types of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers.	
11 Chemical characteristics of potting media involved in this study (n=3). Different letters within the row indicate significant differences ($p<0.05$) between treatment means using	

Duncan's multiple range test.

12 Nutrient content in chrysanthemum plant tissue

LIST OF FIGURES

Figure	Page
1	Changes in temperatures of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) during 12 weeks of composting.
2	Changes in C/N ratio of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) during 12 weeks of composting.
3	Changes in NH_4^+ -N of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) during 12 weeks of composting.
4	Changes in NO_3^- - N and NO_2^- - N of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) during 12 weeks of composting.
5	Changes in volume reduction (%) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
6	Changes in pH of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
7	Changes in C/N ratio of the composting blends of oil palm

wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.

- 8 Changes in total mineral N ($\text{mg} \cdot \text{kg}^{-1}$) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 9 Changes in total N concentration (%) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 10 Changes in P concentration (%) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 11 Changes in K concentration (%) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 12 Changes in Ca concentration (%) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 13 Changes in Mg concentration (%) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment

means using Duncan's multiple range test.

- 13 Pb concentration ($\text{mg} \cdot \text{kg}^{-1}$) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 14 Zn concentration ($\text{mg} \cdot \text{kg}^{-1}$) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 15 Fe concentration ($\text{mg} \cdot \text{kg}^{-1}$) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 16 Mn concentration ($\text{mg} \cdot \text{kg}^{-1}$) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 17 Cd concentration ($\text{mg} \cdot \text{kg}^{-1}$) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 18 Cu concentration ($\text{mg} \cdot \text{kg}^{-1}$) of the composting blends of oil palm wastes (E=EFB, F=frond and T=trunk) and sewage sludges at different ratios (100:0, 3:1 and 4:1) after 12 weeks of composting. Different letters over bars indicate significant differences ($p<0.05$) between treatment means using Duncan's multiple range test.
- 19 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on plant height (cm) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.

- 20 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on diameter:height (cm) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 21 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on number of days to first visible bud after short day treatment (days) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 22 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on first bloom (days) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 23 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on number of bloomed flowers/pot of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 24 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on flower diameter (cm) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 25 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on total leaf area (cm^2) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 26 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on top dry weight (g) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 27 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on root dry matter (g) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.

- 28 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on foliar total nitrogen concentration (%) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 29 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on foliar phosphorus concentration (%) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 30 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on foliar potassium concentration (%) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 31 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on foliar calcium concentration (%) of potted chrysanthemum. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 32 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on foliar magnesium concentration (%) in chrysanthemum plant. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 33 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on foliar iron concentration ($\text{mg}.\text{kg}^{-1}$) in chrysanthemum plant. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 34 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on foliar manganese concentration ($\text{mg}.\text{kg}^{-1}$) in chrysanthemum plant. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.
- 35 Effect of potting media, i.e, peat, compost and compost-peat, with different combinations of fertilizers on foliar zinc concentration ($\text{mg}.\text{kg}^{-1}$) in chrysanthemum plant. Different letters over the bars indicate significant differences ($p<0.05$) between treatment means in Duncan's multiple range test.

LIST OF PLATES



Abstract of the thesis Presented to the Senate of Universiti Putra Malaysia in
Fulfillment of the Requirements for the Degree of Master of Science

**OIL PALM WASTES AND SEWAGE SLUDGE COMPOSTS AS
POTTING MEDIA FOR CHRYSANTHEMUM**

By

KALA DEVI RAMAHSAMAY

JULY 2004

Chairman : Assoc. Prof. Dr. Rosenani bt. Abu Bakar

Faculty : Agriculture

The use of oil palm wastes, particularly the empty fruit bunch (EFB), frond and trunk as compost are now receiving greater attention by researchers. Another organic waste that needs to be disposed off in Malaysia is sewage sludge. This research is important in reducing waste management problem and conserve plant nutrients. Therefore the objective of this study was to determine the optimum blend of oil palm wastes (EFB, frond and trunk) and sewage sludge that will produce a compost physically similar to peat which can be used as potting media.



Analysis of samples of sewage sludges collected from ten different Indah Water Consortium treatment plants in Peninsular Malaysia, showed that the chemical characteristics of the sludges varied greatly, i.e. 6.13 to 57.67% C, pH_{water} 3.57 to 6.43, 0.68 to 2.90% total N, 0.24 to 1.62% P, C/N ratio 4.13 to 37.94, 112 to 2902 mg.kg⁻¹ Mg, 401 to 1209 mg.kg⁻¹ K, and 0.16 to 2.16% Ca. The concentrations of heavy metals in sludges also varied greatly, i.e. 36 to 308 mg.kg⁻¹ Pb, 0.51 to 6.49 mg.kg⁻¹ Cd, 63 to 732 mg.kg⁻¹ Cu, 32 to 420 mg.kg⁻¹ Mn, 10 to 151 mg.kg⁻¹ Ni, 1.22 to 4.01% Fe and 153 to 7012 mg.kg⁻¹ Zn. Sewage sludges produced by Indah Water Konsortium (IWK) has low levels of heavy metals (except for Zn) and may be used on ornamental plants but caution should be taken for plants that are sensitive to Zn.

A study on composting different oil palm wastes with sewage sludge was carried out on a small scale in the glasshouse by using a polystyrene box. Shredded oil palm wastes (EFB, frond and trunk) were mixed with sewage sludge in different ratios (100:0, 3:1 and 4:1 ratio) and moistened to 50 % moisture content. Based on the temperature, C/N, NH₄⁺-N and NO₃⁻ - N + NO₂⁻ -N patterns of the oil palm wastes-sludge blends during 12 weeks composting, all EFB, frond and trunk with added sludge composts seemed to perform similarly. After 12 weeks of composting, the trunk composts had finer particle size, similar to peat, compared to the other composts. However, the EFB-sludge and frond-sludge composts still contained long strands of fibres. These composts may need to be composted for more than 12 weeks to achieve finer particle size. The trunk:sludge (4:1) compost was selected to be the best compost in terms of particle size, colour, nutrient and heavy metals content. It



had 2.05 % total N, pH_{water} 6.2, 18.96 C/N ratio, 0.71% Ca, 0.64% P, 1.39% K, 0.23% Mg and heavy metals concentrations of 26.30 mg.kg⁻¹ Pb, 671 mg.kg⁻¹ Zn, 6306 mg.kg⁻¹ Fe, 91.93 mg.kg⁻¹ Mn, 1.63 mg.kg⁻¹ Cd and 68.83 mg.kg⁻¹ Cu, which is within the recommended levels of Council of European Communities guidelines, CEC (1986) in compost.

When the trunk:sludge (4:1) compost was tested with potted chrysanthemum, plants grown in compost and compost:peat (3:1 v/v) potting media had good vegetative growth (top dry matter weight and total leaf area) and other flowering qualities (earlier appearance of first visible bud/flower and higher number of bloomed flowers) which are suitable for sale than the standard peat medium. The growth of chrysanthemum was influenced by the addition of fertilizers. The use of the compost with only slow release fertilizer, agroblend, was found to be sufficient to produce good plant growth of flowers per pot. Thus this would decrease the cost of fertilizer and labour. On the whole the growth performance of compost and compost:peat (3:1 v/v) growth medium were similar. Therefore, this study showed that composted oil palm trunk-sewage sludge has the potential to be used as a soilless potting medium for chrysanthemum, i.e as a substitute for peat. This may convert oil palm waste into a value-added product and provide an alternative disposal method for sewage sludge produced by IWK.



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

**KOMPOS KELAPA SAWIT DAN ENAPCEMAR
KUMBAHAN SEBAGAI MEDIA TANAMAN KEKWA**

Oleh

KALA DEVI RAMAHSAMAY

JUNE 2004

Pengerusi : Proffesor Madya Dr. Rosenani bt. Abu Bakar

Fakulti : Pertanian

Kegunaan sisa kelapa sawit, iaitu tandan buah kelapa sawit kosong (EFB), pelelah dan batang kelapa sawit sebagai bahan untuk kompos kini mendapat sambutan para penyelidik. Satu lagi bahan buangan di Malaysia yang menjadi masalah pelupusan ialah enapcemar kumbahan. Kajian ini penting untuk mengurangkan masalah pembuangan sisa organik dan untuk mengekalkan



nutrien tanaman. Objektif kajian ini adalah untuk menentukan formulasi campuran optimum sisa kelapa sawit (EFB, pelelah atau batang) dan enapcemar kumbahan yang akan menghasilkan kompos yang secara fizikalnya, serupa dengan tanah gambut untuk diguna sebagai media tanaman pokok hiasan.

Analisis enapcemar kumbahan yang diperolehi daripada 10 loji rawatan Indah Water Konsortium di Semenanjung Malaysia menunjukkan ciri-ciri kimia enapcemar kumbahan sangat berbeza, iaitu, 6.13 - 57.67% C, pH_{air} 3.57 - 6.43, 0.68 - 2.90% N, 0.24 - 1.62% P, 4.13 - 37.94 C/N, 112 - 2902 mg.kg⁻¹ Mg, 401 - 1209 mg.kg⁻¹ K, dan 0.16 - 1.17% Ca. Kandungan logam berat dalam kumbahan-kumbahan juga berbeza iaitu: 36 - 308 mg.kg⁻¹ Pb, 0.51 - 6.49 mg.kg⁻¹ Cd, 63 - 732 mg.kg⁻¹ Cu, 32 - 420 mg.kg⁻¹ Mn, 10 - 151 mg.kg⁻¹ Ni, 1.22 - 4.01% Fe dan 153 - 7012 mg.kg⁻¹ Zn. Enapcemar kumbahan yang diperolehi mempunyai kandungan logam berat yang rendah kecuali kandungan Zn. Maka disyorkan enapcemar kumbahan ini sesuai untuk tanaman hiasan tetapi perhatian perlu diberi kepada pokok-pokok yang terlalu sensitif kepada Zn.

Satu kajian pengkomposan kelapa sawit dan enapcemar kumbahan dijalankan secara kecil-kecilan menggunakan kotak polisterin di rumah kaca. Tandan buah kelapa sawit kosong (EFB), pelelah dan batang kelapa sawit dipotong/dicincang menjadi saiz kecil sebelum dicampur enapcemar kumbahan dengan kadar (100:0, 3:1 dan 4:1) dengan kandungan kelembapan lebih kurang 50 %. Semasa 12 minggu pengkomposan, didapati suhu, nisbah C/N, corak

kandungan NH_4^+ -N dan NO_3^- - N + NO_2^- -N yang diperolehi daripada campuran EFB, pelepas dan batang kelapa sawit dengan enapcemar kumbahan adalah serupa. Kompos hasil daripada batang kelapa sawit dengan penambahan enapcemar kumbahan mempunyai saiz partikel yang lebih halus, seperti tanah gambut berbanding kompos lain. Manakala kompos EFB dan pelepas kelapa sawit dengan penambahan enapcemar kumbahan masih mempunyai serat-serat yang panjang. Kompos tersebut perlu dibiarkan lebih daripada 12 minggu untuk matang dan mencapai saiz partikel yang halus. Oleh itu, kompos batang kelapa sawit dengan penambahan enapcemar kumbahan (4:1) dipilih sebagai kompos terbaik berdasarkan saiz partikel, warna dan kandungan nutrient dan logam berat. Kompos ini mempunyai 2.05% N, pH_{air} 6.2, nisbah C/N 18.96, 0.71% Ca, 0.64% P, 1.39% K, 0.23% Mg dan mengandungi kandungan logam berat, 26.30 mg.kg^{-1} Pb, 671 mg.kg^{-1} Zn, 6306 mg.kg^{-1} Fe, 91.93 mg.kg^{-1} Mn, 1.63 mg.kg^{-1} Cd dan 68.83 mg.kg^{-1} Cu, di bawah paras yang disyorkan oleh Council of European Communities, CEC (1986) untuk kompos.

Apabila kompos batang kelapa sawit dengan enapcemar kumbahan (4:1) ini diguna sebagai media untuk tanaman pokok kekwa, didapati kompos dan kompos:gambut (3:1 v/v) menghasilkan ciri-ciri pokok kekwa yang lebih baik iaitu pertumbuhan pokok yang baik (jumlah berat kering dan luas daun) dan kualiti bunga (bilangan hari kudup/pembungaan yang singkat dan bilangan bunga yang banyak) yang sesuai untuk pemasaran berbanding dengan media tanah gambut. Pertumbuhan kekwa juga dipengaruhi oleh penambahan baja. Penggunaan baja pelepasan perlahan (Agroblend) sahaja didapati menghasilkan pertumbuhan pokok dan bilangan bunga yang bagus. Secara tidak langsung ini boleh mengurangkan kos baja dan buruh. Tiada didapati perbezaan yang bererti

di antara media tanaman kompos dan kompos:gambut (3:1 v/v). Oleh itu kajian ini telah membuktikan bahawa kompos batang kelapa sawit dengan enapcemar kumbahan mempunyai potensi digunakan sebagai media tanaman untuk pokok kekwa, menggantikan gambut. Ini boleh menambahkan nilai produk kelapa sawit dan satu alternatif bagi pembuangan enapcemar kumbahan dari IWK.

I certify that the Board of Examiners have on July, 2004 to conduct the final examination of Kala Devi Ramahsamy on her Master of Science thesis entitled ‘Oil Palm Wastes and Sewage Sludge Composts as Potting Media for Chrysanthemum’ in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981, and the Board recommended that the candidate consists of following persons:

ROSENANI ABU BAKAR, Ph.D.
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

CHE FAUZIAH ISHAK Ph.D.
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

THOHIRAH LEE ABDULLAH Ph.D.
Faculty of Agriculture
Universiti Putra Malaysia
(Member)



MOHD. GHAZALI MOHAYIDIN, Ph.D.
Professor/ Deputy Dean of Graduates School
Universiti Putra Malaysia

Date:

This thesis 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 Supervisory Committee are as follows:

ROSENANI ABU BAKAR, Ph.D.

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

CHE FAUZIAH ISHAK Ph.D.

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

THOHIRAH LEE ABDULLAH Ph.D.

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

AINI IDERIS, Ph.D.
Professor/ Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:



CHAPTER 1

GENERAL INTRODUCTION

Currently, very limited choices of potting media are available in the market, i.e. mainly peat, coconut coir dust (CCD) and red clay soils. Therefore suitable substitutes or alternatives need to be sought before shortage occurs. Moreover every time a container-grown plant is sold, the rooting substrate is sold with it, necessitating the need for more substrate.

Peat is one of the traditional organic materials that have been used extensively in ornamental horticultural industries to prepare potting/planting media. However, peat is a finite resource and large scale of peat extraction causes environmental damage (Barber, 1993; Barkham, 1993; Buckland, 1993). Rising prices and decreased availability of fertilizer have also caused growers to

