التحول الحيوي لمخلفات التصنيع الزراعى

رسالة دكتوراه الفلسفة
في العلوم الزراعية
(ميكروبيولوجيا زراعية)

مقدمة من

يحيي إبراهيم محمود

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لجنة الإشراف

دكتور/ محمد زكريا صديق
أستاذ الميكروبيولوجيا الزراعية- كلية الزراعة - جامعة القاهرة

دكتور/ وليد ضياء الدين صالح
أستاذ الميكروبيولوجيا الزراعية المساعد- كلية الزراعة - جامعة القاهرة

دكتور/ عزمى نصحى إسطفانوس
رئيس بحوث - معهد بحوث الأراضى و المياه و البيئة – مركز البحوث الزراعية

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لجنة الحكم

دكتور/ فكرى محمد عبدالعال غزال .....
رئيس بحوث الميكروبيولوجيا الزراعية – معهد بحوث الاراضى والمياه والبيئة

دكتور/ ناديه فهمى أمين..... .....
أستاذ الميكروبيولوجيا الزراعية – كلية الزراعة – جامعة القاهرة

دكتور/ وليد ضياء الدين صالح.....
أستاذ الميكروبيولوجيا الزراعية المساعد – كلية الزراعة – جامعة القاهرة

دكتور/ محمد زكريا صديق.....
أستاذ الميكروبيولوجيا الزراعية – كلية الزراعة – جامعة القاهره

التاريخ / /

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دكتوراه الفلسفة

في

العلوم الزراعية
(ميكروبيولوجيا زراعية)

قســـــم الميكروبيولوجيا الزراعية
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Name of Candidate: Yahia Ibrahim Mahmoud **Degree:** Ph.D.
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Supervisors: Dr. Mohammed Zakaria Sedik
Dr. Waleed Diaeddeen Saleh
Dr. Azmy Noshy Estafanous
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ABSTRACT

The main aim of this study is to produce compost using agricultural wastes of rice straw and artichoke mixed with cow dunk, beside the addition of some microbial inoculants, sulfur element and also the production of compost extract of known effect as biological treatment for root nematode in tomato plants. Six compost mixtures of these raw materials were made up and exposed for 6 treatments , *i.e*: C1, C2, C3, C4, C5 and C6. The results can be summarized as follows:

The temperature of the treatments C1, C2, C3, C4, C5 and C6 exceeded 60^{o}C in the first 30 days of composting then decreased gradually to 35^{o}C. The final E.C. reached 5.18, 5.56, 5.5, 5.27, 5.6 and 5.70 dS/m^{3}, respectively. The change in apparent density of the compost mixtures ranged from 320-594 kg/m^{3}. The pH values of the compost mixtures C1, C2, C3, C4, C5 and C6 were 8.15, 8.17, 8.05, 6.37, 6.90 and 6.83, respectively.

The C:N ratio decreased at the beginning of the composting from 30.4, 31.0,30.8, 30.9, 30.9 and 30.6 to 21.8, 21.3, 20.3, 22.5, 21.7 and 20.7, respectively. P and K % increased due to loss in organic matter as K reached 1.83% and P reached 0.31% maximum in absence of S element in the compost mixtures, while in presence of S the K and P % decreased to 1.43% and 0.28%, respectively. The $(NH)_3$ concentrations decreased dramatically during composting period 21-39 ppm minimally.

The NO_3 decreased gradually in the first weeks of composting then increased parallel to the temperature loss from 495-575 ppm in the compost mixtures with no microbial inoculants, while those treated with microbial inoculants increased from 435-532 ppm. Organic matter mineralization, N conversion content of the compost mixtures variations based on the dry weight were studied as T.N, ash loss and O.M decomposition rates relative to the dry matter.

The change in the total number of bacteria, fungi, actinomycetes (mesophilic and thermophilic) and pathogens were studied through time intervals of 1, 2, 4, 8 and 16 weeks. The tomato planting test in greenhouse and NPK treatments in the compost mixtures and compost water extracts effects on tomato plants growth, nematode control and sandy soil properties were studied.

The effect of compost and compost extract as on the dry weight of root and shoots as well as their evaluation as limiting factors on root nematodes were studied. It was obviously clear that treatment with compost A was effective on root nematode after 3 months while that with compost B was more effective in decreasing nematode nodules down till 22%.

Key words: compost, biological treatment, tomato, nematode.

DEDICATION

I dedicate this work to the mighty God at first and to my beloving family.

ACKNOWLEDGEMENT

Praise and thanks are to mighty ***God*** *, the most merciful for assisting and directing me always to the right way.*

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CONTENTS

INTRODUCTION

The intensive utilization of chemical fertilizers, cultivation of short seasonal crops particularly in absence or lack of organic manuring and the removal of plant residues from the land, all of these practices, adversely affect the soil fertility status.

Because of the climatic arid conditions dominating in Egypt beside the aforementioned reasons, the Egyptian soils are very poor in their organic matter content, which seldom exceeds 2% and is of tenly less than 1% or even less than 0.1% in some newly reclaimed soils.

Frequent and high supplemental applications of organic fertilizers are necessary for improving the physical, chemical and microbiological properties of the soils, particularly the newly reclaimed ones and hence their productivity.

According to the early salient motto introduced by ancient Egyptians who declared that "what comes out of the soil, must be returned to the soil" hence, the agricultural residues represent the consistent and safe resources of organic matter for Egyptian soils, with highlighting on rice straw, which is produced in huge quantities resulting in a tremendous environmental problems such as the black clouds resulted of the burning of rice straw in open farms. However, there are many disadvantages of using the plant residues for direct application to soil, particularly in case of their use in organic fertilization (Mathur *et al.*, 1993). Therefore, a proper piling and composting of residues before their incorporation to the field is sensible agricultural policy to overcome the problems associated with disposal

of biodegradable matter in soil (Senesi, 1989). Composting is a process of controlled biological decomposition of biodegradable materials under managed conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat in order to achieve biologically stable, safe and plant sanitized compost. The heterogeneous organic matter in the starting materials is transformed after suitable composting period (which include bio-oxidative and maturation phases) into a stabilized end product through partial mineralization and humification. Also, composting include killing of pathogens and weed seeds and improving handling characteristics by reducing the volume and weight of produced compost (Rynk, 1992 and Rodrigues *et al.*, 1995).

However, composting has some drawbacks; including their relatively low levels of nutrients (1-2% N and less than 1% P) as compared to complete fertilizer and the mineralization rates of the macronutrients generally are low leading to increase the compost application rates to satisfy the complete N or P requirements (Egball and Power, 1999). Nevertheless, such problems seemed to be solved by many ways, such as, enriching of composted materials *via* blending several sources of crop residues, differed in their physical and chemical properties, with some amendments such as rocks, minerals, animal wastes and beneficial microorganisms, where each of them must be applied at relevant stages of composting process. Such amendments may lead to accelerate the decomposition rate, correct the nutrients deficiency and increase the ability of produced compost for bio-protecting of plants against phytopathogens (Abd El-Wahab, 1999 and

Abdel-Wahab and Ahmed, 2003). Another way can be applied, which may be accomplished in parallel with the previous one and is combining compost with inorganic fertilizers to magnify the nutrient use efficiency. Generally, organic fertilizers are traditionally applied at rates to meet crop-N requirements since it is often the most limiting factor of crop productivity. Many researchers showed that nitrogen use efficiency is greatest in the combination of organic and inorganic fertilizers (Sikora and Enkiri, 2000; Smith *et al.*, 2001 and Keeling *et al.*, 2003).

Organic matters are considered to be the most important constituents of non-living organic matter in soil. They contribute substantially to improving the global soil fertility status by exerting a number of functions that are specific and typical of "humified" organic matter. These include, among others, the improvement of soil physical properties such as soil structure, porosity and water retention capacity, enhancement of action exchange capacity and pH buffer capacity, slow release of nutrients such as N and P and extended interactions with micro nutritive and/or microtoxic metal ions and xenobiotic organic molecules such as pesticides (Stevenson, 1982).

The present work aims to investigate the chemical and microbiological changes that may take place during composting of different mixtures of some organic residues, *i.e*, artichoke wastes, rice straw and cattle dung, using low cost technology of composting, the open system (turn piles). In addition, the effect of *Phanerochate chrysosporium and Bacillus polymyxa* inoculation and/or periodical

disturbing or non-disturbing of the composted materials was examined periodically during the composting period (16 weeks).

The produced compost types were subjected to the evaluation of their suitability as manures and as nematode control through a pot experiment using tomato plant cultivated in sandy soil as an indicator.

REVIEW OF LITERATURE

1. Compost and co-compost definitions

According to Daizell *et al.* (1987) composting is defined as the decomposition of organic waste materials by a mixed population micro-organisms (microbes) in a warm, moist aerated environment. On the other hand, Obeng and Wright (1987) reported that the term Co-composting means the composting of two or more raw materials together. In the case of human waste and garbage, this kind of composting is advantageous because the two waste materials complement each other well. The human waste is high in nitrogen content and moisture, and the garbage is high in organic carbon content and has good bulking quality, both these waste materials can be converted into a useful compost product. Obeng and Wright (1987) also claimed that the material being composted decomposes as a result of the activity of the bacteria, fungi, actinomycetes, and protozoa present in the waste material. The efficiency of the process depends, to a large extent, on temperature since microbial succession accrues with the temperature changes brought about by microbial activity. Mini *et al.* (1999) summarized the composting process as the biological decomposition of wastes consisting of organic substances of plant and/or animal origin under controlled conditions to state sufficiently stable for nuisance-free storage and utilization.

Materials such as olive press cake, olive tree leaves and branches, vine branches, pressed grape skins, pig manure, sewage sludge and the organic fractions of municipal solid waste have been