COMPARATIVE STUDY OF THE EFFECTS OF A SYNTHETIC PESTICIDE (ENDOCEL) AND PLANTS EXTRACTS ON LITTER DECOMPOSITION IN A *Theobroma cacao* Linn. PLANTATION

BY

SONAIKE TOLULOPE SEUN

B.Sc. (Hons) PLANT BIOLOGY (UNILORIN)

A THESIS SUBMITTED TO THE INSTITUTE OF ECOLOGY AND ENVIRONMENTAL STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTERS OF SCIENCE (M.Sc) IN ENVIRONMENTAL CONTROL AND MANAGEMENT OF OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE,

NIGERIA

2012

CERTIFICATION

This is to certify that this research work was carried out by SONAIKE Tolulope Seun (SCP09/10/H/1302) of the institute of Ecology and Environmental Studies, in partial fulfillment of the requirement for the award of the degree of Masters of Science (M.Sc.) in Environmental Control and Management, Obafemi Awolowo University,Ile-Ife, Nigeria.

…… ……

SUPERVISOR DATE

Dr. O. K. Adekunle

Department of Crop Production and Protection

Obafemi Awolowo University,

Ile-Ife, Nigeria.

…… ……

CO – SUPERVISOR DATE

Dr. (Mrs) A. A. Okoya

Institute of Ecology and Environmental Studies,

Obafemi Awolowo University,

Ile-Ife, Nigeria.

…… ……

Prof. I. E. Ofoezie DATE

Director of Institute of Ecology and Environmental Studies,

Obafemi Awolowo University,

Ile-Ife, Nigeria.

DEDICATION

This work is dedicated to the Almighty God who gave me the wisdom and courage for the successful completion of this study.

To my parents, who have always wanted the best for me and worked so hard to bring me up as a responsible and respectable lady.

ACKNOWLEDGEMENTS

I thank the Almighty God for his guidance, wisdom and care during this study.

My sincere and heartfelt gratitude to my parents Mr. and Mrs. Sonaike, my brothers and sisters, for their constant love and total support during my studies.

Special thanks to my supervisors Dr. O. K Adekunle and Dr. (Mrs) A. A Okoya for their tireless efforts and support in providing valuable advice and supervision concerning this study. My sincere thanks also go to the director of the Institute of Ecology and Environmental studies, Obafemi Awolowo University, Prof I. E. Ofoezie and to my lecturers, Dr. M. B. Adewole and Dr. O. O. Awotoye.

Exceptional thanks to Aderoju Adesiyan for providing logistics for successful completion of this study. You are a friend indeed.

My honest appreciation goes to Akinyele Bankole, Mokweyen Anthony, Akinpelumi Babalola (Bablo), Adebola Samuel and Okiribiti Busola, without whose efforts the field work would have been tiresome and boring. God bless you all. To my room-mates, Lolade, Bukky, Oyelola and Bolaji, I love you all.

Finally my sincere thanks to all my friends at Obafemi Awolowo University and fellow classmates with whom we have walked together the aisle of the four hectic semesters full of challenges and experiences.

TABLE OF CONTENTS

List of Tables

Tables

ABSTRACT

This study was undertaken to determine the effects of Endocel (a synthetic pesticide) and water extracts of neem and siam weed leaves on mineral content and litter decomposition in a *Theobroma cacao* Linn. Plantation. This was with the view of assessing the comparative effects of the synthetic pesticide and the plant extracts on litter decomposition.

The experiment was carried out at the Teaching and Research Farm, Obafemi Awolowo University, Ile-ife, Nigeria. The experimental design was made up of four blocks of seven plots each with three trees per plot giving a total of 21 trees per block. Pre-treatment samples of litter and soil were taken a week before treatment. Aqueous extracts of fresh leaves of siam weed and neem leaves collected from other sites within the university were prepared using standard methods: endocel at 0.1 L/ha and 0.05 L/ha; neem and siam at 40,000 and 20,000 mg/kg each and control at 0.00 mg/L. Cocoa plants were sprayed once every week for five consecutive weeks with the six spray mixtures (treatments) using a knapsack sprayer. Soil and litter samples were collected from each plot once every month for five months starting from 4 weeks after treatment. Microbial analysis of soil and litter samples, C:N of litter and exchangeable cations of soil were determined using standard methods. Data on the microbial analysis and exchangeable cations were subjected to analysis of variance and where there were significant differences ($p<0.05$), treatments means were separated using Duncan's Multiple Range Test.

The mean range of total heterotrophic bacteria (THB) load in the litter samples treated with endocel was $2.45x10^{7}$**±8.17x10**^{6} to $1.36x10^{12}$±$1.36x10^{12}$ cfu/g while that for plant extracts was $3.01x10^{7}$±$7.21x10^{6}$ to $4.44x10^{9}$**±4.22x10**^{9} cfu/g and $9.25x10^{6}$±$2.69x10^{6}$ to **1.15x10**^{11}±$1.15x10^{11}$ cfu/g for neem and siam respectively. Corresponding values for soil were: endocel, **1.56x10**^{6}±$9.92x10^{5}$ to $5.16x10^{9}$±$3.45x10^{9}$ cfu/g; neem, **1.70x10**^{6}±$5.60x10^{5}$ to $2.57x10^{9}$**±2.54x10**^{9} cfu/g; and siam,

$4.14x10^6 \pm 2.46x10^6$ to $5.20x10^7 \pm 2.51x10^7$ cfu/g. The values for the control was $7.84x10^6 \pm 4.95x10^6$ to $4.58x10^7 \pm 2.14x10^7$ cfu/g, and not significantly different with those of the treated plots ($p<0.05$). This is an indication that neither the synthetic nor the plant extracts had a significant effect on the decomposer organisms. However, microbial population in soil were in the order neem>siam >control > synthetic and in the litter, synthetic> siam>control>neem. The C:N ratio for the litter samples in all the experimental plots were in the range 12:1 to 15:1. Values of the exchangeable cations for the six experimental plots from November to January were in the range: 0.14±0.01 to 0.21±0.01 cmol/kg for Na^+; 0.16±0.01 to 0.39±0.02 cmol/kg for K^+; 6.76±0.33 to 10.79±0.61 cmol/kg for Ca^{2+}; 0.40±0.11 to 4.57±1.44 cmol/kg for Mg^{2+}. The corresponding values control were 0.14±0.01 to 0.18± 0.01 cmol/kg for Na^+; 0.23±0.23 to 0.41±0.11 cmol/kg for K^+; 6.07±0.67 to 8.57±0.84 cmol/kg for Ca^{2+}; 0.76±0.20 to 3.44±0.93 cmol/kg for Mg^{2+}.

In conclusion, this study showed that neem, siam and endocel (at manufacturer's recommended rate) pesticides did not have adverse effect on soil micro-organisms and soil micronutrients. Litter decomposition therefore did not vary with the type of pesticide used.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Nutrient cycling in terrestrial ecosystems is highly dependent on detrital food web processes. Saprovores and other heterotrophs are quite important in litter comminution, decomposition, mineralization, nitrogen fixation and thus play a major role in maintaining soil texture and fertility (Crossley, 1970). In forest ecosystems, decomposition of leaf litter is an important factor controlling nutrient cycling and soil organic matter formation. Litter decomposition is regulated by the availability of resources such as organic matter and nutrients for decomposer organisms and by the environmental conditions such as moisture and temperature that affect the activity of the decomposers (Swift *et al.*, 1979). As leaves are broken down by insects and microbial decomposers, organically-bound nutrients are released as free ions to the soil solution which are then available for uptake by plants. In most forests the major source of nutrients for the trees is the process of decomposition.

Decomposition refers to the processes that convert dead organic matter into smaller and simpler compounds. The products of complete decomposition are carbon dioxide, water, and inorganic ions (such as ammonium, nitrate, phosphate, and sulphate). Decomposition is mainly a biological process carried out by insects, worms, bacteria, and fungi both on the soil surface and in the soil. Nutrient recycling and incorporation of organic matter into the soils are critical results of the process which could be disturbed by the increasing use of pesticides in forest management. Since a great proportion of the nutrients in tropical ecosystems are incorporated into the organic matter through decomposition, litter decomposition is an important process for regenerating the nutrients to support plant production in the ecosystem (Cuevas and Medina, 1986). Trees in forests absorb nutrients from

the soil to support their growth. At the same time some part of the nutrient uptake is returned to the forest floor via litter fall. Bargali *et al.* (1993) indicated that decomposition processes play an important role in soil fertility in terms of nutrient cycling and formation of soil organic matter. Litter, therefore, plays a major role in the transfer of energy and nutrients within a woodland ecosystem. The rate of cycling of nutrients through the decomposer subsystem is an important regulator of ecosystem productivity (Swift *et al.*, 1979).

Microflora populations are responsible for the chemical transformation and degradation of complex organic molecules into simpler compounds during decomposition (Crossley and Witkamp, 1964). The activities of soil microorganisms are beneficial but some may be detrimental to the environment, plants and man. Decomposition of organic materials is one of the most important activities being carried out by soil microorganisms as it results in soil organic matter formation and the release of plant nutrients. However, plant and animal components interact in regulating the rates and efficiencies of those decomposition processes which are crucial in the recycling of nutrient elements (Edwards *et al.,* 1973).

The widespread use of pesticides poses a serious potential threat to these decomposition processes. In modern agriculture, pesticides are frequently used in the field to increase crop production. Besides combating insect pests, insecticides also affect the population and activity of beneficial microbial communities in soil (Pandey and Singh, 2004). Nowadays, farmers often apply herbicides and pesticides on their farms. These toxic anti-biological agents eventually enter the soil through drift deposition, runoffs from the site of application or as root exudates (Primental and Levitan, 1986). Although some soil microbiota can utilize and degrade pesticides, these pesticides have been found to adversely affect microbial populations, diversity and biochemical activities such as ammonification, nitrification, denitrification and urea hydrolysis (Greaves and Malkomes,1980; Roslycky, 1986; Taiwo

and Oso,1997). Pesticide accumulation in the litter-soil ecosystem may disrupt detrital food webs and thus impair soil formation and the maintenance of soil fertility (Witkamp, 1971).

World cocoa bean production, harvested from the cacao tree (*Theobroma cacao*), is estimated at 3.5 million tonnes, 90% of which is grown in Cote d'Ivoire, Ghana, Indonesia, Nigeria, Cameroon, Brazil, Ecuador and Malaysia where millions of smallholder farmers depend on the revenue (Norgrove, 2007). West Africa has been the center of cocoa cultivation for many decades, as two-thirds of the world's cocoa is produced in the region. Nigeria is currently the fourth largest producer of cocoa with 190 metric tonnes in 2008 (Aikpokpodion *et al.,* 2010). Cocoa is a crop of economic importance with more than 650,000 ha being cultivated in Nigeria (Sanusi and Oluyole, 2005). It ranked first amongst agricultural export crops in its contribution to foreign earnings (Tijani *et al*., 2001). General and localized study have identified that the greatest factor responsible for the dwindling of cocoa production level in Nigeria is the ravages caused by black pod disease caused by *Phytophthora palmivora* and *P. megakarya*. *P. megakarya*, common in West and Central Africa, sporulates more abundantly than *P. palmivora*. The soil-borne phase of the *P. megakarya* disease cycle causes root infection, maintaining a reservoir of inoculums during the dry season, releasing zoospores into the soil surface water when rains start (Opoku *et al.*, 2007). The soil is therefore the primary source of inoculum and disease tends to progress from pods at the bottom of the trunk and later into the canopy (Opoku *et al.*, 2007). Nigerian cocoa farmers make use of copper based fungicide which is believed to be the fastest and most reliable means of controlling the disease. Other methods of blackpod control include biocontrol, use of plant extracts and cultural methods. Biocontrol methods are being developed and focus on the use of endophytic fungi, such as *Trichoderma theobromicola* and *T. paucisporum*, which have been isolated in South America (Samuels *et al.,* 2006). Plant extracts