USING STABLE ISOTOPES AND OTHER TECHNIQUES AS TRACERS FOR POLLUTION TRANSPORT IN SOIL AND PLANTS

BY

AHMED ABD EL SALAM ALI EASA

B.Sc. Agric. Sc. (Agricultural Biochemistry), Ain Shams University, ١٩٩٩

A thesis submitted in partial fulfillment
of
the requirements for the degree of

MASTER OF SCIENCE
In

Agricultural Science
(Agricultural Biochemistry)

Department of Agricultural Biochemistry
Faculty of Agriculture
Ain Shams University

٢٠٠٧

Approval sheet

USING STABLE ISOTOPES AND OTHER TECHNIQUES AS TRACERS FOR POLLUTION TRANSPORT IN SOIL AND PLANTS

BY

AHMED ABD EL SALAM ALI EASA

B.Sc. Agric. Sc. (Agricultural Biochemistry), Ain Shams University, ١٩٩٩

This thesis for M.Sc. degree has been approved by:

Prof. Dr. Sami Fanous Sharobeem ………………

Prof. of Biochemistry, Faculty of Agriculture, Zagazeeg University.

Prof. Dr. Mohammed Ibraheam El-Said ………………

Assoc. Prof. of Biochemistry, Faculty of Agriculture, Ain Shams University

Prof. Dr. Nagah El Shahat Ali ………………

Prof. of Biochemistry, Faculty of Agriculture, Ain Shams University

Prof. Dr. Farouk Guindi Moawad ……………….

Prof. Emeritus of Biochemistry, Faculty of Agriculture, Ain Shams University

Date of Examination: ١٤ / ٣ / ٢٠٠٧

USING STABLE ISOTOPES AND OTHER TECHNIQUES AS TRACERS FOR POLLUTION TRANSPORT IN SOIL AND PLANTS

BY

AHMED ABD EL SALAM ALI EASA

B.Sc. Agric. Sc. (Agricultural Biochemistry), Ain Shams University, ١٩٩٩

Under the supervision of:

Prof. Dr. Farouk Guindi Moawad

Professor Emeritus of Agricultural Biochemistry, Faculty of Agriculture, Ain Shams University

Prof. Dr. Nagah El Shahat Ali

Professor of Agricultural Biochemistry, Faculty of Agriculture, Ain Shams University

Prof. Dr. Aly Islam M. Aly

Prof. of Chemical Engineering, Atomic Energy Authority

ABSTRACT

Ahmed Abd Elsalam Ali Easa. "USING STABLE ISOTOPES AND OTHER TECHNIQUES AS TRACER FOR POLLUTION TRANSPORT IN SOIL AND PLANTS". Unpublished M.Sc. thesis Department of Agricultural Biochemistry, Faculty of Agriculture, Ain Shams University,

Abu Rawash area is one of the Egyptian areas that subjected to some environmental contaminant due to the prolonged time of wastewater disposal during irrigation that practices environmental contamination in soil and groundwater. The present work aims mainly at the use of different techniques to trace the pollutants coming from sewage water and their movement in agriculture soil. These techniques can be used to give us a complete picture about the nature of these contaminants and its behavior in soil layers.

Two core of sandy soils (١٠٠cm depth), two core of clay soils (٧٠ cm depth), and two types of plants were collected from the studied area during the term of this study.

The optioned results of the physical analysis of soil cores indicated that sewage irrigation practices led to increase the percentage of fine particulars in the treated cores with sewage sludge in comparison with the untreated cores. The data also showed that sandy soils have higher bulk density and lower moisture and porosity in comparison with clay soils. The data indicated that sewage irrigation led to increase soil acidity due to the increase of the fermentation rate of soil organic matter through the depth profiles.

The data obtained from heavy metals analysis of soil cores showed that sewage application led to increase the concentration of available heavy metals of the sewage irrigated cores (cores ١ and ٤) in comparison with the untreated cores (cores ٢ and ٣). Total heavy metals determination of plant samples indicated that sewage effluent irrigation

led to increase heavy metals concentration (Cd, Co, Cu, Fe, Mn, Ni, Pb, and Zn) in the sewage irrigated plant parts in comparison with the untreated plants.

Isotopic enrichment trends were observed along the soil depth profiles with different amplitudes. The δ^{١٣}C in cores one and four (sewage irrigated cores) ranged from -٢٥,٩٢ to -٩‰ and -٢٦،٤٦ to -٢١،٠١ ‰ respectively, while in cores two and three (unpolluted cores) ranged from -٢٥,٧١ to -٢١،١٧‰ and -٢٣،٤٥ to -١٩،٠٨‰ respectively, indicating that sewage irrigation caused δ^{١٣}C to be more depleted in the sewage irrigated cores in comparison with the unpolluted cores. This could illustrate the distribution of carbon isotope of SOM along depth intervals along depth intervals of core samples and reflect the type of organic matter and the decomposition rate in soil profiles.

Sewage application also led to increase the NO٣-N concentrations. Concentration of NO٣ were generally greatest in th root zone (٠-٤٠ cm), which presumably reflect a short-term gain due to mineralization of the soil organic matter and fertilizer or manure inputs. Below the root zone, concentrations of $NO_{٣}$ tended to decrease primarily reflecting short-term losses due to plant uptake and leaching. Values of δ^{١٥}N in the soil samples ranged from +٤،٠٨‰ to +٦،٢٧‰ in core ١, from -٥،٩٧‰ to ٢،٤١‰ in core ٢, from -٣،٥٩‰ to +٧،٤‰ in core ٣, and from -١،١٣‰ to +٧،٩٨‰ in core ٤. These data indicated that the source of nitrate pollution in cores one and four were mixing between sewage water and chemical fertilizer, while in cores two and three the source of of nitrate pollution was only from chemical fertilizer.

Key words: Abu Rawash, Pollution, Heavy Metal, Soil Core, Plant, Technique, Stable Isotope**,** ^{١٣}C, ^{١٥}N, Soil Organic Matter.

ACKNOWLEDGMENT

I would like to express my deep gratitude to **Prof. Dr. Farouk Guindi Mouwad** and **Prof. Dr. Nagah El-Shahat Ali** Biochemistry Department Faculty of Agriculture Ain Shams University for supervising this thesis and their continuous interest.

I would like to express my greatest appreciation and deepest gratitude for **Prof. Dr. Aly Islam M. Aly** Prof. of Chemical Engineering, President of Atomic Energy Authority for planning and supervising this thesis, effective guidance and valuable discussion.

I would like to express my deepest gratitude and indebtedness to **Asses. Prof. Dr. Sawsan Gamal Abd Elsamie** and **Dr. Mona Abbas Ahmed**, central lab of stable isotope hydrology for their continuous encouragement, careful follow-up and unfailing offered during the course of the experiments and throughout the preparation and revision of the manuscript.

I would like also to express my deep thanks for all the staff members of **The Central Lab of Stable Isotope Hydrology,** National Centre for Nuclear Safety and Radiation Control, Atomic Energy Authority.

Finally, I would like to express my deepest thanks for **My Mother and Family** and special thanks to **my Wife** and **my Daughters (Sara and Sama)** for care, support and encouragement.

CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

١. INTRODUCTION

The increase usage of sewage water as water resource for irrigating lands and sludge for improving soil characters causes serious hazards for soil, plants and groundwater. These hazards come from organic and inorganic pollutants present in effluent water and sludge which spread during the movements of these contaminates through the soil layers that retain some of it to a greater or lesser extent and seep the others to contaminate the subsurface water body, or intake into plants through their roots to the other parts. The continuous and extensive use of such water for long time will concentrate heavy metals and toxic organic compounds in soil.

Most attention is given to pollution arising from increasing human activities. Abu Rawash area is characterized by new urbanization areas, which randomly distributed within the cultivated areas. These areas are suffered from the absence of sewerage system for collecting domestic and sewage waters although the presence of Zinen and Abu-Rawash sewage stations that were constructed for collecting and treating wastewater of Giza area. Inadequate treatment processes have been occurred in these stations to minimize heavy and colloidal particles only. This poorly treated water is discharged through two main drains (Zinen and Barakat drains) which penetrate the cultivated areas. Also the additive waste from the urbanizing areas are directly discharge from their houses or indirectly by pumping wastewater and pour it in these drains.

The present work is mainly aim to use different techniques to trace the pollutant coming from sewage water and its movement in agriculture soil. These techniques can be used to give us a complete picture about the nature of these contaminants and its behavior in soil.

٢. REVIEW OF LITERATURE

٢.١ Stable carbon isotope

The natural abundance of the stable isotopes of C, N, H, and O has been successfully applied to various ecological and environmental studies. The natural abundance of C and N were found relevant. While the theory behind isotope fractionation is similar for these elements, the processes causing the fractionation are unique to the individual elements.

٢.١٫١ Carbon isotope background information:

Carbon has two stable, naturally occurring isotopes: ^{١٢}C and ^{١٣}C with a natural abundance of ٩٨,٨٩٪ and ١,١١٪, respectively. These isotopes have slight differences in chemical and physical properties due to their mass differences. Measuring an absolute isotope ratio is not practical; a relative ratio is measured with reference to a standard sample as PDB (calcite structure from a fossil Belemnitella americana from the cretaceous Pee Dee Formation in South Carolina). The isotopic results are expressed as parts per thousand (per mil, or ‰) due to the small isotopic variations between ^{١٣}C /^{١٢}C ratio of the sample and that of the PDB standard. Stable isotopes are commonly expressed in delta (δ) notation, i.e $\delta^{١٣}C$ value of -١٠ ‰ indicates a sample with a ^{١٣}C /^{١٢}C ratio ١٠ parts per thousand lower than the PDB standard; a $\delta^{١٣}C$ value of +٥ ‰ indicates a sample with a ^{١٣}C /^{١٢}C ratio ٥ parts per thousand greater than the PDB standard. ^{١٣}C/^{١٢}C ratios are expressed relative to a standard as delta ^{١٣}C values, where:

$$\boxed{\text{¢}\,^{13}C = \frac{^{13}C/^{12}C_{sample} - {}^{13}C/^{12}C_{standard}}{^{13}C/^{12}C_{standard}} \times 1000}$$

Soil organic carbon:

The two most important soil carbon reservoirs that are subject to isotopic fractionation are soil organic carbon (SOC) and carbonate Carbon (CC). Original SOC is a result of photosynthesis process in plant