



شبكة المعلومات الجامعية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of
15-25- c and relative humidity 20-40%



شبكة المعلومات الجامعية التوثيق الالكتروني والميكروفيلم



بعض الوثائق الأصلية تالفة

بالرسالة صفحات لم ترد بالاصل

*Menoufiya University
Faculty of Agriculture
Department of Soil Science*



STUDIES ON PHYTOREMEDIATION OF HEAVY METALS POLLUTED SOIL

By

NESREEN FAROUK IBRAHIM ZEIN

B.Sc. (Agric. Soils), Tanta Univ. 2000

A THESIS

***Submitted in Partial Fulfillment of the
Requirement for the degree of***

MASTER OF SCIENCE

In

SOIL SCIENCE

Department of Soil Science

Faculty of Agriculture

Menoufiya University

Handwritten signature/initials

2004

*Menoufiya University
Faculty of Agriculture
Department of Soil Science*



STUDIES ON PHYTOREMEDIATION OF HEAVY METALS POLLUTED SOIL

By
NESREEN FAROUK IBRAHIM ZEIN
B.Sc. (Agric. Soils), Tanta Univ. 2000

A THESIS
Submitted in Partial Fulfillment of the
Requirement for the degree of

MASTER OF SCIENCE
In
SOIL SCIENCE

Department of Soil Science
Faculty of Agriculture
Menofiya University

2004

CREDIT SHEET

This M.Sc. Thesis Entitled

“Studies on Phytoremediation of heavy metals polluted soil”

Submitted by: **Nesreen Farouk Ibrahim Zein**

has been supervised by

1. Prof. Dr. Mohamed Mohamed Hamada Shalaby

*Professor of Soil Science,
Department of Soil Science,
Faculty of Agriculture
Menoufiya University*

2. Prof. Dr. Sanaa Wasif Barsoom

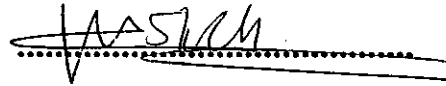
*Professor of Soil Science,
Department of Soil Science,
Faculty of Agriculture
Menoufiya University*

3. Dr. Mohamed Saber El-Yamani

*Senior Researcher of Soil Science,
Soil Water and Environment Research Institute
Agricultural Research Center*

Signatures of Supervision Committee

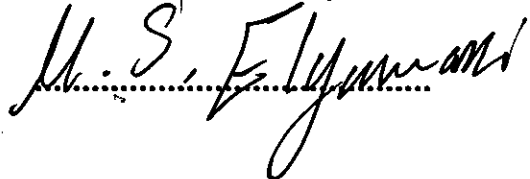
Prof. Dr. Mohamed M.H. Shalaby



Prof. Dr. Sanaa W. Barsoom



Dr. Mohamed S. El-Yamani



APPROVAL SHEET

Title of Thesis: "Studies on Phytoremediation of heavy metals polluted soil"

Submitted to: Department of Soil Science, Faculty of Agriculture,
Menoufiya University

Name of Student: **Nesreen Farouk Ibrahim Zein**

B.Sc. Agric. Sci., (Soils), Kafr El-Sheikh, Tanta Univ. (2000)

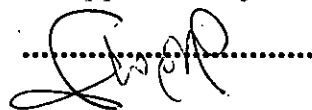
Degree: Master in Agricultural Science (Soils)

Examiners Committee

Prof. Dr. Salah El-Dein Ahmed Faizy

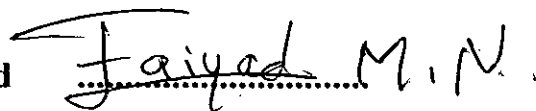
*Prof. of Soil Sciences,
Head of Soil Science Department,
Faculty of Agriculture, Kafr El-Sheikh,
Tanta University*

Approved By



Prof. Dr. Mohamed Naguib El-Sayed Faiyad

*Prof. of Soil Science,
Department of Soil Science,
Faculty of Agriculture,
Menoufiya University*



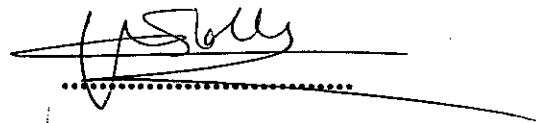
Prof. Dr. Sanaa Wasif Barsoom

*Prof. of Soil Science,
Department of Soil Science,
Faculty of Agriculture,
Menoufiya University*

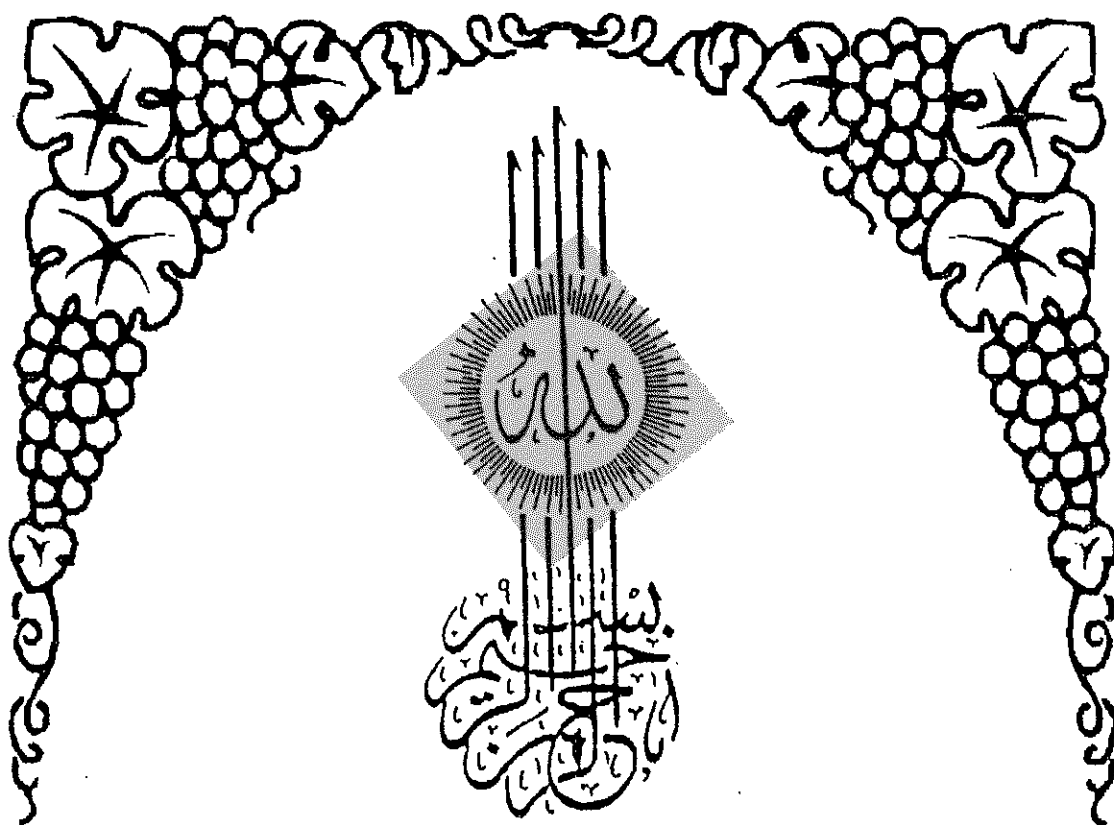


Prof. Dr. Mohamed Hamada Shalaby

*Prof. of Soil Science,
Department of Soil Science,
Faculty of Agriculture,
Menoufiya University*



Date: 10/10/2004



قَالَ لَوْلَا سُبْحَانَكَ اللَّهُ عَمَّا يُشْرِكُونَ
أَلَمْ نَجْعَلْكَ آيَاتٍ لِّقَوْمٍ يَعْلَمُونَ

اللَّهُ مَنَّا جَلِيلٌ أُنزِلَتْ آيَاتُهُ
عَلَيْكَ يَا مُحَمَّدُ



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

البقرة - آية ٢٢



To

My Parents

My Lovely Husband

My Sister

My Brothers

ACKNOWLEDGEMENT

**IN THE NAME OF GOD, THE MOST GARCIOUS,
THE DISPENSER OF GRACE**

(First of all thanks to Allah for every thing)

Thanks and appreciation to Prof. Dr. Mohamed Mohamed Hamada Shalaby, Prof. of Plant Nutrition, Soil Dept. Fac. of Agric. Menofiya University for suggesting the problem of this work, his cooperative, fruitful help, guidance through all steps of this work, reviewing the manuscript and putting this thesis in the final form.

Thanks are also to Prof. Dr. Sanaa Wasif Barsoom, Prof. of Plant Nutrition, Soil Dept. Fac. of Agric. Menofiya University for her continuos help criticism encouragement, supervision.

Sincere thanks are to Dr. Mohamed Saber El-Yamani, Senior Researcher of Soil Science, Soil Water and Environment Research Institute, Agricultural Research Center for shearing in suggesting the problem, guidance through all steps of this work and continuos help and encouragement.

Thanks to all staff members of soil science department, Faculty of Agriculture, Menofiya University and all staff member of soil chemistry and physic research Sakha Station especially Dr. Hamida El-Sanafawy and Dr. Nasser Talha for their help and cooperation.

CONTENTS

	Page
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	4
2.1. Phytoremediation.....	4
2.2. Hyperaccumulators.....	7
2.3. Heavy metals and human health	9
2.4. Nickel	12
2.4.1. Ni contents in soil	12
2.4.2. Ni in plant.....	15
2.4.3. Pollution of Ni.....	17
2.5. Lead	19
2.5.1. Lead (Pb) contents in soil	19
2.5.2. Pb in plant	21
2.5.3. Pollution of Pb	22
2.6. Cadmium	26
2.6.1. Cadmium contents in soil.....	26
2.6.2. Cd in plant	27
2.6.3. Pollution of Cd.....	31
3. MATERIALS AND METHODS	38
3.1. Soil preparation	39
3.2. Plant and cultivation.....	40
3.2.1. The first experiment (Jute).....	40
3.2.2. The second experiment (Flax)	40
3.3. Methods of analysis	41
3.3.1. Soil analysis	41
3.3.2. Plant chemical analysis	42
4. RESULTS AND DISCUSSION.....	44
4.1. Availability of Ni, Pb and Cd in soil as affected by their application	44

4.2. Agronomical characterizations of cultivated fiber crops as affected by Ni, Pb and Cd concentrations and their combinations	44
4.2.1. Jute plants at 45 days age.....	44
4.2.2. Flax plants at 45 days age	49
4.2.3. Jute mature plants.....	55
4.2.4. Flax mature plants	61
4.3. Photosynthetic pigments content of plants as affected by heavy metal.....	67
4.3.1. Jute photosynthetic pigments.....	67
4.3.2. Flax photosynthetic pigments	70
4.4. Heavy metals content and uptake of crop plants as affected by heavy metals applications	74
4.4.1. Nickel content and uptake of jute and flax at 45 days age	74
4.4.2. Lead content and uptake of jute and flax at 45 days age	81
4.4.3. Cadmium content and uptake of jute and flax at 45 days age	87
4.4.4. Nickel concentration and uptake of jute mature plants	91
4.4.2. Lead concentration and uptake of jute mature plants.....	97
4.4.6. Cadmium concentration and uptake of jute mature plants	102
4.4.7. Nickel concentration and uptake of flax mature plants	106
4.4.8. lead concentration and uptake of flax mature plants	112
4.4.9. Cadmium concentration and uptake of flax mature plants	118

4.5. Translocation of Ni, Pb and Cd within jute and flax plants as affected by heavy metals applications	125
4.5.1. Nickel jute and flax at 45 days age	125
4.5.2. Lead jute and flax at 45 days age	127
4.5.3. Cadmium (Cd) jute and flax at 45 days age	127
4.5.4. Nickel (Ni) translocation of jute and flax mature plants	128
4.5.5. Lead (Pb) translocation of jute and flax mature plants:	131
4.5.6. Cadmium (Cd) translocation of jute and flax mature plants	134
5. SUMMARY	137
6. REFERENCES	145
7. ARABIC SUMMARY	