STUDIES ON BEHAVIOUR OF SOME HEAVY METALS IN SOIL

By

MOHAMED ABDEL-FATTAH MOHAMED KID

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

DOCTOR OF PHILOSOPHY
in

Agricultural Science
(Soil Science)

Department of Soil Science
Faculty of Agriculture
Ain Shams University

1991

Approval Sheet

STUDIES ON BEHAVIOUR OF SOME HEAVY METALS IN SOIL.

By

MOHAMED ABDEL-FATTAH MOHAMED EID
B. Sc. (Soil Sci.) Faculty of Agric. Ain Shams Univ., 1980.
M. Sc. (Soil Sci.) Faculty of Agric. Ain Shams Univ., 1984.

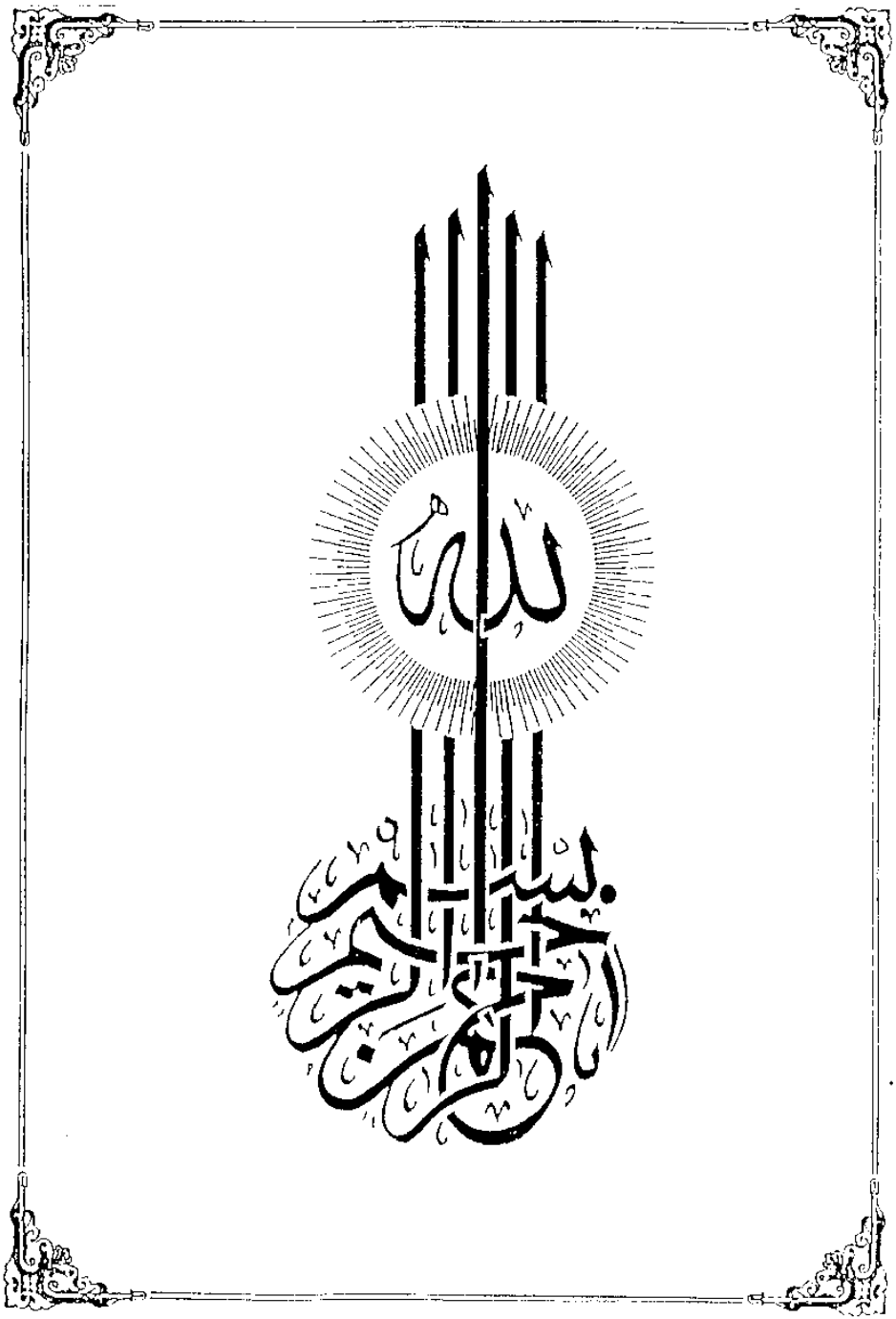
This thesis for Ph. D. degree has been approved by :

Prof. Dr. M. E. El-Nennah
Prof. of Soil Chemistry.
M. El-Nennah

Prof. Dr. O. M. M. Aly
Prof. of Soil Science.
Osvis M. Aly

Prof. Dr. A. S. Ismail
Prof. of Plant Nutrition.
A. S. Ismail

Date of examination : 6. 12. 1990



STUDIES ON BEHAVIOUR OF SOME HEAVY METALS IN SOIL.

by

MOHAMED ABDEL-FATTAH MOHAMED EID

B. Sc. (Soil Sci.) Faculty of Agric. Ain Shams Univ., 1980.

M. Sc. (Soil Sci.) Faculty of Agric. Ain Shams Univ., 1984.

Under the supervision of:

Prof. Dr. El-Nennah, M. E. Prof. of Soil Chemistry Fac. of Agric. Ain Shams Univ., Egypt.

Prof. Dr. Höfner, W. Prof. of Plant Nutrition Insti. of Plant Nutrition Giessen Univ., Germany.

ABSTRACT

Experiments under greenhouse and laboratory conditions were conducted to investigate the effect of sewage sludge on the behaviour of the heavy elements Zn, Cu and Ni in soil and to assess the periodical changes of the elements in the different forms when added to soil at different levels with sewage sludge. Moreover, the heavy elements in soil and sludge-soil mixtures were extracted by two different sequential extraction methods. An evaluation of the extractability of the two methods was also considered.

Sewage sludge limited the toxicity of the applied heavy elements to the soil. At the same time it increased the dry weight of grass, although the grass content of Zn and Cu was significantly increased. Addition of Zn, Cu or Ni singly at the

same certain level with sewage sludge 5% raised their grass content and uptake as follow: Ni ≫ Zn > Cu. Competition between Zn and Cu and not Ni for adsorption sites on the sludge-soil mixture was observed. Low Ni content of the sludge mixed with soil may be the reason. The distribution of heavy elements among the different forms in soil appeared to be due to many factors. a) Sewage sludge redistributed the element between the different soil fractions. b) Although the dynamic equilibrium and the redistribution of heavy elements among the different forms in the soil, increasing the rate of heavy element in the soil, slightly increased their percentage in readily available and organic fractions. c) Decreasing the soil pH increased the percentage of Zn, Cu and Ni in the water soluble and readily available forms. d) For 18 months incubation, a little enhancement for Zn, Cu and Ni in residual fraction at the expense of them in the water soluble and readily available forms was found. e) Increasing the soil moisture content decreased the readily available forms, while the more fixed forms increased. The majority of Zn, Cu and Ni was found in the "carbonate", "organic" and "sulfide" forms according to Sposito's method, while in the "humin", "organic matter" and "residual" forms according to the proposed method, in the used soil treated with 5% or 10% sludge (pH 6-7). Multiple regression equations showed that the data of proposed method, in most cases, are more relevant than the corresponding obtained from the other one with respect to Zn, Cu and Ni content in plant.

ACKNOWLEDGEMENT

The author wishes to express his deepest appreciation and gratitude to Prof. Dr. M. E. El-Nennah Prof. of Soil Chemistry Fac. of Agric. Ain Shams Univ., Egypt. and Prof. Dr. W. Höfner Prof. of Plant Nutrition Insti. of Plant Nutrition Justus Liebig Univ. Giessen, Germany, for their supervision, valuable advice, kind encouragement and assistance through this work.

It is a chance to ask God to have mercy upon the Deceased Prof. Dr. T. El-Kobbia, Soils Dept., Ain Shams Univ., for his faithful help, and supervision particularly in the eary stages of this work.

Greatful thanks are due to Dr. A. S. El-Sebaay lecturer of Soil Chemistry, Fac. of Agric. Ain Shams Univ. for remarks gratitude assistance.

Sincere thanks are also, forwarded to all staff members of Soil Sci. Dept. Fac. of Agric. Ain Shams Univ., Egypt, and Insti. of Plant Nutrition Justus Liebig Univ. Giessen, Germany, for providing facilities to continue this work.

CONTENTS

LIST OF TABLES

LIST OF FIGURES