STUDIES ON BIO-ORGANIC FERTILIZATION OF WHEAT UNDER NEWLY RECLAIMED SOILS

THESIS

Submitted in Partial Fulfillment Of The
Requirements For The Degree

Of

DOCTOR OF PHILOSOPHY

In

Agricultural Microbiology

BY

FARID SHAWKI FARID BADAWI

B.Sc. (Soil Sci.)
Faculty of Agricultural, Ain Shams University (1990)

M.Sc. (Soil Sci.)
Faculty of Agricultural, Ain Shams University (1997)

Department of Agricultural Microbiology
Faculty of Agriculture
Cairo University

2003

APPROVAL SHEET

STUDIES ON BIO-ORGANIC FERTILIZATION OF WHEAT UNDER NEWLY RECLAIMED SOILS

BY

FARID SHAWKI FARID BADAWI

This thesis has been approved by:

Prof. Dr. Mohamed Ali El-Borollosy
Prof. Agric., Microbiology,
Fac. Agric., Ain Shams University

Prof. Dr. Nadia Fahmy Emam
Prof. Agric., Microbiology,
Fac. Agric., Cairo University

Prof. Dr. Moawad Kamel Zahra
Prof. Agric., Microbiology,
Fac. Agric., Cairo University (Supervisor)

Committee in Charge

Date : / / 2003

Cairo University
Faculty of Agriculture
Department of Agricultural Microbiology

SUPERVISION COMMITTEE

Name : **FARID SHAWKI FARID BADAWI**

Title : **STUDIES ON BIO-ORGANIC FERTILIZATION OF WHEAT UNDER NEWLY RECLAIMED SOILS**

Degree : **Ph.D. Agricultural Microbiology**

Under the supervision of :

Prof. Dr. Moawad Kamel Zahra

Prof. Agric., Microbiology,
Fac. Agric., Cairo University.

Prof. Dr. Zakia Ahmed Helmy

Prof. Agric., Microbiology,
Fac. Agric., Cairo University.

Prof. Dr. Saleh Ahmed Saleh

Prof. Agric., Microbiology, Microbiology Dept.,
Soils, Water and Environ. Res. Institute,
ARC, Giza, Egypt.

Name of Candidate : Farid Shawki Farid Badawi..... Degree: Ph.D.....
Title of Thesis : **"Studies on bio-organic fertilization of wheat under newly reclaimed soils"**.....
Supervisors : Prof. Dr. Moawad Kamel Zahra.....
Prof. Dr. Zakia Ahmed Helmy.....
Prof. Dr. Saleh Ahmed Saleh.....
Department: Agricultural Microbiology.....
Branch : Soil Microbiology .....Approval.....

ABSTRACT

The present work concerns to study the bio-organic fertilization of wheat under newly reclaimed soils. The aims of the present study is to reduce the full dependence on chemical fertilizers and keep high productivity of wheat in the same time. To achieve the aims of this study, four enriched composted heaps were made from rice straw and filtermud cake at ratio of 1:1 by weight, then all heaps supplemented by chicken manure. Compost type (H_1) was considered as a control, while (H_2) received the mineral amendments of bentonite, rockphosphate and manganese-ore. Compost type (H_3) received biofertilizers of cellulolytic fungi, *Azotobacter chroococcum* and *Bacillus megaterium*. Compost type (H_4) received both mineral amendments and biofertilizers. All heaps were aerobically composted till maturation (after 75 days) and stored for 360 days after maturation. The physical, chemical and biological changes during the composting process and storage were evaluated. Also, the degree of maturity were tested.

A pot experiment was carried out under greenhouse conditions to select the most suitable rate of compost application for wheat growth under sandy soil conditions. Also, another pot experiment was conducted under greenhouse conditions to evaluate the response of wheat to *Azorhizobium* inoculation, compost application and different N-levels under sandy soil conditions. Finally, pot and field experiments were conducted to study the effect of selected compost types combined with *Azorhizobium* inoculation and different N-levels, compared to the recommended dose of N-fertilizer on wheat growth under sandy soil conditions.

The obtained results from monitoring of the composting process showed that temperature reached maximum values within 1-3 days after each heap turning, then dropped to be similar to the ambient temperature at maturity with slightly higher temperature in amended heaps as compared to the unamended ones. Furthermore, W.H.C, bulk density, E.C, total NPK, soluble-N and available P and K were increased with progressing the composting process and storage. While, O.C, O.M and C/N ratio were decreased. The changes were greatly affected by the applied amendments. In addition, the total counts of mesophilic bacteria and actinomycetes showed a little increase at early intervals of composting process, then they gave a high increase till the end of the process. On the other hand, the total counts of thermophilic microorganisms, mesophilic fungi and cellulose decomposers gave a high counts at early intervals, then they declined at the end of the composting and storage. *Azotobacter* and acid producing bacteria recorded a slight high counts in matured composts and there is an slight reduction in counts of both microbes at storage. In addition, all composted heaps at maturity showed a drop in temperature to be similar to the ambient temperature, while pH tested under anaerobic conditions recorded an alkaline values. All ratios of the mesophilic/thermophilic microorganisms

M. K. Zahra

were more than 1.0. The ratios of E_4/E_6 (extinction coefficient) for all heaps was relatively lower which indicates a large particle size and characterized with humic acids more than fulvic acids. Amended heaps showed higher activity of dehydrogenase and nitrogenase activities compared to the unamended ones. Also, no inhibitory effect was appeared from using of compost water extract of all heaps during the germination test.

The obtained results from the first pot experiment showed that there are significant differences between application rate of zero and 5 ton compost/fed on wheat growth under sandy soil conditions, while there were no significant differences between 5 and 10 ton/fed. Application of 5 or 10 ton compost/fed improved chemical properties of sandy soil.

The obtained results from the second pot experiment showed that the response of wheat plants to *Azorhizobium* inoculation, different compost types and various N-levels was significant. The response of wheat to application of any type of compost (particularly H_2 or H_4) combined with inoculation gave higher results of plant growth, NPK contents as well as yield and some yield parameters under sandy soil conditions. The response of wheat to *Azorhizobium* inoculation combined with different N-levels showed that using higher levels of N-fertilizer with or without inoculation gave higher values of wheat plant growth, NPK uptake as well as yield and some yield parameters. The response of wheat to compost types (H_4 or H_2) combined with 25 kg N/fed gave grain yield similar to or higher than those obtained by the full dose of chemical N-fertilizer. On the other hand, *Azorhizobium* inoculation showed no significant effect on the sandy soil properties, while application of composts to sandy soils led to improve their chemical properties, particularly compost types (H_4 or H_2).

Also, the results of the third pot as well as the field experiments confirmed that application of compost types (H_4 or H_2) plus 25 kg N/fed combined with *Azorhizobium* inoculation gave wheat grain yield similar to those obtained by the recommended dose of chemical N-fertilizer. Application of compost types (H_4 or H_2) to sandy soils led to improve their chemical properties.

M. K. Zahra

was appeared from using of compost water extract of all heaps during the germination test.

The obtained results from the first pot experiment showed that there are significant differences between application rate of zero and 5 ton compost/fed on wheat growth under sandy soil conditions, while there were no significant differences between 5 and 10 ton/fed. Application of 5 or 10 ton compost/fed improved chemical properties of sandy soil.

The obtained results from the second pot experiment showed that the response of wheat plants to *Azorhizobium* inoculation, different compost types and various N-levels was significant. The response of wheat to application of any type of compost (particularly H_2 or H_4) combined with inoculation gave higher results of plant growth, NPK contents as well as yield and some yield parameters under sandy soil conditions. The response of wheat to *Azorhizobium* inoculation combined with different N-levels showed that using higher levels of N-fertilizer with or without inoculation gave higher values of wheat plant growth, NPK uptake as well as yield and some yield parameters. The response of wheat to compost types (H_4 or H_2) combined with 25 kg N/fed gave grain yield similar to or higher than those obtained by the full dose of chemical N-fertilizer. On the other hand, *Azorhizobium* inoculation showed no significant effect on the sandy soil properties, while application of composts to sandy soils led to improve their chemical properties, particularly compost types (H_4 or H_2).

Also, the results of the third pot as well as the field experiments confirmed that application of compost types (IL_1 or II_2) plus 25 kg N/fed combined with *Azorhizobium* inoculation gave wheat grain yield similar to those obtained by the recommended dose of chemical N-fertilizer. Application of compost types (H_4 or H_2) to sandy soils led to improve their chemical properties.

ACKNOWLEDGMENT

The author wishes to express his sincere thanks, deepest gratitude and appreciation to Prof. Dr. Moawad K. Zahra, Prof. of Agricultural Microbiology; Prof. Dr. Zakia A. Helmy Prof. of Agricultural Microbiology, Faculty of Agriculture, Cairo University and Prof. Dr. Saleh A. Saleh, Head of Research, Department of Agricultural Microbiology, Soils, Water and Environment Research Institute, Agricultural Research Center (ARC), Giza for their active supervision, helpful guidance and continuous assistance in writing and preparing this manuscript.

I would like to show my whole hearted and best thanks to all members of Biofertilizers Production Unit, Department of Agricultural Microbiology, Soils, Water and Environment Research Institute, Agricultural Research Center (ARC), Giza for their great help and for use of all facilities.

Thanks are also extended to all staff members of Agricultural Microbiology Dept., Fac. Agric., Cairo Univ., for their valuable advice and cooperation.

CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES