PERFORMANCE EVALUATION OF NATIVE AND EXOTIC SPECIES OF EARTHWORMS FOR AGRO-HORTICULTURAL WASTE MANAGEMENT

by

PAYAL GARG

Centre for Rural Development and Technology

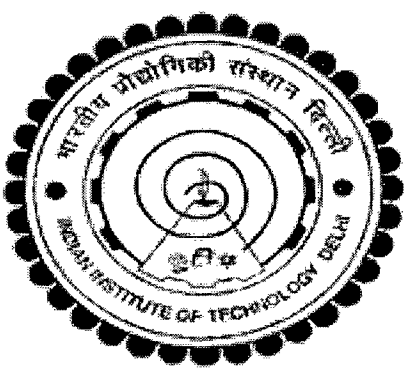
Submitted

In fulfillment of the requirement

of the degree of

Doctor of Philosophy

to the



Indian Institute of Technology Delhi

August 2009

sericulture, silk worm,

CERTIFICATE

This is to certify that the thesis entitled "**Performance evaluation of Native and Exotic species of earthworms for agro-horticultural waste management**" being submitted by **Ms. Payal Garg** to the Indian Institute of Technology, Delhi for the award of the degree of Doctor of Philosophy is a record of bonafide research work carried by her. Ms. Payal Garg worked under our guidance and supervision, and has fulfilled the requirements for the submission of this thesis, which to our knowledge has reached the required standard.

The results contained in this thesis have not been submitted in part or in full to any other university or institute for award of any degree or Diploma.

Satyawati 17/8/09

(Dr. Satyawati Sharma) **(Prof. Santosh Satya)**

Thesis Supervisors
Centre for Rural Development & Technology
Indian Institute of Technology, Delhi
Hauz Khas, New Delhi- 110016, India

Acknowledgements

We meditate on the glory of the Creator;
Who has created the Universe;
Who is worthy of Worship;
Who is the embodiment of Knowledge and Light;
Who is the remover of all Sin and Ignorances;
May He enlighten our Intellect.

It gives me immense pleasure to express my sincere regards for my supervisor, Dr. Satyawati Sharma whose academic excellence and constant encouragement steered me through the work all the way and all the time. Her calm approach coupled with patience and generosity throughout the course of present work helped me to complete my research work. I would seize this opportunity to express my deep sense of gratitude to my supervisor, Prof. Santosh Satya, who despite her busy schedule helped me in every possible manner. It was the encouragement, motivation and guidance provided by her that has given me all the energy and vision to complete this task. Her academic excellence coupled with holistic vision and personal affection instilled immense confidence in me throughout my research work including field level studies. I warmly thank Prof. P.L. Dhar and Prof S.N. Naik, Head CRDT, all faculty members and office staff of the centre for providing facilities for my research work.

I sincerely thank Dr. J.M. Julka, Zoological Survey of India, Solan, Himachal Pradesh for helping in the identification and inventory preparation of various native earthworm species. He also helped me by providing the basic literature on native earthworms. My heartfelt gratitude to Dr. Sultan Ismail (Chennai), for his valuable suggestions and sharing his expertise especially regarding use of native earthworm species.

I am grateful to Dr. Ransingh Arya, JVT Bijnore who despite his busy schedule helped me in every possible manner and gave technical guidance, support and encouragement to complete the field work. Help provided by JVT staff has resulted in successful completion of the work. Infact the deep involvement of Dr. R.S. Arya towards rural development and inculcating human values is an immense source of inspiration for me. I gratefully acknowledge Padamshri T.G.K. Menon, Indore for the initial support and providing basic knowledge about biodynamics. I am equally grateful to Dr. G.S.R. Murthy (Andhra Pradesh) for helping me in providing Homeosolution preparation and literature for experiments. I thank to Ms. Binita Shah, Supa Biotech Pvt. Ltd, Nainital (Uttranchal) for helping me providing the biodynamic preparations for experiment.

I sincerely thank Dr. Balraj Singh, Dr. S.S. Tomar, Scientist, IARI, Mr. Brijmohan, Mr. Sita Ram, IARI for discussions and providing the microbial culture and okra pest to carry my experiments. I am grateful to Dr. Vineet Rana for his help during my field experiments.

I would like to take this opportunity to thank Mr. Sheeshram ji, a progressive farmer of village Garhi for providing me a suitable site and facilities for the field experiments. Infact, without his help it would not have been possible to complete field work on native earthworms. I am also grateful to Shri Prashant Maharishi, Shri Maharaj Singh, Shri Shoorveer Singh, Shri Teejpal, Shri Samarpal (Bijnore) for their continuous help in all the field experiments and organizing training workshop in District Bijnore. In fact, field level research and demonstration unit would not have been completed without their technical advice and support.

I am grateful to my lab friends, Dr. Shivani Chaturvedi, Geetanjali Kaushik, Poonam Kaushik, Ashish Yadav, Prachi Kaushik, Kaviraj Pradhan, Neeru Kadian, Poonam Singhal and Shweta Sharma for their support in many ways. My heartfelt thanks are due to, Mr. Rakeshji, Mr. Sushil, Ms. Ranjana, Ms. Pushpa, Shri Shreepal, Shri Jeetsingh, who provided relentless support to accomplish the lab as well as field work at IIT Delhi.

My heartfelt gratitude to my parents-in-law, for giving all the support during my Ph.D work. I am indebted to my mother-in-law who supported me during my tough phase. In fact, it would have been impossible for me to complete this study without their blessings and support. This acknowledgement would be incomplete, if I don't mention the name of my husband Amit Agarwal, whose cooperation and moral support was instrumental throughout my research work. My son Shaurya deserves a special mention for bearing with all my PhD commitments.

Last but certainly not the least I am ever indebted to my parents, for giving me life in the first place, for educating me, for unconditional support, encouragement to pursue my interests, even when the interests went beyond my patience and whose love and blessings brought me here up to. I am grateful to my brothers for giving me mental support during my study.

Finally, I acknowledge and thank Science-Society Division, DST, New Delhi for Financial Support through Young Scientist project for carrying out the research work. Dr. Vinita Sharma, Mrs. Shobhna Bhaskaran and Mr. Sunil Agarwal, Mrs. Usha Dixit, deserve my special thanks for providing timely support to complete the project work.

Payal Garg

ABSTRACT

Earthworms are important organisms helping nature to maintain nutrient flow from one system to another and also minimize environmental degradation. Recently, use of native earthworms in waste management has been recognized as it has inbuilt eco- sustainability features and would offer a solution to the possible conflicts between the basic characteristics of native and exotic earthworm species. In this context, present study was taken up with the following major objectives: (i) Identification and selection of suitable native species of earthworms in a rural area. (ii) Comparative study on the growth characteristics and heavy metal tolerance of exotic and native earthworm species. (iii) To enhance the multiplication of native earthworm species by growth promoters and bioinoculants. (iv) Production and characterization of vermicompost and vermiwash produced by native and exotic species of earthworms. (v) Field evaluation of vermicompost and vermiwash prepared by both earthworm species on selected crops.

To begin with, collection and identification of native earthworm species prevalent in the study area (agricultural area adjacent to Jeevan Vidya Trust, village Govindpur, Bijnore district, (U.P.) was done. Total 8 species were found prevailing in the study area and among these, Allolobophora parva (A. parva) was found more distributed and hence it was selected for further studies. The results of preliminary investigation revealed that total number of E. fetida (exotic species) was found higher in substrate (without soil) while in case of A. parva, maximum growth was observed in the substrate having 30% soil. The growth of both types of earthworms was found higher during monsoon season. On the basis of comparative study of native and exotic earthworms under different survival conditions it was found that for both species the optimum temperature, moisture content and pH were 30°C, 65-70% and 7.5 respectively. In this context it may be noted that though the multiplication of A. parva is slow than E. fetida but fold increase in weight of A. parva was higher than E. fetida. This interesting experimental observation would help in assessing the true potential of native earthworm species and scope of further enhancement using bioformulation and bioinoculants.

In order to enhance the multiplication of earthworms, certain growth promoters and bio-inoculants were tried. Homeo-formulation (SSY1), as growth stimulant produced better results than BD formulation and bioinoculant (Azotobacter chroococcum). 1ml (SSY1)/2 Kg of substrate was found optimum for enhancing the multiplication (10.6 fold) of A. parva. The results of vermicomposting experiments (A.parva) using leaf litter mixture, Putranjiva roxburghii and sugarcane trash based substrate with Homeo formulation (SSY1) clearly indicated that total

nitrogen content (1.2%) was maximum in vermicompost of leaf litter mixture followed by sugarcane trash (0.85%) and P. roxburghii (0.78%). However, TP and TK in different vermicompost were found in the order: sugarcane trash>leaf litter mixture>P. roxburghii. In most cases NPK content in vermicompost by A. parva was found either more or at par with the vermicompost prepared by E. fetida. Experimental findings on the relative heavy metal accumulation and tolerance of exotic and native earthworm species unveiled a very interesting fact. The native earthworm A. parva exhibited higher tolerance, better survival and growth in heavy metal contaminated leaf litter based substrate as compared to the exotic species.

The results of Vermiwash revealed that vermiwash prepared by native species of earthworms showed significantly more N (0.22%), P (0.33%), minor nutrients (ppm) {Cu (0.24), Fe (1.82), Mn (0.53), Zn (0.06), Na (128), Ca (222), Mg (201)} and total phenolic content (48ppm) in comparison to vermiwash prepared by exotic earthworms. Bioassay results clearly show that the pest of okra crop (Spilosoma obliqua) can be controlled by vermiwash/cowurine only at the initial stage (i.e. 2nd instar larvae), providing guidelines for vermiwash application in vegetable crops.

The data of preliminary investigation by conducting field trials using vermicompost (prepared by native and exotic earthworms) for a pulse crop (Vigna mungo) under controlled conditions indicated that, total crop yield was found significantly higher (~10%) in case of vermicompost prepared by native earthworms than exotic earthworms in both the varieties of seeds (local and T-9). In case of a vegetable crop (Okra), vermicompost along with spray of 10 and 20% concentration of vermiwash (prepared by both species of earthworms) was found to be more effective in achieving higher yield of okra fruit (~8%) than control.

In toto, the present study brings out the fact that the use of native earthworm species by adding bioformulation/bioinoculants in the substrate for enhancing their multiplication can be successfully employed in vermicomposting of agro-horticultural waste. The experimental findings have certainly helped us in understanding the potential and significance of native earthworms in waste management while preserving the local biodiversity- a distinct merit of native earthworms over exotic species. This aspect needs to be highlighted by linking the 'waste management and nutrient recycling system' to sustainable agriculture. Present investigation is a small drop in the ocean for exploring the potential of native earthworm species in terms of eco-sustainability and economical feasibility for achieving rural prosperity.

CONTENTS

CHAPTER 6: Quality assessment of vermicompost and vermiwash (native and exotic species) under laboratory and field conditions