DYNAMICS OF BURIED WEED SEED POPULATION IN CROP FIELDS UNDER 'JHUM' (SHIFTING AGRICULTURE) AND TERRACE CULTIVATION IN MEGHALAYA

By

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THESIS SUBMITTED IN FULFILMENT OF THE DEGREE OF

DOCTOR OF PHILOSOPHY IN BOTANY

NORTH-EASTERN HILL UNIVERSITY
SHILLONG, INDIA
1992

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I certify that the thesis entitled ***"Dynamics of buried weed seed population in crop fields under 'Jhum' (shifting agriculture) and terrace cultivation in Meghalaya"*** *submitted by* ***Mr. Uttam Kumar Sahoo,*** *for the* ***Degree of Doctor of Philosophy*** *of the North-Eastern Hill University, Shillong, embodies the record of original investigation by him under my supervision. He has been duly registered and the thesis presented is worthy of being considered for the award of the* ***Ph.D. Degree.*** *The work has not been submitted for any degree of any other University.*

SHILLONG
THE 9th APRIL 1992

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Supervisor

ACKNOWLEDGEMENTS

I express my deep sense of gratitude and sincere thanks to my revered teacher, Dr. R.S. Tripathi, M.Sc., Ph.D., F.N.A.Sc., Professor of Ecology, Department of Botany, North-Eastern Hill University, Shillong 793 014, India, whose able guidance, keen interest, constant inspiration and encouragement throughout the course of the investigation enabled me to complete the task. I have learnt immensely from him and it is only because of him that I could be introduced into the wonderful world of ecology.

I am grateful to Dr. H. N. Pandey, Reader in Botany, North-Eastern Hill University, Shillong, for his valuable suggestions and criticisms from time to time during the course of this investigation.

My grateful thanks are due to Professor Y.S. Chauhan, Head of Department of Botany, NEHU, Shillong, for providing necessary laboratory facilities.

I am grateful to Dr. R.N. Prasad, Director, ICAR Research Complex for North-Eastern Hill Region, Shillong, for providing me facilities to carry out the field experiments at the ICAR farm, Barapani. I am also grateful to the Scientist-in-Charge of the Central Potato Research Station, Upper Shillong, for extending facilities for field experiment at CPRS farm. I am also grateful to Bah Karbin Pathaw, a farmer from Laitmynsaw Village, Upper Shillong, who allowed me to carry out the field experiments at his 'Jhum' fields.

I thank Dr. Stephen Moss, Long Ashton Research Station, Department of Agricultural Sciences, University of Bristol, England, for his useful suggestions and helpful information on soil seed bank.

It gives me great pleasure in thanking Dr. Tawnenga, Dr. A.K. Das and Dr. M.L. Khan, for their suggestions and encouragement throughout the study.

I am thankful to all my colleagues in the Plant Ecology Laboratory, viz., Miss J. Misra, Mr. S.K. Barik, Dr. Umashankar, Mr. L. Boral, Miss P. Rao, Miss T. Lyngdoh, Dr. G. Pradhan, Mr. D. Dutta and Dr. B. Wankhar, for their moral support and cooperation in various ways. I also thank Mr. A. Giri, Zoology Department, who extended help whenever asked for.

The help received from Dr. Y. Kumar and Mr. P.B. Gurung in identification of weed species and Mr. Joseph F. Khongbuh in typing the thesis are gratefully acknowledged. I thank Mr. Rameshwar Rai and Mr. K.D. Marak, who helped me in carrying out the field studies.

I must put on record my special depth of gratitude to my mother, brothers, sisters, sister-in-laws and other well-wishers who shared my difficulties and constantly encouraged me during the course of this study.

I am grateful to the Principal, Pachhunga University College, Aizawl, Head of the Department of Botany, Pachhunga University College and other colleagues of the Botany Department of the College for their cooperation and encouragement.

This research was completed during my tenure as a Junior Research Fellow in a UGC Research Project entitled "Studies on the dynamics of weed seed and seedling population in hill agroecosystems of Meghalaya" (Sanction No. F.3-37/87-SR-II). The financial support received from the University Grants Commission, New Delhi, is gratefully acknowledged. The award of a Senior Research Fellow under a Research Project sponsored by the Council of Scientific and Industrial Research, New Delhi (Sanction No. 37(50)/87-EMR.II) during the preparatory phase of this thesis, was also a great help.

Uttam Kumar Sahoo

(UTTAM KUMAR SAHOO)

SHILLONG
THE 9th APRIL 1992.

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CHAPTER I

General Introduction

'Soil seed bank' represents seed reserve or seed pool which is partly composed of seeds produced on the area and partly of the seeds blown from elsewhere (Cohen, 1966). The seeds generally enter into the soil either in dormant condition or the dormancy is imposed upon them. These seeds form the soil seed bank. It remains there in dormant state as long as the unfavourable conditions persist. The longevity and size of the soil seed bank depends upon the life span of the seeds and species composition of the seed pool. It partly reflects the history of vegetation and is also likely to contribute to its future (Major & Pyott, 1966). The dormant fraction of the seed bank is likely to continue to many generations of the plants, sometimes over decades. Therefore, seed bank may be said to represent a store of 'evolutionary memory'.

Seed bank has a strong link to the survival of a plant population. A clear understanding of the dynamics of a plant population requires a thorough knowledge of the seed population dynamics in soil. The study of seed population dynamics in soil in the context of crop fields encompasses such aspects as 'seed rain' (sensu Harper, 1957), weed seed input through farmyard manure, contaminated crop seeds and

other agencies, weed seed dispersal, status of the weed seed bank in soil, fate of the buried weed seeds in time and space, weed seed losses caused by various agencies and weed seed population flux as a whole.

Most weed seeds undergo a period of dormancy after their dispersal. Depending on the species and the prevailing environmental conditions, the dormancy in seeds may last from few days to many decades. Such seeds continue to remain in dormant condition in soil as long as the unfavourable conditions persist in soil-seed environment. Therefore, the soil seed bank partly contains the seeds shed or blown onto it in the current seasons and partly of the seeds which have remained dormant from preceding years. This may also include some species no longer growing there. Thus the seed content of the soil partly reflects the past vegetational history of the land. The knowledge of various aspects relating to soil seed bank may be helpful even in forecasting the future weed vegetation.

Most weeds shed seeds before the crop harvest by virtue of their rapid growth and short life cycle. Therefore, before the weed plants die, they leave enormous quantities of seeds in the crop fields, which increases the size of the weed seed bank in soil and causes weed infestation in several subsequent years. Thus "One year's seeding seven

years' weeding" is not just a saying, it has a scientific basis too.

Weeds share much of the light, water, nutrients and other resources of the agroecosystems and adversely affect the crop yield. Thus, one of the prerequisites for improving crop productivity is to keep the crop fields free from weeds as far as possible employing various control measures including the application of herbicides. The herbicides, no doubt, kill the weed plants, however, the weed seeds lying at different depths of soil remain unaffected. Such seeds contribute to the recruitment of weeds when the conditions become favourable for germination and seedling emergence in subsequent generations. Therefore, the weed seed population in soil is a key factor in determining the dynamics of weed populations in crop fields.

In situations where effective weed control practice is lacking, the unchecked weed growth and successful seeding by weeds result in accumulation of seeds in soil in large numbers. This large weed seed reserve can contribute to the severity of weed infestation only when it contains sufficient quantity of viable seeds. In fact, the germinability of buried weed seeds, their longevity and dormancy mechanism regulate the weed infestation in subsequent years. The intensity of weed infestation, temporal and spatial variability in weed

population and composition of weed flora in agroecosystems are strongly influenced by the nature and dynamics of weed seed bank in soil.

Weed problem is a very common feature in all agro-ecosystems. The problem, in particular, is far more acute in shifting agriculture (locally called 'Jhum') where modern weed control measures are not employed. Though the terrace cultivation has been recommended as an alternative to 'jhum' as one of the measures to minimize deforestation and soil erosion and to improve crop yield, traditional 'Jhum' cultivation is still the chief agronomic practice of the tribal people of north-east India. The crop fields under both 'Jhum' and terrace cultivation in Meghalaya are heavily infested by a large variety of native and exotic weed species owing to the favourable climatic conditions for their growth and absence of efficient weed control measures.

The crop fields under 'jhum' cultivation are usually left as fallow for about 4-5 years before they are brought again under cultivation. There is a rapid and luxuriant growth of weeds during the fallow period. In 'jhum' cultivation, manual hand weeding is the sole method employed for weed control; there is no application of herbicides. On the contrary, the crop fields under terrace cultivation are subjected to continuous cropping and the fallow period, if any, happens

to be of a short duration. Therefore, the agro-ecosystems under terrace cultivation do not get enough time to develop protective vegetational cover. Moreover, the regular crop rotation and application of herbicides suppress the growth of weeds. Besides, mechanical as well as manual hand weedings are also frequently done to control weeds. Thus the 'Jhum' and terrace cultivation, both of which are prevalent in the hill region of Meghalaya vary considerably from each other. The variations in cultivation practices bring about changes in phenologies of weeds, and dispersal abilities of the colonizing species (Swaine & Hall, 1983; Uhl et al. 1981), as a consequence of which the dynamics of weed seed population in soil may also be influenced.

Weeds produce seeds in large numbers, a good proportion of which becomes incorporated into the soil weed bank of crop fields. Though a part of the soil seed bank, of course, gets exhausted with time, a large fraction of the buried weed seed population still remains there in viable state to perpetuate the weed problem. Therefore, it is important to know the fate of the weed seeds that are dispersed into an agroecosystem. These weed seeds subsequently get incorporated in the soil seed bank. The following pertinent questions could be raised with regard to the fate of weed seed bank in soil and related issues.

1) Do all the seeds entering the soil form an integral component of the soil seed bank as well as the weed flora?

2) How long do they survive in soil?

3) How does the burial affect their dormancy mechanism and actual germination?

4) How and to what extent do the prevailing cultivation practices influence the fate of buried weed seed population?

These are some of the questions which need to be answered through manipulative field studies and 'control' experiments.

Keeping the above points in view, the present study on the dynamics of buried weed seed population in different crop fields under 'jhum' and terrace cultivation has been made to cover the following aspects:

1) Weed seed input to the crop fields through seed rain, contaminated crop seeds and FYM.

2) Species composition of the weed flora and soil seed bank.

3) Existing status of the soil seed bank.

4) Fate of the buried weed seed population.

5) Change in seed viability and dormancy of seeds of a few selected weeds due to burial.

6) Weed seed loss from the crop fields.

The experimental data on various aspects mentioned above have been presented in Chapters IV to X. The General Introduction (present chapter) outlines the significance of weed seed bank in soil and sets out the objective of the thesis. The literature pertainining to various aspects of weed seed bank in soil, such as fecundity of weeds, weed seed input into the soil, viability, dormancy and germinability of the buried weed seeds, change in buried weed seed population in time and space and loss of weed seeds from the soil seed bank have been briefly reviewed in Chapter II (Review of Literature). Chapter III deals with the soil, climate and vegetation and also describes the salient features of the seeds of a few selected weed species. Although the data contained in Chapters IV - X have been critically discussed in the corresponding chapters, the major findings of the entire work have also discussed in an integrated manner (Chapter XI, General Discussion).