EFFECT OF AGRICULTURAL PRACTICES ON THE STRUCTURE AND FUNCTION OF VESICULAR-ARBUSCULAR MYCORRHIZAE IN MEGHALAYA.

BY

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DEDICATED TO MY PARENTS

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I, **Susant Kumar Parida** , hereby declare that the subject matter of this thesis is record of work done by me , and that the contents of this thesis did not form the basis of the award of any previous degree to me or to the best of my knowledge , to anybody else, and that this thesis entitled "***Effect of agricultural practices on the structure and function of vesicular-arbuscular mycorrhizae in Meghalaya***" has not been submitted by me for any research degree in any other University / Institute.

This is being submitted to the North-Eastern Hill University for the degree of Doctor of Philosophy in Botany.

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GENERAL INTRODUCTION

The soil of North-East India is generally deficient in nutrient (*Singh et.al.*, 1989) and it takes many years to accumulate and enrich the top soil layers. Soil organic matter also helps in natural regeneration of various crop plants and microbes. In north-east region the most commonly practised agricultural system is Jhum cultivation, which causes depletion of soil organic matter, and indirectly leads to less growth of crop plants. Traditional cutting and burning of forest vegetations have a very crucial effect on vegetation and soil microbial population (Deka and Mishra., 1982). The burning in the forest areas attached to agricultural practices may also affect the population of symbionts (Klopatek *et. al.*, 1988).

Mycorrhiza is almost unique symbiotic association between fungi and the roots of higher plants. The term " Mycorrhiza " was first coined by Frank (1885), a German Pathologist , where he described the essential structure and function of the symbiotic relationship between roots of trees and fungi. Broadly five types of mycorrhiza are recognised on the basis of nature of penetration of fungal hyphae into the host roots. Various soil factors like pH , temperature, moisture, aeration , soil compaction, cutting of trees , addition of chemical fertilisers , jhum cultivation and root exudates may affect the formation of mycorrhizal association. In north-east India in general and Meghalaya in particular, the valley and terrace practices are being observed widely (Plate-1, 2, and 3).

In valley, most of the farmers regularly cultivate various types of crops i.e paddy, maize and potato, whereas, terrace practice mostly observed at high altitudes requiring more

Plate-1: - Showing maize, paddy and potato crops in valley practice.

Plate- 2: - Showing maize, paddy and potato crops in terrace practice.

Plate- 3: - Showing maize, paddy and potato crops in jhum practice.

PO

MZ

PD

VALLEY PRACTICE

PLATE-1

PO

MZ

PD

TERRACE PRACTICE

PLATE –2

PO

MZ

PD

JHUM PRACTICE

PLATE-3

labour input for both ploughing of land and cutting of land into a proper plain form and carrying out oxen and other tools for ploughing of lands.

Any physical and chemical change in the properties of soil reduces the productivity of valley, terrace, and jhum agricultural fields. In Meghalaya, where most of the farmers do not use chemical fertilisers due to their socio-economic conditions and lack of efficient transportation facilities, the vesicular-arbuscular mycorrhizal (VAM) fungi can play an important role in improving the crop productivity.

The importance of VAM fungi in agricultural crops is widely observed (Bethlenfalvay, 1992). Paddy, maize and potato have been found to be infected by VAM fungi under field conditions (Dhillon, 1992). The physiological characters for improved efficiency has received great attention (Tinker, 1975 a, and b). Plants require relatively large amount of phosphate which is immobile and is adsorbed into the soil solution making absorption difficult. The ability of VAM fungi to transfer and translocate different ions varies considerably (Cooper and Tinker, 1978). The distances upto which translocation is effective are quite large in some cases (Rhodes and Gerdemann,1975). Bhattarai (1983) observed high VAM infection in different strains of maize under upland and lowland cultivation practices, however, some more detailed study on the role of VAM in different crops is needed. Phosphorus is considered as the most important nutrient required for growth responses of crop plants to VAM (Krishna and Bagyaraj . , 1982).

There are substantial evidences to show that increased phosphorus uptake is possible because of the capacity of the external hyphae of VAM fungi to absorb phosphate from the soil and translocate it to the host root (Merry weather and Fitter, 1995) Ravanskov and Jakobsen (1995) found that plant fungus combinations were compatible with respect to

mycorrhiza formation, which was measured both as root colonization and growth of external hyphae. They further noted that the symbiosis differed markedly with respect to functional compatibility as phosphorus uptake by each fungus depending on the host plant. According to Nadian *et al.*, (1996) the soil compaction had no significant effect on root length containing arbuscules, and vesicles, but total root length colonized by arbuscules-vesicles or by any combination of arbuscles, vesicles and intra-radical hyphae significantly decreased as soil compaction was increased. Mc Millan *et al.*, (1998) observed inhibition of hyphal growth of a VAM fungus in soil containing sodium chloride and it limits the spread of infection from spores. The mycorrhizal symbiosis enables the plants to have a longer and better distributed root surface area for absorption of nutrients. Besides P the VAM fungi also enhance uptake of N, K and some other microelements (Furlan and Bernier 1989).

There are some evidences of the functional compatibility of symbioses between host plants and arbuscular-mycorrhizal fungi measured as hyphal P transport to plants (Ravanskov and Jakobsen,1995). It was also observed that nitrogen metabolism of external hyphae of the VAM fungus was quite high in *Glomus intradices* (Jakobsen *et al.* ,1994). Different strains of VAM fungi may vary in their efficiency for nutrient uptake (Jensen,1985) Davis and Fucik, (1986). This difference is generally assigned to the difference in ability of extension of the fungal hyphae from the root surface (Abbott and Robson,1991). Certain evidences show that the hyphae of VAM fungus in wet soil remain infective and it decreases if the soil is disturbed (Robson *et al.*,1989). The number of infectious propagules of indigenous VAM fungi was determined at the rice cropping systems in two varying strata and in a rainfed field on the irrigated farms. The mycorrhizal inoculum was consistently less in poorly field with a rice than in the better drained field with a rice-corn-mungbean pattern (Liang *et al*,1987).

Mycorrhiza also increases the water transport and tolerance of seedlings to drought by providing increased surface area of roots due to massive network of hyphae extended to large distance in soil than root hairs (Abbott and Robson, 1991). The role of mycorrhizal infection in the nutrient uptake particularly phosphorus is well documented. It increases solubilization, absorption and uptake of P from the soils low in phosphorus. It also enhances nitrogen fixation, which results into increased shoot growth, dry matter accumulation, and legumes (Walker *et al.*, 1996). Earthworm also acts as a very good vector of viable propagules of mycorrhizal fungi in various crop fields (Reddell and Spain, 1991).

In the recent past due to changes in environmental conditions caused by over exploitation of forest resources and destruction of vegetation during jhum cultivation and other deforestation activities and also due to use of chemical fertilisers particularly a decrease in the microbial activity in soil is observed. This may also result in change in the soil composition. In such situation it may be difficult to enhance the crop productivity in nutrient deficient fields.

Keeping in mind the above factors including socio-economic conditions of the farmers, the beneficial role of extramycorrhizal mycelium to plants is worth investigating.

Therefore in the present investigation it was planned to study the following aspects:-

(a) Regular (Monthly) survey of vesicular-arbuscular mycorrhizal association with certain crop plants (potato, maize, and paddy) under different agricultural practices (valley, terrace, and jhum) for infection level , hyphal biomass and total root infection.

(b) The isolation of VAM fungal species and their diversity in different soils under various agricultural practices and interaction between VAM and earthworms in dispersal of spores .

(c) Physico-chemical properties (pH, moisture content, organic matter, N, P, and K) of soils of different fields .

(d) Quantification of extramycorrhizal mycelium and its role in the transfer of nutrients from soil to plants.

(e) The interspecies interaction of crops from VAM compatibility in different agricultural systems in terms of their mycorrhizal hyphal mass in soil and its efficiency to improve the growth of plants.