STUDIES ON THE CLIMATIC FACTORS ON THE DEVELOPMENT AND EFFICIENCY OF ECTOMYCORRHIZAE OF PINE
(*Pinus kesiya* Royle Ex. Gordon)

By

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CERTIFICATE

We certify that the thesis entitled **Studies on the climatic factors on the development and efficiency of ectomycorrhizae of pine (Pinus kesiya Royle ex. Gordon)** submitted by Mr. Birendra Nath Jha, for the degree of **Doctor of Philosophy** of the North-Eastern Hill University, Shillong, embodies the record of original investigation carried out by him under our supervision. He has been duly registered and the thesis presented is worthy of being considered for the award of the Ph.D. degree. This work has not been submitted for any Degree of any other University.

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CONTENTS

GENERAL INTRODUCTION

Khasi pine (Pinus kesiya Royle ex. Gordon), an indigenous timber yielding species is dominant at the higher altitudes of foot hills of North-Eastern Himalayas. It grows luxuriantly as an early successional tree species of natural forest ecosystem. Under natural conditions, the roots of pine form a symbiotic association with fungi termed as 'Mycorrhiza' (Frank, 1885). The mycorrhizal association helps in the establishment and survival of the seedlings of pine (Marx, 1975; Marx et al., 1976; Sharma, 1981; Bledsoe et al., 1982; Valdes, 1985; LoBuglio and Wilcox, 1988). The symbiotic association enhances the physiological activity of the root tissue system and also the absorption of mineral nutrients from the soil (Hatch, 1937; Harley, 1960; Bowen and Rovira, 1969; Rovira and Bowen, 1971).

Various types of mycorrhizal associations, have been reviewed (Lewis, 1973, 1975, 1976; Read, 1982) and broadly grouped into three major groups (ectomycorrhiza, endomycorrhiza and ectendomycorrhiza). Pines have ecto- or ect-endomycorrhizal association formed mainly by basidiomycetes, hypogeous ascomycetes, phycomycetes and deuteromycetes (Gerdemann, 1974; Trappe, 1962, 1977).

The success of an introduced plant species depends upon a number of ecological factors (Grime, 1979). The mycorrhizal association, especially the ectomycorrhiza type, is adapted to nutrient stresses and is an ecological aid to plant species growing in a temperate condition (Mexal, 1980).

However, considering the plant communities as a whole, the ectomycorrhizal association is found only in 3% (Meyer, 1973) or 5% plants (Mexal, 1980), while majority of the plants possess vesicular-arbuscular type of mycorrhiza (Gerdemann, 1975; Mexal, 1980).

Ectomycorrhizal fungi enhance absorption of inorganic nutrients, particularly phosphorus (Theodorou, 1968, 1971; Ho and Zak, 1979), produce growth hormones (Moser, 1959; Ulrich, 1960; Miller, 1967, 1971; Gogala, 1967, 1971; Slankis, 1973), growth regulators (Shamakhanova, 1962; Turner, 1962), check the root pathogens (Perrin, 1985; Duchesne et al., 1987, 1988, 1989), decrease soil toxicity and increase resistance to extreme soil temperature (Lapeurie et al., 1984) and drought conditions (Parke et al., 1983; Heinrich et al., 1988).

Climatic factors may affect the growth and development of ectomycorhizal fungi. Some information has been acquired on inter and intra specific growth variation of ectomycorrhizal fungi in response to different temperatures (Moser, 1958; France and Reid, 1979; Cline et al., 1987). The studies carried out in laboratory condition on ectomycorrhizal fungi may, however, show difference in response to natural environmental conditions due to complexity and interaction between soil, climatic and biological components (Mikola, 1948).

pH may also affect the growth of ectomycorrhizal fungi (Norkrans, 1949). These fungi exhibit a broad or narrow range of tolerance (Theodorou and Bowen, 1969; Laiho, 1970; Hung and Trappe, 1983; Stroo and Alexander, 1985; McAfee and Fortin, 1987). The probable reasons affecting their growth in terms of enzyme activity is, however, seldom attempted (Ho and Zak, 1979; Dighton, 1983). Studies on acid phosphatase activity together with the physical factors may provide some clues to explain the growth pattern of ectomycorrhizal fungi.

Similarly, some experiments on the water supply show that ectomycorrhizal fungi could survive in water deficient soils (Uhlig, 1972; Malabari, 1979; Parke et al., 1983; Heinrich et al., 1988) and can translocate the stored water to the host (Duddrige, 1980).

Light intensity also has effects on the growth of ectomycorrhizal fungi (Ashton, 1976; Son and Smith, 1988).

The role of ectomycorrhizal fungi in nutrient uptake has widely been attended, but the role of climatic and edaphic conditions on the development of mycorrhiza is very less studied. Until the end of the 19th century, it was believed that plants with ectomycorrhizae absorb more nitrogen than non mycorrhizal plants (Frank, 1894). Later on, the work of Hatch (1937), Mitchell et al. (1937) and Finn (1942) strengthened the view that ectomycorrhizal seedlings of pine contained greater quantities of nitrogen, potassium and phosphorus than the non mycorrhizal seedlings (Ashford et al., 1975; Edmonds et al., 1976; Chilvers and Harley, 1980; Bowen and Smith, 1981; Harley and McCready, 1981; Strullu et al., 1981, 1982; Alexander, 1982; Heinrich and Patrick, 1985; Heinrich et al., 1988). Work on phosphatase activity of ectomycorrhizal roots has also been extensively undertaken (Williamson and Alexander, 1974; Antibus et al., 1981). Little work on the physical factors affecting the pine seedlings and development of ectomycorrhiza are available. Light intensity (Hatch, 1937) and moisture content of the soil (Reid, 1979) can encourage ectomycorrhiza formation, while studies on the effect of climatic factors on the development of mycorrhiza are needed.

The problem of environmental degradation is very complex. Extensive industrialization, urbanization and increased human population have adversely affected the forest ecosystem. Large scale deforestation has been changing the global climatic conditions. However, high precipitation and hilly topography with less vegetation have led to the formation of nutrient poor soil in the area.

The changing climatic and edaphic conditions due to continuous deforestation provoked to take up the present study on ectomycorrhizae of pine on the following aspects.

- Spatial distribution of ectomycorrhizal fungi in pine stand at different altitudes of Khasi hills, Meghalaya.
- Isolation technique, maintenance and mass culture of ectomycorrhizal fungi.
- Effect of climatic factors on the growth behaviour of ectomycorrhizal fungi _in vitro_ conditions.
- Effect of climatic conditions on the development of ectomycorrhizae.
- Nutrient status (N and P) of pine seedlings and phosphatase activity of ectomycorrhizal roots of pine under different climatic conditions.