ECTOMYCORRHIZAL STATUS AND GROWTH OF KHASI PINE (*PINUS KESIYA*, ROYLE EX. GORD.) IN THE SOILS OF DISTURBED LAND OF CHERRAPUNJEE

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Introduction

The slash and burn type of shifting cultivation practiced by the tribal population of the hilly tracts of North-eastern India, has affected the fertility potential of soil in many ways. The area of Cherrapunjee (Alt., 1200 m; Lat., 25° 20'N and Long., 91°35'E) receiving highest rainfall (1150 cm/year) in the world, is the extreme example of severely damaged ecosystem. The intense soil erosion and rapid loss of fertility through run-off loss has converted the entire area into denuded land with few grass species here and there, and patches of protected forest (Ramakrishnan *et al.*, 1979). Reduction in the Endogone spore population and the colonization of non-mycorrhizal plant species in the disturbed soils of Cherrapunjee has been reported (Sharma *et al.*, 1982)

Pinus kesiya an endemic conifer tree of the North-east India is being completely eliminated from this region. Species of pine are highly mycotrophic and the disturbed lands are reported to be deficient of mycorrhizal propagules (Trappe and Strand, 1969; Trappe, 1977). The present study was designed to investigate the soil potential of Cherrapunjee for the initial growth performance of *P. kesiya*.

Material and Methods

Soils from two quite different grass-land communities (Gr I & Gr II) of Cherrapunjee, were collected from 0-15 cm horizon. Gr I, possessed *Paspalum notatum*, *Osbeckia crinita* and *Imperta* sp., as the dominant species whereas Gr II was dominated by the *Drocera* sp., *Bulbostylis* sp., and *Anaphalis controrta*. The experiment was performed with the natural soil under glasshouse conditions in Shillong. Both the soil types were used in filling up separately the plastic pots of 1 kg capacity in which half of the set was used for the inoculation treatment with ectomycorrhizal fungi and the remaining half for the control. In another set, the local pine forest soil with indigenous mycorrhizal propagules, was used for comparison. 3 replicates of pot was maintained for a treatment in each harvest.

10 seeds of *P. kesiya* were put in each pot and after 4 weeks of germination the seedlings were thinned to five. Inoculation

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was done at this stage. All the seedlings were taken out carefully and the soils were filled up again in the respective pots. Then five holes were made in the soil in which 3 gms of the ectomycorrhizal inoculum consisting of short (mycorrhizal) roots and soil under young plantations of *P. kesiya* was inserted followed by seedling transplantation. The following was the experimental design :

A—Gr I Soil + Mycorrhizae
B—Gr I Soil (Control)
C—Gr II Soil + Mycorrhizae
D—Gr II Soil (Control)
E — Forest soil (Indigenous mycorrhizae)

The plants were watered twice in a week with tap-water and three harvests at an interval of two months were taken for the evaluation of different growth parameters The roots and shoot were weighed to a constant weight after drying at 80 ± 50°C for 48 hours. The mycorrhizal formation was assessed by counting the number of dichotomous branching formed by the root laterals.

The soils used were analysed for chemical characteristics following Jackson (1967). Available phosphorus was determined by molybdenum blue method using Bray's extraction solution, total nitrogen by Kjeldhal method and organic matter by Walkley-Black method Soil pH was read out in soil water suspension (1 : 5) by a digital pH meter.

Results

In first and second harvests, the inoculated plants, though showed higher growth in terms of root and shoot length and dry matter production than the control but the differences were not [illegible] In third harvest, the inoculated [illegible] showed significantly higher growth [illegible] control ones in both the Gr I and [illegible] soils (Table 2). However of the [illegible] Cherrapunjee soils, the Gr II soil [illegible] better growth of the pine and showed [illegible] mycorrhizal formation, shoot length [illegible] shoot biomass. The root biomass [illegible] the soil was nearly the same. It is [illegible] from root/shoot ratio that the Gr [illegible] favoured shoot growth over root growth [illegible] compared to the Gr I soil. Though [illegible] pine forest soil was nearly as rich as [illegible] soil (inoculated) but the former [illegible] comparatively poor growth of the [illegible] In general, the inoculated plants [illegible] healthy and green while the control [illegible] were yellowish with stunted growth.

Table 1 shows the chemical characteristics of all the three soil types considered [illegible]

Table 1

Chemical characteristics of soil

	Gr I soil	Gr II soil	[illegible]
Moisture content (%)	14.8	20.24	[illegible]
Organic matter (%)	1.72	4.35	[illegible]
Total Nitrogen (%)	0.08	0.18	[illegible]
Available Phosphorus (ppm)	0.28	1.75	[illegible]
pH	6.80	5.7	[illegible]

Table 2

Effect of mycorrhizal fungi on the growth of P. kesiya in two grassland soils of Cherrapunjee and a pine forest soil

Soils Treatments	Mycorrhizal formation No. of dichotomy	Root length	Shoot length	Root biomass	Shoot biomass	Root/ Shoot ratio
Gr I Inoculated	97.44 ±41.36*	52.3 ±16.93NS	13.03 ±1.45*	0.132 ±0.03NS	0.22 ±0.06 NS	0.59 ±0.12*
Gr I Control	26.23 ±18.33	41 4 ±10.08	9.96 ±1.21	0.124 ±0 03	0.18 ±0.02	0.70 ±0.05
Gr II Inoculated	127.66 ±37.18*	53.6 ±13.47*	16.91 ±0.79*	0.12 ±0.04*	0.38 ±0.04*	0.29 ±0.06*
Gr II Control	17.63 ±15.21	40 4 ± 8 0	8.72 ±1.3	0.08 ±0.02	0 18 ±0.04	0.407 ±0 06
Pine forest Indigenous mycorrhizae	110.45 ± 29.22	48.27 ±12.2	14.5 ±1.88	0.131 ±0.05	0.034 ±0.09	0.397 ±0.06

Note—: Values given are the means of 10 replicates with standard deviations.
* Significant at 5 % level; NS, Not significant.

Discussion

The importance of ectomycorrhizae in growth and development of forest trees in well established (Marks and Kozlowski, 1973). *Pinus* is a highly mycotrophic genus and even facultatively mycotrophic host also grows markedly better with mycorrhizae than without (Harley, 1969). Hence, the better growth of inoculated pine plants in both the soils (Gr I and II) in comparison to the control ones and similarly better growth in indegenous pine forest soil was, therefore, normal. The comparatively poor shoot growth and fair root growth in Gr I soil may be attributed to its low nutrient status which is reported to favour root growth (Atkinson, 1973).

The poor mycorrhizal formation by the root laterals of the control plants in both the soils may be attributed to the deficiency of the mycorrhizal propagules in the soil, which has been disturbed severely partly due to the excessive use of land with steep slopes, through primitive type of agriculture practice and partly due to the heavy rainfall which might be responsible for the accelerated soil erosion. It has been reported that the mycorrhizal deficiency occurs amidst ectomycorrhizal forest regions also where soils have been depleted of suitable fungi by long agronomic use (Trappe and Strand, 1969; Trappe, 1977). The frequent disturbances of soil lead to be a lower potential for infection of new host plants (Reeves *et al.*, 1979) and the delay in infection by mycorrhizal fungi or their elimination from the soil can be disastrous for tree species by reduction in adequate nutrient supply (Trappe and Strand, 1969), and also by non-protection of the seedling roots from pathogen (Zak, 1964; Mark, 1966). According to Trappe (1977) "the absence of mycorrhizae on planting stock may not reduce field performance if (a) the planting site soil contain abundant mycorrhizal inoculum and (b) seedlings are planted early enough in the growing season so that abundant mycorrhizae can develop before seedlings are subjected to environmental stress" On the basis of this experiment it is suggested that the seedlings properly inoculated with selected mycorrhizal fungi or mycorrhizal roots in nursery may be tried for the afforestation in this area.

Acknowledgement

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SUMMARY

The ectomycorrhizal progagules in the disturbed land of Cherrapunjee were found to be very low, as reflected in the initial growth of *Pinus kesiya* seedlings. The growth perform[ance] of the seedling inoculated with ectomycorrhizal roots was significantly higher (P<0.05) th[an] that of the non-inoculated (Control) ones. The use of selected ectomycorrhizal roots [as] inoculum in pine seedlings prior to plantation may be attempted for afforestation in this area.

खासी चोड़ (पाइनस केसिया रोयले पूर्व गार्डन०) की बाह्य कवकमूल स्थिति और वृद्धि का चेरापूंजी की विघ्न पड़ी भूमि की मृदाओं पर प्रभाव

एन०के० वर्मा व आर०पी० शुक्ला

सारांश

पाइनस केसिया के पौधों की प्रारम्भिक वृद्धि मन्द रहने से जैसा अनुमान होता है, वैसा चेरापूंजी में बाह्य कवकमूल के वर्धी अंश बहुत कम पाये गये। बिना टीका लगाए (नियामक) पौधों की तुलना में कवकयुक्त जड़ों का टीका लगाए पौधों की वृद्धि क्रियाशीलता सार्थकतः अधिक (पी 0.05) पाई गई। क्षेत्र के वनीकरण के लिये रोपवन लगाने से पूर्व चीड़ के पौधों में चुने हुये बाह्य कवकयुक्त जड़ों को टीके के उपयोग करके देखा जाना चाहिये।

References

Atkinson, D. (1973). Some general effects of Phosphorus deficiency on growth development; *New Phytol.* 72 : 101.

Harley, J.L. (1969). *The Biology of Mycorrhizae*; 2nd ed. (Leonard Hill, London), 334 pp.

Jackson, M.L. (1967). *Soil Chemical Analysis*; (Prentice Hall, New Delhi) 498 pp.

Marks, G.C. and T.T. Kozlowski Eds (1973). *Ectomycorrhizae Their Ecology and Physiology* (Academic Press, New York).

Mark, D.H. (1966). The role of ectotrophic mycorrhizal fungi in the resistance of Pine roots to infection by *Phytophthora cinnamomi* Pands. Ph.D. Diss. N.C. State University, Raleigh.

Ramakrishnan, P.S., O.P. Toky, B.K. Mishra and K.G. Saxena (1979). Slash and Burn Agriculture in North eastern India. *Fire Regimes and Ecosystem Pronertis.* Eds. Mooney, H.A.; Bonnickson J.M.; Christensen, M.R.; Lotanl, J.E. and Reiness, W.A.; USDA For. Serv. Gen. Tech. Report, Washington D.C. (In Press).

Reeves, F.B., D. Wagner, T. Moorman and J. Kisl (1979) The role of endomycorrhizae in revegetation practices in the semi-arid west I and comparison of incidence of mycorhizae in severely disturbed vs natural environments; *Amer. J. Bot.* **66** : 6-13.

Sharma, G.D., B.K. Tiwari, K.G. Saxena, N.K. Verma and R.R. Mishra (1982). Mycorrhizal and Soil microbial characters as influenced by shifting Agriculture. Training courses on Mycorrhiza Research Techniques. International Foundation for Science, Sweden. pp. 408-416.

Trappe, J.M. (1977). Selection of fungi for ectomycorrhizal inoculation in nurseries; *Ann. Rev. Phytopathol.* **15** : 203-222.

Trappe, J.M and R.F. Strand (1969). Mycorrhizal deficiency in a Douglas-fir region nursery; *For. Sci.* **15** : 381-389.

Zak, B. (1964). Role of mycorrhizae in root disease; *Ann. Rev. Phytopathol.* **2** : 377-392.

CORRIGENDUM

Article "Observation on flowering, fruiting and germination behaviours of some useful forest plants of Arunachal Pradesh" by B.S. Beniwal and N.B. Singh, published in the *Indian Forester*, Vol. 115, No. 4, 216-227.

For	*Read*
Page 217, item 7, line 8	
Dipetrocarpus	*Dipterocarpus*
Page 223, last line	
M. azedarach	*M. azaderach*
Page 224, line 16	
Phosbe	*Phoebe*
Page 225, line 11	
Pterygeta	*Pterygota*
Page 226, line 5, 11, 15 & 23	
Stereospermum chelonoldes	*Stereospermum chelonoides*
Taluma phellocarpa	*Talauma phellocarpa*
Terminalia belliraca	*Terminalia bellirica*
Zathoxlum limonella	*Zanthoxylum limonella*