THE EFFECT OF *Pisolithus tinctorius* AND PINE PLANTATION SOIL MYCORRHIZAE ON PINE SEEDLING GROWTH IN MALAWI.

by

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Summary

Vegetative inoculum of *Pisolithus tinctorius* from U.S.A. was compared against indigenous *P.tinctorius* and crude pine plantation soil as mycorrhizal inocula in the nursery. Three pine species, *Pinus kesiya*, *P.oocarpa* and *P.patula* were inoculated to give 3 treatments and a control, and assessed 2 weeks, 3, 5 and 7 months later for height, survival, root and mycorrhiza development.

The exotic vegetative inoculum performed equally effectively with the soil inoculum and is recommended for further studies. The indigenous fungus performed poorly and will be re-tested using vegetative inoculum.

There is potential of using vegetative inoculum in adverse sites that are remote from established pine plantations.

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Introduction

Afforestation in Malawi is currently oriented towards participation of the society as a whole with emphasis on reclammation of degraded, infertile and bare hills. Initial establishment of trees in such sites depends on proper site/species selection as well as mycorrhizal inoculation where pines are planted. Chipompha (1982 a, b) observed that exotic pines tried in Malawi require pine mycorrhizal soil inoculum. The distance between the pine plantations and new planting sites is increasing with time, making haulage of soil expensive.

In order to reduce establishment costs, an alternative inoculation method is required. Research elsewhere (Schenck, 1984) has shown that vegetative Pisolithus tinctorius is the best candidate for this project.

Through financial support from the International Foundation for Science, the project started in 1981 with 3 objectives:

1. to identify an economic and effective local mycorrhizal fungus for pine inoculum
2. to compare this fungus with imported Pisolithus tinctorius
3. to develop an appropriate simple and effective inoculation technique for the recommended symbiont.

This paper summarises current findings.

Materials and Methods

Fungal forays were conducted throughout the country and 3 mycorrhizal fungi collected from pine and eucalypt stands. These were Amanita muscaria, Scleroderma bovista and Pisolithus tinctorius. P.tinctorius in Malawi has only been found in Eucalyptus stands. Elimination trials with these fungi resulted in the selection of P.tinctorius for further

studies as it was suited to hot, dry and degraded sites.

Pinus kesiya, P.oocarpa and P.patula were used as hosts and there were 4 treatments:

1. sterilised bush soil (control
2. exotic Pisolithus tinctorius (exotic)
3. indigenous P.tinctorius (indigenous)
4. pine plantation soil (soil).

Each treatment had 6 replications each of 22 seedlings per species, set out in a randomised block design.

The bush soil was sterilised with Methyl bromide at the rate of 408gm^{-3} for 48 hours, and this gave the basic potting medium for all treatments. The inocula were introduced as a band in 15cm layflat polythene tubes, before topping with sterilised soil. The pine plantation soil was mixed with sterilised soil in the ratio 1:2 which is the standard pine inoculation technique in Malawi. Treatment 2 was a leached vegetative culture of Pisolithus tinctorius No.288 from the U.S.A., while treatment 3 was a spore inoculum of P.tinctorius collected from local E.tereticornis stands. Pine seedlings were pricked out soon after inoculum placement.

Assessments and data analyses

Height and survival of all plants were assessed 2 weeks, 3, 5 and 7 months after pricking out. Root collar diameter was measured using a calliper at 5 and 7 months on a random sample of 18 plants per treatment pe r species by destructive sampling. Root and shoot dry weights were determined on the sample plants after oven drying at 105°C for 12 hours. A Plot Volume Index (PVI) (Shenck, 1984) was calculated from the plant volume derived from the height, diameter and survival.

Mycorrhizal counts, number of roots greater than 0.5cm length, root length and the colour of associated mycelia were recorded from the sample plants.

All data was subjected to analysis of variance (Freese, 1980) as required.

Results

Plant height, survival and root: shoot ratios (length and dry weight) are given in Fig.1, Table 1 and Table 2 respectively. Mycorrhizal counts and Plot Volume Indices are summarised in Tables 3 and and 4 respectively.

Survival at 7 months was not significantly different ($P \leq 0.05$) between treatments (Table 1).

Table 1. Survival (%) of pine seedlings 7 months after inoculation with mycorrhiza.

	Type of inoculum			
Species	control	exotic	indigenous	soil
P.kesiya	82	100	86	95
P.oocarpa	82	100	95	86
P.patula	77	100	86	86

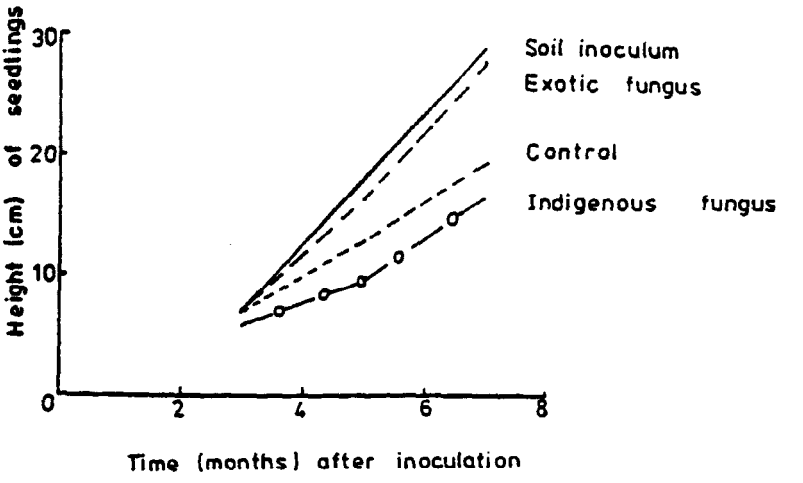

Fig. 1. Height growth of pine after mycorrhiza inoculation treatments.

However, there was a significant difference ($p \leq 0.05$) in heights at 5 and 7 months age, with treatments 2 and 4 dominating (Fig.1). There was also no significant difference in root: shoot ratios between treatments (Table 2) 5 months after inoculation ($p \leq 0.05$).

Mycorrhiza development showed high significant differences between treatments at $p \leq 0.05$, with the exotic inoculum best and the control least (Table 3). Also there was a significant difference in mycorrhiza development between the three pine species, with P.oocarpa having fewest mycorrhizae and P.kesiya the most.

Table 2. Root: shoot ratios of pine plants 5 months after inoculation with mycorrhiza.

Treatmnet	Species	Ratio	
		Length	Dry weight
Control	P.p.	1.3	0.01
	P.o.	1.1	0.02
	P.k.	0.9	0.02
Exotic	P.p.	0.8	0.02
	P.o.	1.0	0.02
	P.k.	0.7	0.02
Indigenous	P.p.	1.2	0.02
	P.o..	1.7	0.02
	P.k.	1.2	0.02
Soil	P.p	1.0	0.02
	P.o	0.8	0.02
	P.k.	0.9	0.02

Table 3. Mycorrhiza development on pine roots 5 months after inoculation.

	Treatment			
Species	Control	Exotic	Indigenous	Soil
P.kesiya	3	1178	20	227
P.oocarpa	0	357	20	98
P.patula	10	585	252	134
	4	707	97	153

Plant vigour as determined by PVI was lowest in plants with indigenous P.tinctorius and highest in soil inoculum (Table 4) 5 and 7 months after inoculation. PVI Was not significantly different between the contro and the indigenous inoculum, and also between the exotic inoculum and soil inoculum. However between the two pairs of treatments PVI was significantly different ($p \leq 0.05$).

The mycelium associated with the indigenous P.tinctorius treatment were dark brown in colour, while that in the exotic P.tinctorius treatment was brown, resembling the original vegetative inoculum. The soil inoculum had a wide colour diversity of mycelium, while the control treatments showed predominantly black and white mycelia.

Table 4. Effect of mycorrhizae on pine plant vigour as estimated by volume index (PVI).

Age(mo)	Species	Treatment			
		Control	Exotic	Indigenous	Soil
5	P.kesiya	8.2	17.4	7.8	30.0
	P.patula	7.2	13.6	5.4	12.5
	P.oocarpa	19.2	25.3	8.8	12.0
	Mean	11.5	18.8	7.3	18.2
7	P.kesiya	20.5	34.7	8.5	53.9
	P.patula	16.4	16.0	8.5	31.8
	P.oocarpa	33.6	55.4	31.7	45.7
	Mean	23.5	35.4	16.2	46.8

Discussion

The pine soil inoculum gave best mycorrhiza development and plant growth (Fig.1 and Tables 3 & 4) probably because it contains symbionts that are highly compatible with pine seedlings and are already well adapted to the Malawi environment. Riffle and Maronek (1984), Marx (1975) and Trappe (1977) and other workers have shown that the best mycorrhizal symbionts must be well adapted to their environment. The exotic P.tinctorius used in this experiment also performed effectively and this is because it was in a vegetative form. Marx and Kenney (1984) recommend vegetative inoculum of ectomycorrhizal fungi as the most biologically sound method of inoculation. However P.tinctorius has a very wide host range (Marx, 1980 and Trappe, 1962) and is highly adaptable to various environments worldwide. Spore inoculum as used for the indigenous P.tinctorius is the least effective inoculation method for ectomycorrhizae (Marx & Kenney, 1984) due to poor germination of spores and high competition with other soil microflora. This explains the poor performance of the indigenous symbiont (Table 3).

Soil inoculum in Malawi is still extensively used for all pine establishment. However Foot (1969) recommends that soil be collected for pine stands that are over 15 years old. Younger stands give erratic mycorrhiza development (Chipompha, 1982a) and cannot be relied upon for large-scale afforestation.

The advantage with P.tinctorius is its rapid adaptation to various environments, especially degraded and dry areas. This is an attribute that will enhance reforestation of degraded areas.

Table 3 shows that Pinus kesiya gave the best response to inoculation with Pisolithus tinctorius. This is the pine used

species used for afforestation of low-altitude areas in Malawi (Hardcastle, 1977).

It is suggested that Pisolithus tinctorius be tested further using vegetative inoculum. Since in Malawi P.tinctorius has only been found in Eucalyptus stands, it will be necessary to dapt this symbiont to Pinus species before producing vegetative inoculum from it. These are aspects that are being investigated in the second phase of the project. Meanwhile a cost/benefit analysis is being sone to compare the exotic (vegetative) Pisolithus tinctorius and pine soil inoculum under field conditions.

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