THE KENYA FORESTRY RESEARCH INSTITUTE

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SOME FACTORS INFLUENCING NATURAL DECAY RESISTANCE IN EUCALYPTUS AND CEDAR

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Summary

The natural decay resistance of wood of five species of Eucalyptus was compared with Juniperus procera (Cedar) in the laboratory by inoculating with brown and white rot fungi and in the field (graveyard) by exposing the wood to environmental conditions likely to be encountered in nature. Under laboratory conditions, wood samples in contact with the soil generally decayed to a greater extent than those buried in the soil. Wood of J. procera and Eucalyptus microcorys was more resistant to decay than that of the other species. After five years in the field, wood billets of E. saligna and E. grandis had incipient rot while those of E. camaldulensis, E. globulus, E. microcorys and J. procera had only superficial mycelium. Termite attack was severe on E. saligna, moderate on E. globulus and E. grandis, and slight on E. camaldulensis, E. microcorys and J.

procera. The overall results suggest that timbers of E. microcorys and J. procera are more resistant to decay at the age of twenty years and do not indicate significant differences in decay resistance.

Introduction

A decrease in natural hardwood forests in Kenya coupled with the general slow growth of most indigenous hardwood species has led to increased dependence on fast growing exotic hardwoods. These high yielding hardwoods include certain eucalyptus which are valuable as a source of fuelwood, fencing posts, poles, sleepers and other outdoor constructions in contact with the ground. Selection of individual timber species requires comparative tests to ascertain their natural tolerance or resistance to degradation by biological agents such as wood decay fungi and termites.

This paper reports on findings of investigations carried out to compare the natural durability of five species of Eucalyptus and cedar under laboratory and field conditions.

Materials and Methods

The following species were used for the study:

Eucalyptus camaldulensis Denh (River red gum)

E. globulus Labill (Tasmanian blue gum)

E. grandis W. Hill ex Maiden (Flooded gum)

E. microcorys F. Muell (Tallow wood)

E. saligna Smith (Sydney blue gum)

Juniperus procera Hochst ex Rich

The sample trees were twenty years old and were cut from Muguga arboretum.

Accelerated Laboratory Tests

Five trees were selected from each of the 6 species and 32 woodblocks measuring 50mm x 15mm obtained from the heartwood of each tree. Two brown rot fungi, Gleophyllum trabeum (Pers ex Fr.) Murrill and Coniophora puteana (Schum ex Fr.)

Murrill and 2 white rot fungi Phellinus gilvus (Schn) Pat and Pycnoporous sanguineus (L. ex Fr.) Murril were selected for the test. The inoculum fungi were local isolates that have been associated with wood decay (Ondieki 1973).

The modified Soil/Block technique for assessing decay (Hedley and Foster, 1972) was used with slight modifications (Fig. 1). Tests were undertaken using Muguga Forest Loam Soil that had a pH 6.4, 51.4% Sand, 28.8% Clay, 15.8% Silt and 4.1% organic matter. The soil was passed through a 6mm sieve, and 550g packed firmly into one litre kilner jar and moistened to field capacity. The woodblocks were weighed, conditioned by soaking in water over-night and their initial moisture content determined. Four soil buried (SB) woodblocks were pushed down into the soil at the corners of the jars (Fig. 1).

Figure 1: Position of test woodblocks and inoculum disk in the culture jar.

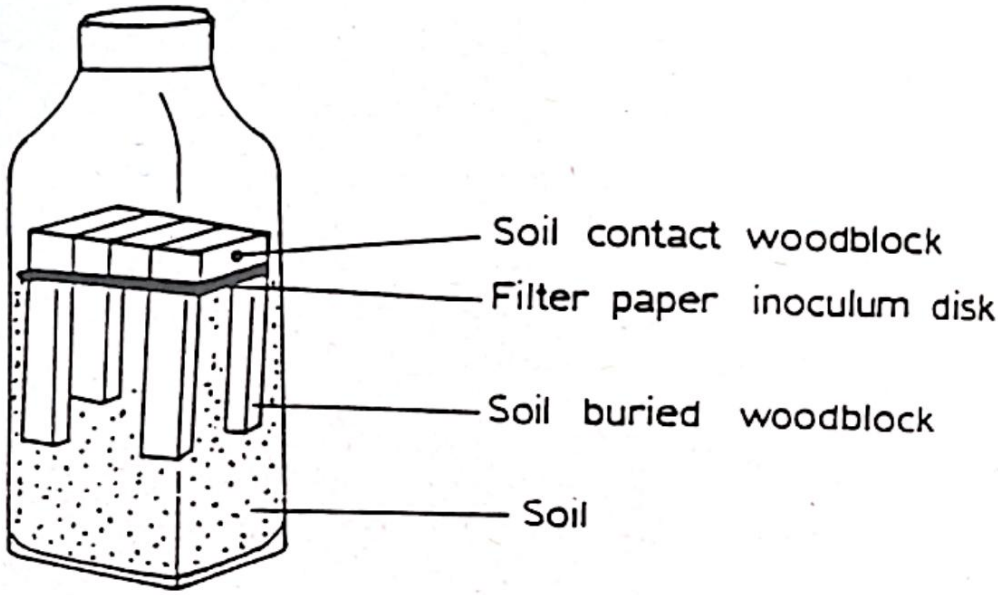

FIG.1. POSITION OF TEST WOODBLOCKS AND INOCULUM DISK IN THE CULTURE JAR.

These were covered with a 60mm sheet of blotting paper that had been soaked in 2% malt extract agar (MEA). Four soil contact (SC) woodblocks similar to those buried in the soils were laid across the feeder strip (Fig. 1)

The jars containing the woodblocks, feeder strip and soil were sterilized by the autoclaving at 120°C for thirty minutes and allowed to cool. After cooling, they were immediately inoculated under aseptic conditions by placing across both ends of the soil contact blocks a 10mm square MEA disk in which each of the test fungus was actively growing. Each timber and fungal species combination was replicated four times. An uninoculated set up for each timber species was included as a control. Inoculated and uninoculated woodblocks were incubated at room temperature (21°c + 3) and relative humidity of 85% for 27 weeks, after which they were removed,

brushed to remove adherent soil and surface mycelium. They were immediately weighed to obtain the final moisture content and thereafter oven-dried at 105°C for 48 hours and re-weighed. For each woodblock, the difference in oven dry weight before and that after the test was computed and expressed as a percentage. Loss in weight for the experimental woodblocks was adjusted for weight loss in the control set up. The analysis of variance was carried out using arsine transformed percentage values to determine if the timbers differed significantly in decay resistance.

Field Trial

Six billets free from defects were cut from the heartwood of each of the six timber species. The billets measuring 100cm x 5cm X 5cm were allowed to season to 16% moisture content and then moved to

a field site at Muguga. The layout of the experiment was a complete randomised design. Half the length of the billet was buried in the soil. Espacement of the billets was 1m X 1m. Inspection was carried out every six months. This involved removing them from the holes and rating them for resistance to decay and termite attack. The rating scale used for decay was:

1. Sound with no evidence of decay
2. Localized superficial mycelium
3. Incipient rot
4. Advanced
5. Failure or completely decayed with total loss of strength.

Termite attack was rated as follows:

A Sound with no evidence of termite attack
B Slight termite attack
C Moderate termite attack

D Severe termite attack

E Failure or completely destroyed by termites

After each assessment the billets were re-installed into the ground. The ratings over a five year period were compiled for individual timber species and compared to determine the overall resistance of the timbers to degradation by fungi and termites.

Results

Accelerated laboratory tests

Decay of woodblocks under brown and white rot fungi was variable. With the four fungi the rate of decay was higher in the soil contact (SC) test than in soil buried test (Table 1 and 2). When timbers of E. camaldulensis and E. grandis were subjected to the white rot fungus Pyconporous sanguineus, they lost upto 50% of their weight while those of E. microcorys and J. procera lost about 10% in the soil contact test. In the same test E. globulus and E. saligna lost 30% and 20% respectively. Significant differences in decay among the timber species were found when subjected to the white and brown rot fungi used in the SC test (Table 1). When wood of the test species was buried in the soil (SB) only the white rot fungi caused significant

decay. With the white rot fungi, wood of E. camaldulensis, E. grandis and E. saligna were most prone to decay.

Table 1: Mean percentage weight loss (decay) for the six species in the soil contact test

Timber species	Control blocks		Test blocks (adjusted weight losses[2])			
	Final moisture content[1]	Wt. loss	G.trabeum	C.putenea	P.sangunenus	P.gilvus
Eucalyptus camaludensis	43	1.54	18.2c[3]	16.09c	49.26d	27.44d
E.globulus	48	2.40	10.31b	7.02b	30.22c	14.07b
E.grandis	52	1.52	20.16c	11.69b	51.12d	23.44c
E.microcorys	46	2.90	2.67a	1.42a	10.19a	3.88a
E. saligna	53	1.18	8.64b	9.43b	21.58b	24.29cd
Juniperus procera	49	1.89	2.84a	0.94a	7.05a	4.95a

1 Moisture content of control blocks at end of incubation period

2 All mean values for decay of individual timber species by the different fungi has been adjusted for loss in weight of the control treatment

3 Column values (arsine transform) with the same letter are not significantly different (P = 0.05)

Table 2: Mean percentage weight loss (decay) for the six species in the soil burial test

Timber species	Control blocks		Test blocks (adjusted weight losses[2])			
	Final moisture content[1]	Wt. loss	*G. trabeum*	*C. putenea*	*P. sanguinenus*	*P. gilvus*
Eucalyptus camaludensis	57	0.92	2.72a[3]	1.49c	7.38c	4.92b
E. globulus	60	0.96	1.04a	1.16a	4.56b	2.84a
E. grandis	68	1.14	1.01a	2.77a	8.18c	5.27b
E. microcorys	59	0.71	0.52a	0.22a	2.33a	1.92a
E. saligna	65	0.57	1.32a	2.45a	4.71b	6.42c
Juniperus procera	62	0.86	0.75a	0.53a	2.76a	1.75a

(1, 2, 3, Foot notes indicate explanations as in Table 1)

Field Trial

Table 3 shows the trend of decay and termite attack on six species. Observations for the five years showed localized superficial mycelium on test billets of E. camaldulensis, E. globulus, E. microcorys and J. procera while those of E. grandis and E. saligna had incipient decay. Termite attack was severe on billets of E. saligna; moderate on E. globulus and E. grandis and slight on E. camaldulensis, E.microcorys, and J. procera. The dominant termite was Odontotermes montanus while associated fungi during successive assessments were mainly Ascomycetes and Fungi Imperfecti.

Table 3: Scores for decay and termite attack for billets over a five year period in the field

Time M.	E. camald-ulaensis	E.globulus	E.grandis	E.microcorys	E.saligna	J.procera
6	1A	1A	1A	1A	1A	1A
12	1A	1A	1A	1A	1A	1A
18	1A	1A	1B	1B	1B	1B
24	1A	1B	1B	1B	2B	1B
30	1B	2B	1B	1B	2B	1B
36	2B	2B	2B	1B	2B	1B
42	2B	2B	2B	1B	3C	2B
48	2B	2B	3B	2B	3C	2B
54	2B	2C	3C	2B	3C	2B
60	2B	2C	3C	2B	3D	2B

Discussion

Wood decay fungi destroy wood by degrading cellulose and lignin. Brown and white rot fungi act on the wood components differently with the former degrading cellulose and its associated pentosans while the latter decompose all components of wood including lignin.

In the accelerated laboratory test, remarkable differences in decay were found between the tested timber species depending on whether the specimen woodblocks were on the soil surface or buried in the soil. The difference in decay in the soil contact woodblocks of all the timber species in comparison to the soil buried ones (Table 1 and 2) could be attributed to several factors. These include ability of individual fungi to colonise the wood, coupled with differential action of each fungus on the timbers, aeration conditions in the soil

and moisture content of the woodblocks. White rot fungi caused significant decay in both the soil contact and soil buried woodblocks due to their ability to degrade both lignin and cellulose components of the wood and the apparent higher moisture content of woodblocks which favours degradation of wood by this group of fungi as shown. It has been found by Hedley and Foster (1972) that white rot fungi have the ability to degrade wood at higher moisture levels. Individual fungi differed in their effectiveness to degrade wood of the various tested species. This was evident with most of the timber species in contact with the white rot fungi P. sanguineus and P. gilvus with the former causing twice as much decay (Table 1).

Significant differences between species suggest that they differ in decay resistance. Decay in E. microcorys and J.

procera did not differ significantly under all test conditions. Water soluble extratives in the wood elements have been shown to influence the natural durability of many trees (Cartwright and Findlay, 1958; Da Costa 1975 and 1979). This factor was not analysed. The performance of individual species under field conditions was variable with time. The most notable feature was that biodegradation by fungi and termites tended to occur concurrently. Thus E. grandis and E. saligna which had the highest rating for termites attack also had the highest rating for decay (Table 3). The lowest scores for both decay and termite attack were recorded for the timbers of E. camaldulensis, E. microcorys and J. procera. It would appear that the overall durability of individual species in the field is most likely to be influenced by dominant fungi and termite group. Though field tests generally require upto ten years for

concrete inferences (Sangster 1942, Ruyroka 1980) results of the current study when combined with the laboratory tests revealed that the timbers of E. microcorys and J. procera were more durable.

Conclusion

Though the basis on which comparisons for natural durability should be made, is a matter of question this study has established that the service life of the timbers assayed can be determined by performance under attack by a specific fungus. A decision as to which two timber species should be selected for a specific use should inculcate all data relevant to the species, laboratory test results, field or service records, reputation among users and the availability of mature timber.

Further work is required to determine, the active ingredients in the wood elements influencing natural durability; effects of variation in wood density and strength on timber biodegradation; silvicultural and other related factors associated with variation in durability;

and variation of timber from tree species at different age classes to decay/termite attack with and without selected wood preservatives.

A multi-disciplinary approach with other programmes of KEFRI should resolve some of the above together with involvement of regional research centres to examine the effects of varying environmental conditions.

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