International Biodeterioration & Biodegradation 85 (2013) 16–22

Contents lists available at SciVerse ScienceDirect

International Biodeterioration & Biodegradation

journal homepage: www.elsevier.com/locate/ibiod

Imported wood decomposition by termites in different agro-eco zones of India

Rashmi Ramesh Shanbhag*, R. Sundararaj

Institute of Wood Science and Technology, 18th Cross, Malleswaram, Bangalore 560003, India

ARTICLE INFO

Article history:
Received 19 December 2012
Received in revised form
14 March 2013
Accepted 14 March 2013
Available online 11 July 2013

Keywords:
Natural resistance
Termites
Tropical and temperate timbers
Agro-eco zones
Termitidae
Odontotermes obesus

ABSTRACT

Some imported timbers are well known for their durability and their reputation has carried them far from their original homes, although some have not maintained their reputation under different conditions or where new varieties of termites have appeared. It is necessary to know the behaviour of wood species under different environmental conditions and their durability class before the timber or timber product is put into use. The degree of wood deterioration is dependent on conditions such as soil, rainfall, altitude, temperature, and other environmental conditions under which the timber is put to use. Natural durability refers to the ability of wood species to resist attack by different agents, especially biological ones. This paper describes the natural resistance of important imported timber species of India against termites in different agro-eco zones. Field experiments were carried out at six locations falling under five Indian agro-eco zones with the aim of evaluating the natural resistance of 20 species of imported woods. Wood stakes measuring 30.5 × 3.8 × 3.8 cm as per IS:401-1982 standards were implanted in the soil and observed for a period of 4 yr, and visual damage assessment was done. The termites active in the test yard and on the test stakes were collected, preserved in 70% ethanol, and identified using taxonomic keys. Results revealed significant variation in rate of degradation of wood species with climatic zones producing significant variation as well. The tested timbers were categorized into three groups: susceptible, resistant, and moderately resistant. Termites collected belonged to nine species under four genera and the single family Termitidae. *Odontotermes obesus* was the dominant species in most of the locations.

1. Introduction

The world's timber resources play an important role in the economic development of both wood-producing and importing regions (Wong et al., 2005). Timber, being a biological material, is susceptible to biodegradation by a variety of organisms, and the need to protect the wood and prevent heavy economic losses constitutes a major challenge. Among the various biodeteriorating organisms, termites are a major threat to the service life of wood (Scheffrahn, 1991). In tropical Africa, for example, fungus- growing termites can consume almost all dead wood and more than 50% of leaf and grass litter (Bignell and Eggleton, 2000).

Wood decomposition is a complex process (Swift et al., 1979) that involves biotic and abiotic influences, as well as the mechanical and chemical properties of the wood itself (Harmon et al., 1986). For some types of litter decomposition climate is a very important factor, at least in the early stages of decomposition (Meentemeyer, 1978). Couteaux et al. (1995) considered climate to be the dominant factor influencing decomposition in areas subjected to unfavourable (dry and cold) weather conditions. Swift et al. (1979) hypothesized that the relative contribution of soil fauna (as opposed to micro-flora) to decomposition was dependent on the climatic region, being greatest at mid latitudes and decreasing towardsthe poles.

Among the most important wood properties are species, hardness, presence of toxic substances, feeding inhibitors or deterrents, and moisture content of the wood and soil (Smythe et al., 1971; Carter and Smythe, 1974). Physical, mechanical, and chemical properties of the wood are probably interdependent, and result in variability in the wood's resistance to termites. Some properties drive the termite towardswood whereas some confer termite resistance to wood by acting as toxicants, feeding deterrents, repellents, or non-preferred substrates (Walcott, 1948; Abushama and Abdel Nur, 1973; Scheffrahn, 1991).

Therefore, a significant difference in the rate of decomposition may signal either a change in decomposer community or in the conditions of biotic or abiotic resources at a site.

* Corresponding author. Tel.: +91 9845985744.
E-mail addresses: rashmishanbhags@gmail.com (R.R. Shanbhag), rsundararaj@icfre.org (R. Sundararaj).

0964-8305/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ibiod.2013.03.037

The avoidance of timber loss due to destruction by termites or other organisms benefits the economy of any country concerned. India is a timber-deficient country and the gap between supply and demand is increasing consequently, Indian import policy concerning wood and wood products has been liberalized with a view to supporting local needs and facilitating conservation of forests (Shashidhar and Agarwal, 2006). As a result India now imports many timber species from other countries, such as Malaysia, Indonesia, South Africa, Australia, and Nigeria. It is vital to understand the behaviour of wood species under different environmental conditions and their durability class before the timber or timber product is put to use, as the degree of deterioration will be dependent on conditions such as soil, rainfall, altitude, temperature, and other environmental conditions that the timber will have to withstand (Rao, 1982). The present study aims to identify the natural resistance of woods that are commonly imported to India under subterranean conditions in different agro-eco zones.

2. Materials and methods

2.1. Natural resistance of imported wood against termites

2.1.1. Sample preparation

To conduct field experiments for natural durability of imported wood in six different places falling in five agro-eco zones of India (Table 1) 20 species of woods imported from different countries and a native grown *Hevea brasiliensis*) were used for the study (Table 2). *Hevea brasiliensis* served as the control because it is the most susceptible tree species to termite attack in this study. Stakes of each of the wood species measuring 30.5 × 3.8 × 3.8 cm, as per IS:401-1982 standards, consisting of pure heartwood, and avoiding sapwood and pith, were prepared. Care was taken to ensure that the stakes selected came from different logs, to avoid pseudo replications, and that they were free from large knots, stains, moulds, decay, or other defects. The stakes were dried at 80 °C to attain constant weight, and were labelled. Each stake was weighed after drying and this weight pre-implantation weight was recorded.

2.1.2. Field termite test

After the imported wood stakes were prepared, 10 replications for each species at all the six sites were implanted in the soil with half buried below and half exposed above the ground by following a random block design in all the selected locations. The surrounding soil was firmly pressed around the stakes to ensure good contact with the soil. Visual examinations and physical checks of the wooden stakes at all the testing sites were initially carried out at an interval of three months for a year after implantation followed by the six monthly observations over the long term. Any visible damage/attack by termites was recorded. Decay was measured by probing the timber and the material around each stake with a sharp pocketknife and assigning a rating to each attack. If a wooden piece showed evidence of termite activity, the specimen was given a visual rating for termite attack based on a 10, 9, 8, 7, 6, 4, 0 rating system (Lebow et al., 2006) (Table 3). The termites active in the area and on the test stakes were collected, preserved in 70% ethanol, and identified using taxonomic keys.

In Nallal, a village in Hoskote district in the state of Karnataka, India, which is a semi-arid environment, 20 replications were used instead of 10 for other locations. Half of the replications were removed after a period of 6 months and brought back to the laboratory, rinsed, and scrubbed with a brush to remove all soil and carton material; then they were oven-dried and weighed. The weight loss was calculated by subtracting the weight of the recovered wood from the initial weight of the wood stakes. Simultaneously all the 21 wood species used in study were analysedfor their density (IS 401:1982), for their cellulose content by the anthrone reagent method (Sadasivam and Manickam, 1992), for their lignin content by the Klason lignin method (Rowell et al., 2005), and for their total phenolic content by the Folin-Ciocalteau reagent method (Sadasivam and Manickam, 1992). Weight loss in the wood stakes was correlated with the physical and chemical properties of the wood.

Table 2
Details of the wood species used in the study.

Sl. no.	Trade name	Origin	Scientific name
1	Maple	Belgium	*Acer pseudoplatanus* L.
2	Maple	France	*Acer pseudoplatanus* L.
3	Kapoor	Malaysia	*Dryobalanops aromatica* C.F. Gaertin
4	White Beech	France	*Fagus grandifolia* Ehrh.
5	Beech	Belgium	*Fagus sylvatica* L.
6	S Beech	France	*Fagus sylvatica* L.
7	Ash	France	*Fraxinus angustifolia* Vahl.,
8	Ash	Belgium	*Fraxinus excelsior* Quctnon Flynn
9	Rubber	India	*Hevea brasiliensis* Muell. Arg.
10	Narra	Africa	*Pterocarpus soyauxii* Taub.
11	Padouk	Cameroon	*Pterocarpus soyauxii* Taub.
12	European Oak	France	*Quercus robur* L.
13	Balau	Indonesia	*Shorea laevis* Ridl.
14	Maranti	Malaysia	*Shorea marcoptera* Dyer.
15	Sal	Malaysia	*Shorea robusta* Gaerth. F.
16	Mayanmar Teak	Myanmar	*Tectona grandis* L.f.
17	African Teak	Ivory coast	*Tectona grandis* L.f.
18	African Teak	Ghana	*Tectona grandis* L.f.
19	African Teak	Tanzania	*Tectona grandis* L.f.
20	Australian teak	Indonesia	*Tectona grandis* L.f.
21	Pyinkado	Myanmar	*Xylia dolabriformis* Benth.

2.2. Statistical analysis

Data analysis was performed using SigmaStat® 3.1 statistical software. Data were checked for normality and as the tests for

Table 1
Field testing sites and their characteristics.

State	Field layout	Climatic zones	Latitude and longitude	Average rainfall	Temperature
Karnataka	Nallal	Semi arid	13° 4′ 0″ N/77° 47′ 53″ E	826 mm	Max.: 38.3 °C Min.: 23.8 °C
Andhra Pradesh	Hyderabad	Tropical wet and dry	17° 22′ 31″ N/78° 28′ 27″ E	789 mm	Max.: 40 °C Min.: 25 °C
	Visakhapatanam	Tropical wet and dry (Coastal area)	17° 48′ 0″ N/83° 18′ 0″ E	1202 mm	Max: 37.4 °C Min.: 18.8 °C
Kerala	Palode, Thiruvanathapuram	Tropical wet	8° 45′ 8o47″ N/77° 4″ E	2500 mm	Max.: 37° C Min.: 20° C
Madhya Pradesh	Jabalpur	Humid subtropical	23.43° N/81.50° E	1350 mm	Max.: 40 °C Min.: 19.8 °C
Rajasthan	Jodhpur	Arid	26° 18′ N/ 73° 04′ E	320 mm	Max.: 43 °C Min.: 37 °C