Laboratory and Field Evaluation for the Resistance of commonly used woods against *Coptotermes heimi* (Wasmann)

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ABSTRACT

The current study was conducted to evaluate the resistance of four wood species (*Azadirachta indica*, *Pinus roxberghii, Dalbergia sissoo* and *Populus deltoides*) against subterranean termite species *Coptotermes heimi* by choice and no choice field and laboratory trials. Of these four wood species *P. roxberghii* and *D. sissoo* proved to be most resistant to termite attack. Taken together these results we can conclude that *D. sissoo* is the least preferred and *P. deltoides* is the most preferred wood by the *C. heimi.* The data obtained from the field choice and no-choice the woods are arranged in order of preference DS>PR>AI>PD whereas in laboratory choice and no-choice trials the order of preference was PD>AI>PR>DS.

Key words: *Coptotermes heimi*, wood resistance, feeding preference, visual rating.

Introduction

In Pakistan, wood is an essential component of the residential as well as commercial constructions. However the durability of the woods has not yet been tested with specific concern to termite attack. *Coptotermes heimi* (Wasmann) is widely distributed termite species throughout Pakistan (Chaudhry, 1972). This species has been recorded damaging the living trees of Shishum *(Dalbergia sissoo)*, toot *(Morus alba)*, and popular *(Populus deltoides)*. This species not only attacks the wooden logs and wooden installation but it also infest the standing living to an extent where the trees become hollow completely. In Peshawar, a wooden bridge was found seriously infested by this termite (Sen-Sarma, 1975).

Natural durability of the woods is classified in different ways around the globe. The heartwood of many timber species is resistant to biological breakdown to some extent which is referred as natural durability that may add to the wood resistance to decay, marine usage, termites or other insects (Stirling, 2009; Willeitner and Peek, 1997).

The purpose of this study was to evaluate the resistance of four different woods of commercial importance i.e. *Dalbergia sissoo, Azadirachta indica, Populus deltoides* and *Pinus roxberghii* against subterranean termite *C. heimi* in field as well as laboratory trials.

MATERIALS AND METHODS

Field trials

The woods (*Dalbergia sissoo, Azadirachta indica, Populus deltoides* and *Pinus roxberghii)* used for the study were purchased from the commercial timber market. The field test was conducted at Lahore College for Women University and Jallo forest park (Eastern part of Lahore). For field trials each wood was cut into 2cm×2cm×2cm (L×R×T) dimensions, oven dried for 24h at 60°C and weighed prior to trial. For Choice feeding trials, the wooden blocks were arranged in a group of four woods, tied with copper wire and installed in the experimental area in triplicates at a depth of 15-20cm below the surface of the soil. The replicates were installed at a distance of 2m from each other. After one month the experimental setups were recovered from the soil, cleaned, oven dried and re-weighed to determine the mass loss. In addition, wood specimens were visually rated according to the (AWPA, 1997): and was graded from 10(sound, surface nibbles permitted), 9 (light attack), 7 (moderate attack), 4 (heavy attack), or 0 (failure). For choice field trials, the blocks were prepared as for the choice trials except that three same wooden blocks were tied together so as the termites will have no choice of the food and were installed in the soil at 15-20sm depth 2m apart from each other

Laboratory trails

Workers and soldiers of *C. heimi* were collected from the Lahore College University Campus and maintained in the laboratory for 24h prior to use. The moribund termites were removed and only active termites were used for the laboratory trials. For no-choice laboratory trials wooden blocks were prepared as described above and placed in the center of the glass Petri dish (15×90mm) above a sterile moist filter paper. One hundred workers and twenty soldiers were added to the dish. The moisture was maintained in the dishes by monitoring the moisture of the filter papers. The experimental setups were maintained in triplicates. The experimental setup was maintained at 26^{o}C for 14 days. After 14 days the blocks were removed, dried and re-weighed to calculate the amount of wood consumed and percentage termite mortality was

recorded. Mean visual rating was recorded as described above with 10 (sound, surface nibbles permitted) to 4 (heavy attack). For choice laboratory trials the experimental setups were prepared as for no-choice test with the difference that instead of one, two different wooden blocks were placed in the same Petri dish.

Statistical analysis

The data obtained was analyzed by One-way ANOVA with Tukey's post test using GraphPad Prism version 5.03 for Windows, GraphPad Software, San Diego California USA, www.graphpad.com".

RESULTS AND DISCUSSION

The data obtained from the current study are presented as mean mass loss due to termite activity, mean visual rating to describe the extent of wood damage caused by the termite and percentage mortality of the termites in laboratory trials.

In choice field trials *P. roxberghii* was very resistant (VR) with 10 visual rating, *A. indica* was resistant (R) with 9 visual rating, *D. sissoo* was moderately resistant (MR) with 7 visual rating and *P. deltoides* was susceptible (S) to termite attack. One way ANOVA revealed that mean mass loss of different woods are significantly different from one another ($F=7.850$; $P<0.001$; Table 1).

In no-choice field trial *D. sissoo* was found to be very resistant (VR), the wood of *P. roxberghii* is resistant (R), the wood of *A. indica* is moderate resistant (MR) and *P. deltoides* is susceptible (S) to termite attack. This visual rating was based on the mean mass loss of the woods as a result of termite activity with maximum loss is for *P. deltoides* is (106±15.2 mg) and least for *D. sissoo* (13.0±5.7 mg). From the data obtained in no-choice field trial the order of preference as food for *C. heimi* is PD>AI>PR>DS. One way ANOVA with Tyukey's test revealed that mean mass losses of different woods are significantly different from each ($F=7.617$; $P<0.001$; Table 2).

In choice laboratory trials the woods were arranged in pairs; *D. sissoo*/*P. deltoids* and *A. indica*/*P. roxberghii*. The data obtained in choice trial has shown that *P. deltoides* was susceptible (S) to termite attack and was preferred over *D. sissoo* which was rated as very

resistant (VR) to termite attack. The maximum loss was observed for *D. sissoo* (36.0±7.23) and the least loss was for *P. deltoides* (6.0±0.57). *A. indica* was preferred over *P. roxberghii* in the laboratory choice trial and *P. roxberghii* was rated as resistant to termite attack with 9 visual rating and *A. indica* was rated moderately resistant with 7 visual rating. From the data obtained we can conclude that *D. sissoo* was preferred by the termite over *P. deltoids* whereas *P. roxberghii* was preferred over *A. indica.* The order of resistance determined from the MVR was DS>PD and PR>AI. One way ANOVA has revealed that mass loss was significantly different for different woods when compared with each other (F=7.860; *P<0.001*; Table 4)

In no-choice laboratory trial of the wood preference, the percentage mortality of *C. heimi* was 50.00, 68.5, 75.5 and 80.00 % for *P. deltoids* (PD), *A. indica* (AI), *P. roxberghii* (PR) and *D. sissoo* (DS) respectively. The mean mass loss indicated the maximum mass loss of *P. deltoides* (41.6±4.93 mg) and the least mass loss was for *D. sisso* (6.6±2.51 mg). From the data obtained we can conclude that *D. sissoo* is the least preferred and *P. deltoides* is the most preferred wood for *C. heimi* and the order of preference in no choice laboratory trial is PD >AI > PR >DS. One way ANOVA revealed that means of different woods were significantly different from one another (F=19.66; *P<0.001*; Table 4).

In laboratory trials termite mortality was recorded. The highest mortality was observed with *D. sissoo* and the lowest with *P. deltoids*. The high mortality rates with *D. sissoo* and *P. roxberghii* could be attributed to the natural texture of the woods and their chemical constituents. *Dalbergia sissoo* was very resistance to attack by termite *Odontotermes obesus* (Akhtar and Ali, 1979). Extractive content of the woods determine the resistance of the wood against the damaging agents (Martawijaya, 1996).

The data supports an early report that natural resistance of the wood to termite attack is related with higher specific gravity of the wood species (Esenther, 1977; Peralta *et al.* 2004). *D. sissoo* has high specific gravity (0.572) and is highly resistant. The woods used for the current study have an economic importance and damage caused to these woods may lead to significant decline in the revenue that could be generated by intelligent use of these woods. Neem is a source of environment-friendly biopesticide. Neem extract is used in sprays against fleas in cats and dogs (Ganguli, 2002). *Populus* is used in match manufacture, rural house construction, pulp

and paper industry (Siddiqui *et al*. 1996). Pine oil has irritant action with medicinal importance. (Hussain, 1987 and Nunes *et al.* 2004). Therefore, it is of utmost importance that significant steps should be taken to protect the woods and wooden structures from the termite attack.

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Table 1: Results of mean visual rating and mean mass loss of four woods against *C .heimi* after one month exposure in no choice field trial.

Wood species	Common name	Mean visual rating	Mean mass loss g(mean±SE)
D. sissoo (DS)	Shishum	10(VR)[(i)]	13[a]±5.7
P. roxberghii (PR)	Pinus	9(R)	26[b]±11.5
A. indica (AI)	Neem	7 (MR)	53[c]±37.8
P. deltoides (PD)	Poplar	4 (S)	106[d]±15.2

Table2: Results of mean visual rating and mean mass loss of four wood species against *C. heimi* after one month exposure in choice field trials.

Wood species	Mean Visual rating (MVR)	Mean Mass loss (mg) (Mean±SE)
D. sissoo/ P. deltoides	7/4 (MR/S)	23.3±5.77[b]/130±10[b(ii)]
P. roxberghii / A. indica	10/9(VR/R)	26.6±5.77[a]/ 70±26.4[c]

Table 3: Results of mean visual rating and mean mass loss of four wood species against *C. heimi* after 14 days exposure in no choice laboratory trial.

Wood species	Common name	Visual rating	Mean mass loss (mg) (mean±se)	Percentage mortality
P. deltoids (PD)	Poplar	4 (S)	41.6±4.93[a]	50
A. indica (AI)	Neem	7 (MR)	24.6±10.6[b]	68.5
P. roxberghii (PR)	Pinus	9(R)	12.6±3.2[c]	75.5
D. sissoo (DS)	Shishum	10(VR)	6.6±2.51[d]	80

Table 4: Results of mean visual rating and mean mass loss of four woods against *C .heimi* after 14 days exposure in choice laboratory trials.

Wood species	Pair of wooden blocks	Mean visual rating	Mean mass loss (mg) (Mean±SE)
D. sissoo/P. deltoids	DS/PD	10/4(VR/ S)	36±7.23[a]/6±0.577[a]
P. roxberghii/A. indica	PR/AI	9/7(R /MR)	8.3±7.76[b]/27±7.21[b]

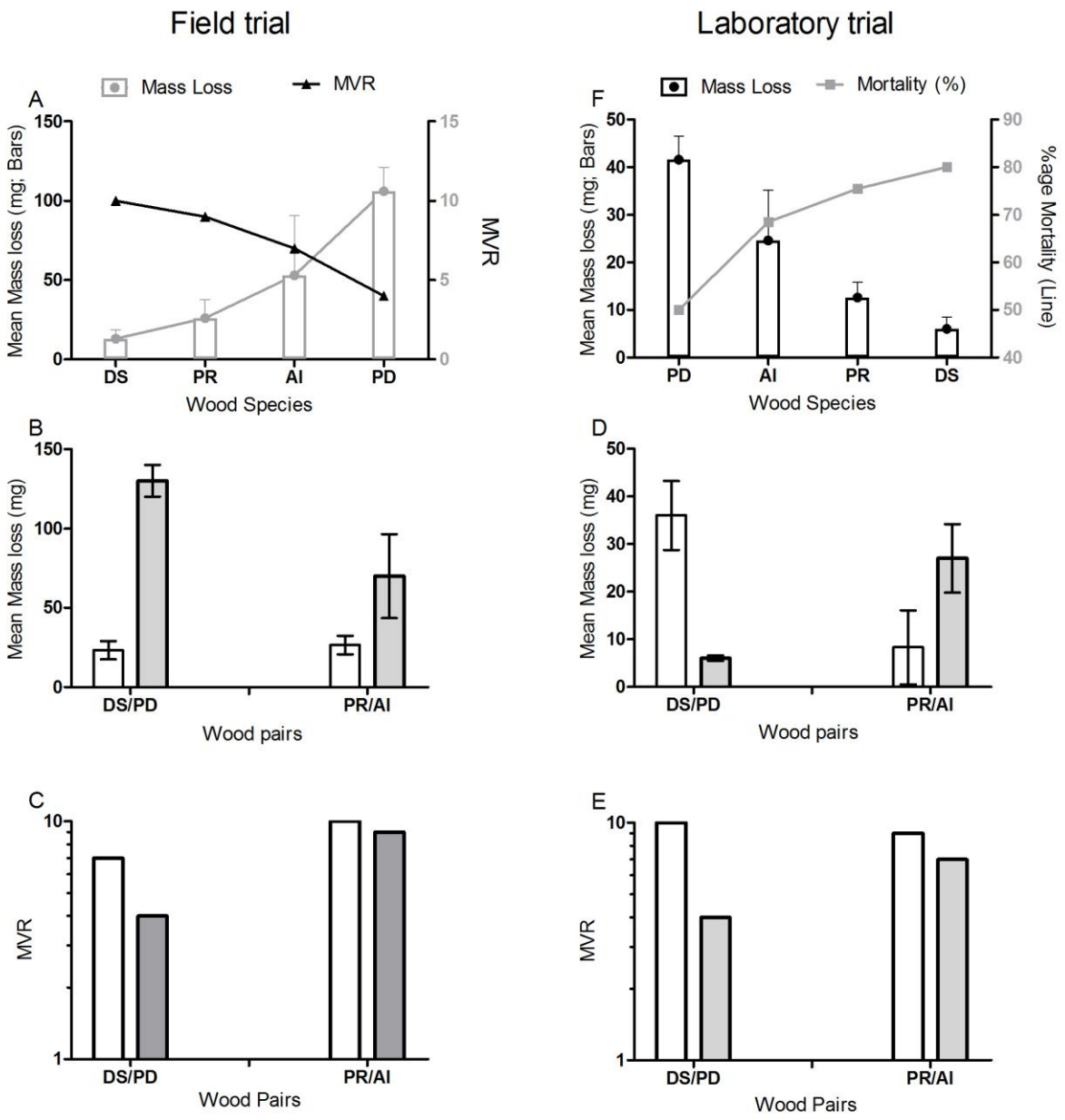

Figure 1: Choice, No-choice field trial (A, B), Mean visual rating (A,C) and Choice, No-choice laboratory trials (D, E) and Mean visual rating (D,F) of four different woods used in the current study and exposed to *Coptotermes heimi* for 30 days (field trials) and 14 days (laboratory trials). The order of preference for food source determined by mean mass loss and mean visual rating was DS>PR>AI>PD[iii] as determined in choice field trials (A). In no-choice assay the order of preference was PD>AI>PR>DS as determined from the mean mass loss (B) whereas the mean visual rating was PR>AI>DS>PD (C). For laboratory choice assay the order of preference as food source was PD>AI>PR>DS as determined by mean mass loss and %age mortality (D). In no-choice assay the order of preference was DS>AI>PR>PD as determined from the mean mass loss (E) whereas the mean visual rating was DS>PR>AI>PD (F).

[i] : MR moderate resistant, R: resistant, VR: Very resistant, S: susceptible

[ii] Means followed by different letters within column indicates the significance level of the means ($P < 0.001$).

[iii] *D. sissoo, P. roxberghii. A. indica, P. deltoids*