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Original Research Article

Evaluation of anti termites sold in Cote d'Ivoire against termites damage on woods of selected timbers

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***[1]Eboua N. Wandan, [2]Kalé Gbegbe, [2&3]Irié Zo Bi , Joseph [3]Koula, and [2]Julien-Gomez K. Beda**

[1]Laboratoire de Gestion de l'Environnement, Département Eaux Forêts et Environnement, Institut National Polytechnique – HB, BP 1093 Yamoussoukro, Côte d'Ivoire, Direction.
[2]Direction Régionale des Eaux et Forêts, BP 1081 Yamoussoukro, Côte d'Ivoire.
[3]Département Math-Info, Institut National Polytechnique – HB, BP 1093 Yamoussoukro, Côte d'Ivoire, Direction,

* Corresponding Author
E-mail :wandaneb@yahoo.fr
Tel.: +225-06 21 85 70
08 48 24 52

Termites are known to cause tremendous losses to wood and wooden structures in buildings, besides loss in agriculture and forestry crops. For controlling termites, synthetic termiticides have been used in Cote d'Ivoire. This study aims at evaluating the preservation efficiency of anti-termites sold in the country. Four anti-termite chemicals, two largely used but not homologizes and two homologized were used to treat four timber wood boards. The results indicated that wood boards which are not treated loosed weight compared to the treated ones. Besides that, white woods seemed to be more protected compared to red wood probably due to better absorption of termicides solution by white woods which are softer than the red ones which are hard. The results indicated also that albeit, the type of application of the termicides, there are no difference between the protection bestowed by the chemicals. Above all, all the four termicides found in the market seemed to present the same level of protection against the termites' attacks. The problem was that pyrical and phosgene were homologated whereas the two others did not go any efficacy test or homologation. Some of the termiticides contained banned pesticides and should be removed from the market.

Key words: Termiticides, wood board, Cote d'Ivoire, banned pesticides

INTRODUCTION

Wood is the oldest industrial product used by humans in many industries, the largest of which is the construction and furnishing (Haygree and Bowyer, 2006), It offers the advantage of being natural and renewable. But unfortunately it is attacked by several organisms among which are phytophagous sects (Reeb, 1997, Temesgen, 1996).

Termites attack wood without sparing those used by humans: wood construction, railway sleepers, electricity poles, stakes, etc (Ibrahim and Adebote, 2012). But the greatest economic impact is for homes. They may attack all parts of wood: the studs, window openings, door frames, stairs, framing, flooring, baseboards, etc (Ghaly and Edwards, 2011).

The attack always begins with the pieces of wood in contact with soil, concerning subterranean termites. Few materials can stop them and they can damage materials such as plaster, mortar sufficiently hard, plastic materials, etc in order to attain woods (Salman et al., 1982; Wood, 1991; Tsunoda, 2005).

Houses are their source of feeding, especially when the conditions are favorable for their development.

Among wood-boring insects, termites, whose activity is enhanced by heat and humidity, cause extensive damage to wooden structures not manufactured or processed in the houses, in addition to losses in agriculture and forestry

(Sen-Sarma et al., 1975). Depending on their mode of attack there are two categories of termite: (1). Wood Termites are characterized by direct installation of their colonies in the timber and developing there without any association soil and (2) subterranean termites which form colonies living underground building galleries or tunnels with various debris, soil, feces, and saliva (Wood, 1996; Eggleton,. 2000; Paul and Rueben, 2005).

To overcome their attacks, several termiticides are reported to be used in Cote d'Ivoire. Some of these chemicals are licensed for application against soil termites. In construction, however, none of these chemicals has been tested for efficacy. In addition, they are not. Moreover, they are widely used in to treat woods. No information is given in their labels concerning the active ingredient or the application rate. They are often applied as such following a tradition already established by construction workers.

The aims of this study was to survey all termiticides available on the market and assess their efficacy in protecting wood against termites

The damage caused by termites is of two types: perforation corresponding to tracking insects in search of food and the partial or complete destruction of wood. Wood preservation enables it to last for a long period as possible. This preservation is done by using chemicals, fungicides and insecticides applied correctly. It only makes sense if this protection remains effective for at least ten years or more. For this reason, the chemical must be effective against the agents of destruction of timber, be as sustainable as possible, should not alter the physical or mechanical properties of wood, and must properly penetrate into wood by at least one of the current methods of treatment.

MATERIALS AND METHODS

METHODS

Wood treatment chemicals

Four Chemicals found in the markets were tested in this study.These are:

– Xylogil® whose active ingredients are the organochlorines pesticides: lindane and aldrin whose concentrations are not indicated on the label. It is sold by the company Induschimie in a container of 4 L,

– Xylamon® whose active ingredient seems to be Aldrin. It is marketed in 4 L jug by CIPROCHIM Company,

– Pyrical 480 EC, which active ingrdient is Chlorpyrifos-Ethyl 480 g / l. It is formulated by Arysta LifeScience SAS (NOGUERES-France) and distributed by the CALLIVOIRE under approval no RCI: 00- 0498 IN. It is sold in boxes of 100 ml and 250 ml,

– Phosphene, an insecticide-fungicide containing 9 g/l of Permethrin and 75.5 g/l of tributyltin oxide of TBTO (BTO). It is sold as emulsifying oily formulation and is marketed by the Sadofoss No. 00-0500 Approval In / Fos in 4-liter.

Biological material

Wood boards used in this study were of 45 cm long, 12 cmlarge and 2 cm thickness. They were locally from a factory and were used as such. These boards were made form 4 species of timber of industrial importance in wood industry in Côte d'Ivoire. Indeed, they represent more than 10% of most currently exploited species (DPIF, 2008). These species include 2 white woods Samba or ayous (*Triplochiton scleroxylon* K. Schum - Sterculiaceae.) and Frake (*Terminalia superba* Engl and Diels - Combretaceae.) and 2 red woods, Kotibé (*Nesogordonia papaverifera* R. Cap - Sterculiaceae) and Dabema (*Piptadeniastrum africanum* Brenan-.Mimosaceae).

Termites used in this assay were collected from termite mounds around the test site according to the recommended method by Williams et al., (1999) and Amburgey et al., (2002). Two species: Cubitermes spp. and Trinervitermes *trinervius* and *Ancistrotermes cavithorax* belonging to the family of Termitidae.

METHODS

Application of the termiticides

Wooden boards were treated early in the morning (6 hours 30 minutes) as directed on the package. Pyrical was diluted at 1 liter Pyrical 480 EC to 50 L of water. The 2% solution obtained was used to treat wood boards. For phosphene, the concentrated formulation was diluted in a solvent (1v/7v). The other two products, Xylogil and Xylamon were used as such.

The application of the products involved painting or dipping of boards. For the painting, the products were applied using brushes across the surface of the boards which were subsequently disposed on the attack arena (Figure 1). Regarding the dipping, the solutions prepared were transferred into trays and wood boards were dipped in these solutions for 30 minutes. After draining, the boards were placed on the area of attack.

In order to increase the attack of woods by termites and obtain results in a short period of time, the methods proposed by Williams et al., (1999) and Amburgey et al., (2002) were used to construct an area of attack. The exposition arena which was constructed in an open area of the agroforestry domain of the Department of Water, Forestry and Environment of the National Polytechnic Institute -HB of Yamoussoukro, Cote d'Ivoire. It covers an area of 18 m^2 (9 m x 2m) and consisted of a principal drilled hole filled with collected termites (nests) which was connected by trenches to secondary holes (Figure 1).

The untreated wooden boards as well as the treated ones were randomly exposed to the attack arena during three months in order allow the termites to used wood as feed (Figure 2). Every week; water was sprayed on the arena in

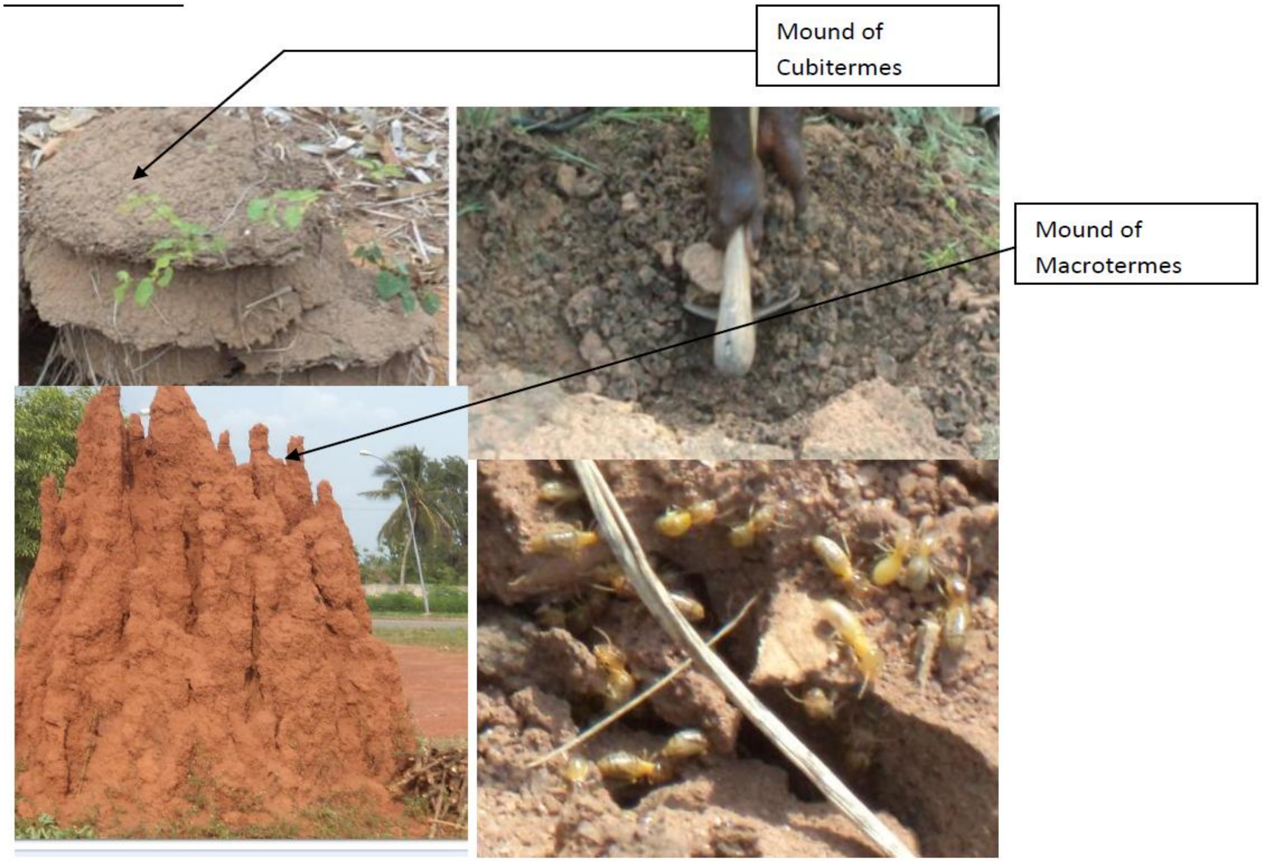

Figure 1: Picture showing termite mound harboring termites (left); collection of termites after destruction of the mound, (right) termites inside the mound

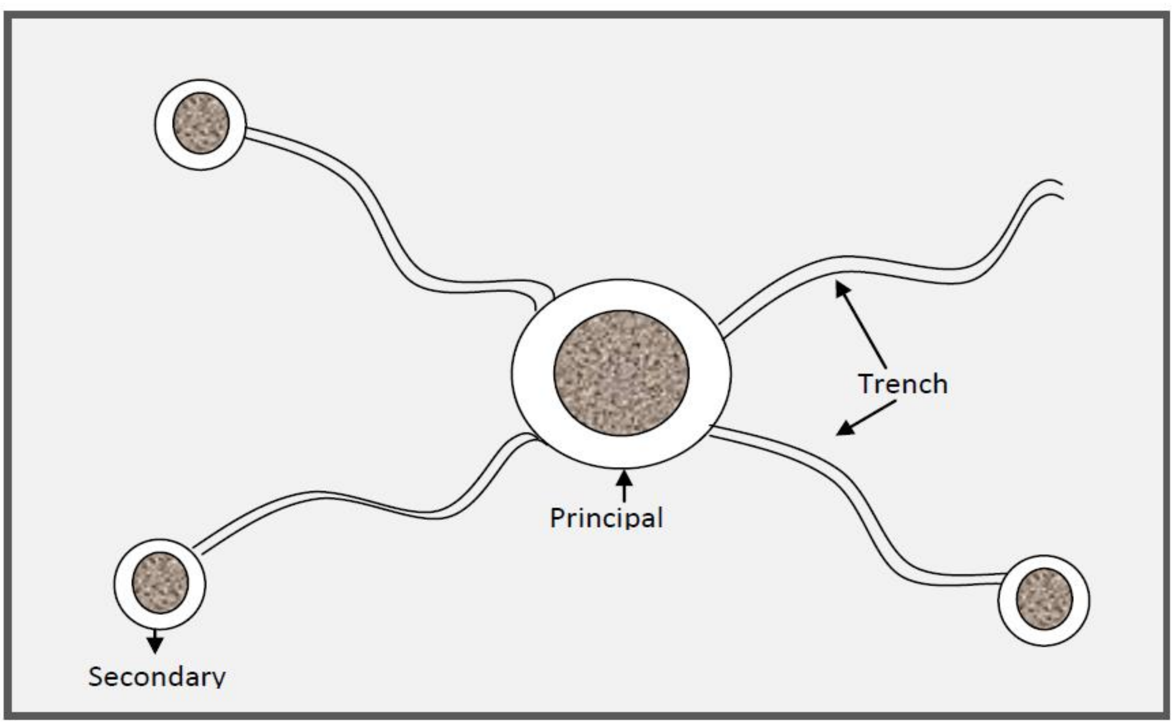

Figure 2: Illustration of the exposition area. It covers 9x2m (18 m^2) and is composed of a central drilled hole (principal) filled with termites collected in the nests (mound) which was connected by trenches to secondary holes

Figure 3: Treated wooded boards (impregnated or painted) were spread out on the exposition arena (above and around) as suggested by par Peters and Fitzgerald (1997).

Figure 4: (a) soil particles attached to the wood boards, and (b): wood board put in drying in an oven

order to keep the area humid which favors the upward migration of termites.

Data Collection

To assess the level of protection of wooden boards by the different anti termites used, weight loss of boards following the attacks by termites were recorded. For this reason, all the boards were weighed in the laboratory with a Sartorius Laboratory balance with an accuracy of 0.01 g to determine the initial weight before applying the products,. At the end of the trial, these boards were washed to remove dirt clods (Figure 3), dried in an oven at 80 °C in an oven Memmert for 48 hours (Singh and lkumar, 2008). After drying, the boards were weighed to determine the final weight.

Data analysis

For data analysis, we used the "Final weight" (g) instead of the "Weight Loss" (g), because unlike the "Weight Loss" the "Final weight" variable (g) implies a simple and practical direct reasoning. The higher the "Final Weight" (g), the more the timber is resistant to attack by termites. The greater the "weight loss" (g), the lower timber is resistant to attacks. Also, for comparison values, the data were reduced by dividing each value of "final weight" (g) by the corresponding "original weight" (g).

The variables are defined as follows:

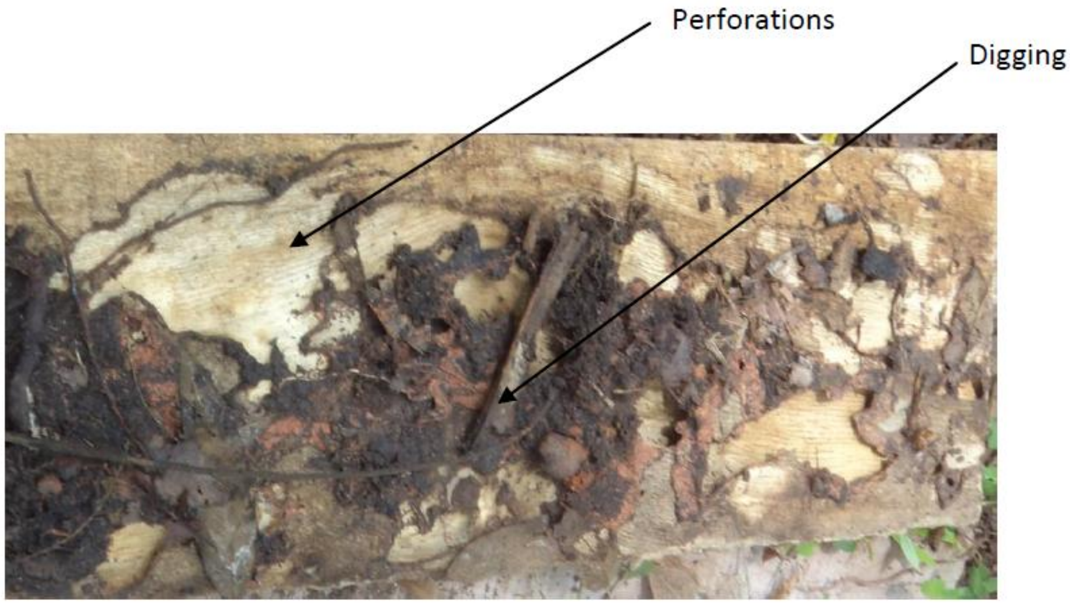

Figure 5: Perforation and destruction of wood boards due to the attack of termites

- Wood: Red (Dabema, Kotibé) and White (Frake, Samba),
- Chemicals used as anti-termites; No product, Pyrical, Phosphene, and Xylogil Xylamon,
- Type of application: Brishing and impregnation,
- Pfinal: Final weight (g).

Statistical analysis of data

Calculations and statistical analyzes were performed with the free software R.2. ANOVA was used for variance analysis; the test of Kolmogorov-Smirnov was used to the normality of distribution at the level of 5%. The test of Bartlett has permitted to verify the homogeneity of variances. The Wilcoxon rank test (nonparametric test) was used to confirm or reject the equality of the two means and the test of Fisher's was used for the comparison of means.

RESULTS

After putting the different wood boards in contact with termiticide's solutions, we observed either the presence of partial perforations on board or their total destruction (Figure 5) due to the attack of the termites (Fouquet, 2000).

Resistance to attack depending on the essence

Figure 6 showed that the losses of weight (final weight / initial weight) were higher for the control (no application) compared to the treated boards (with application). The weight losses were between 0.83 ± 0.91 and 0.06 ± 0.06 gr for the untreated boards while for the treated wood boards, the weight losses were between 0.87 ± 0.04 and 0.92 ± 0.02. If we combine the results of the non-treated boards and those of the treated ones, the values of weight loss were between 0.86 ± 0.05 and 0.90 ± 0.04. Based on thesis results, one can state that there is a difference between species for their resistance to the attacks of termites.

This difference must be due to the type of wood (white or red).

If we considered the timber species, that is say, the confounding effect of non-treated and treated wood (Figure 7) we observed that the results was identical to the one shown by figure 2b, corresponding to the application of the anti-termites. This indicated that there may be a difference between the timber species coming from the type of wood (red or white).

Effect of the method of application of the termiticides

Figure 8 shows the effect of anti-termites based on the mode of application of these products. The results indicated an average weight loss of 0.86 ± 0.05 gr for the untreated boards compared to 0.90 ± 0.04 for painting board and 0.90 ± 0.03 for dipping boards.

Efficacy of the termiticides

Weight losses due to non-application of anti-termites ranged from 0.85 ± 0.00 and 0.91 ± 0.00 for control (untreated)(Figure 9). For treated boards, the weight losses were between 0.88 ± 0.00 and 0.91 ± 0.00 gr. Thus, there was a highly significant difference ($p < 0.001$) between the untreated wood the anti-termite and treated ones. These results indicated that the use of any of the four anti-termite chemicals increased the protection of wood compared to untreated wood. It also noticed that the anti-termite chemicals differ significantly in relation to their protection

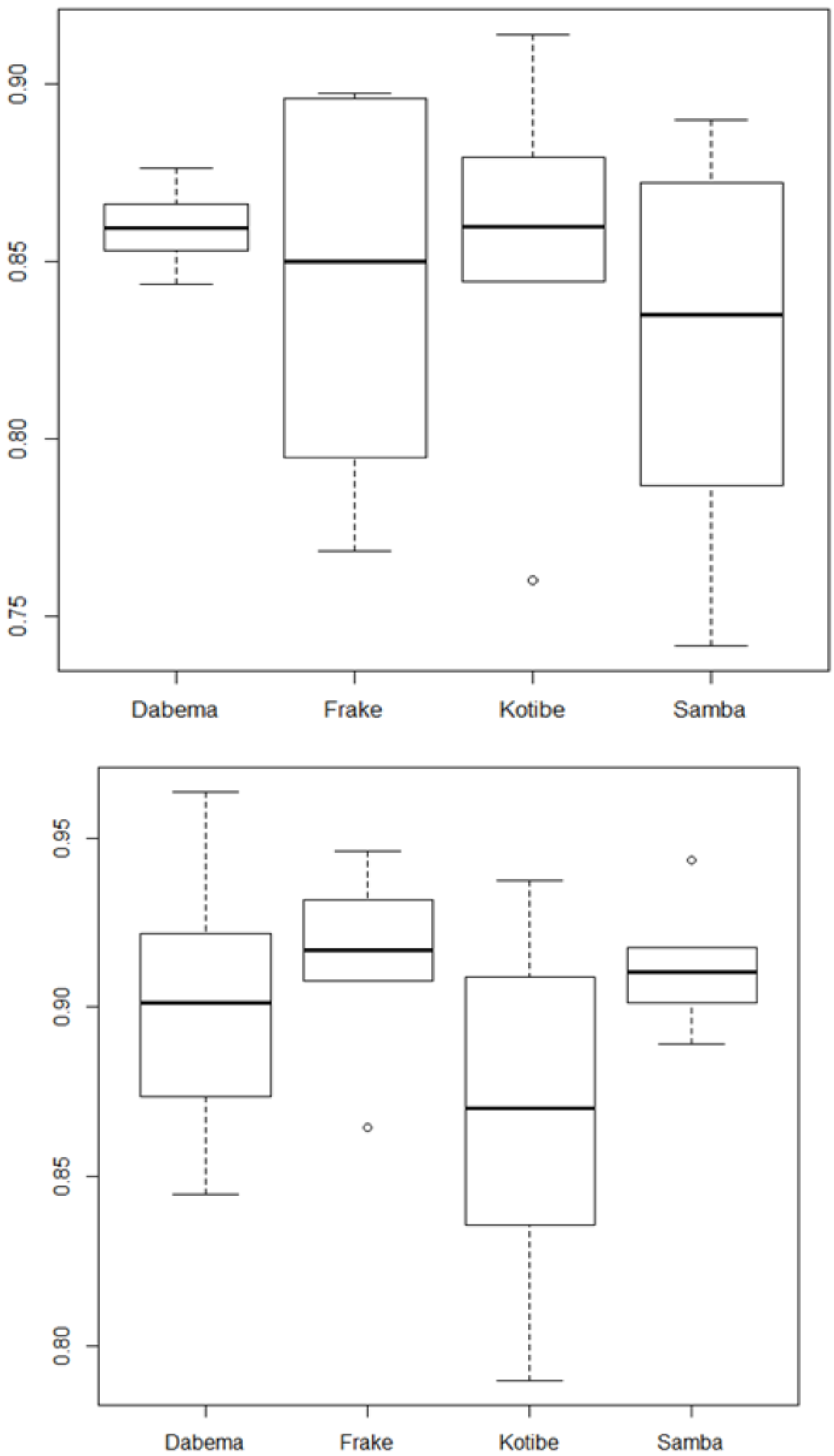

Figure 6: Efficacy of the protection against termites by the anti-termites chemicals: treatments (above), and check or no application (below)

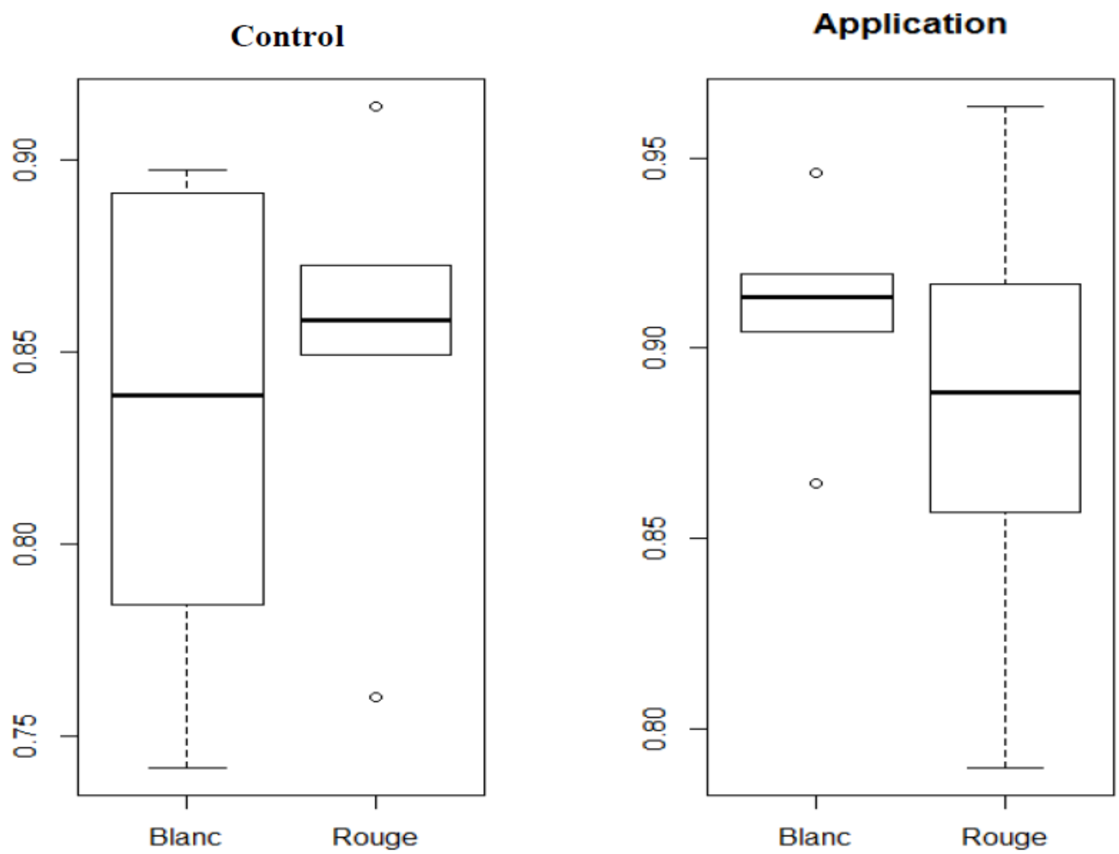

Figure 7: Final weight of wood boards: (left) without application of the anti-termites, and after application of the anti-termites (right).

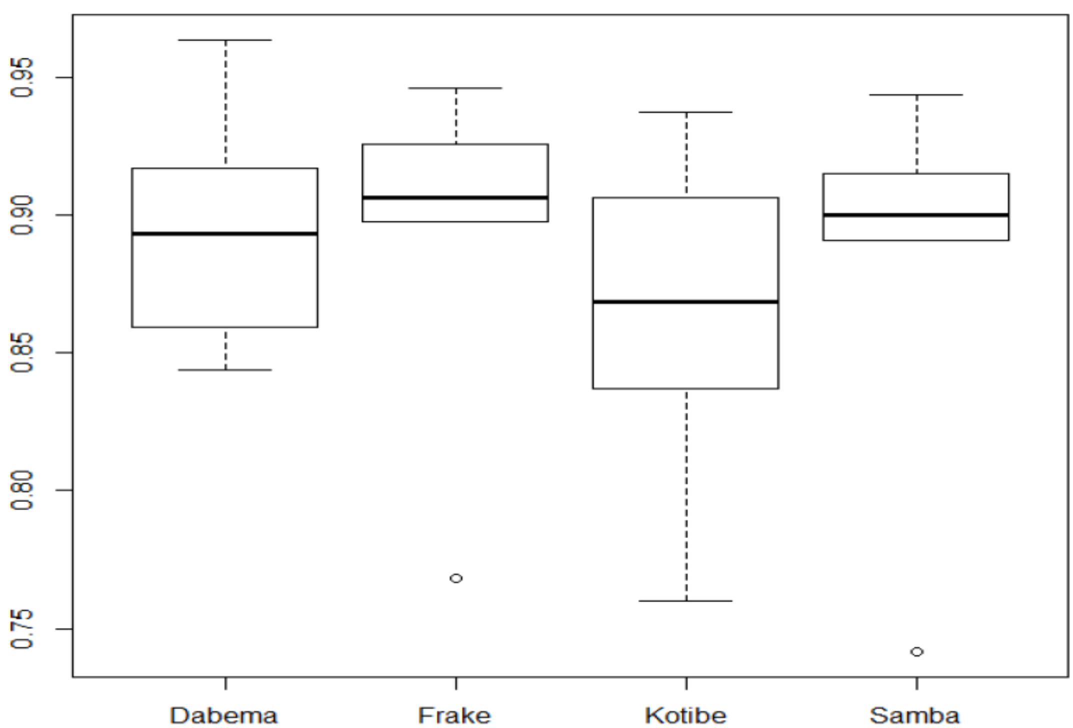

Figure 8: Levels of protection of wood boards against the attacks of termites by the anti-termite chemicals expressed by weight loss

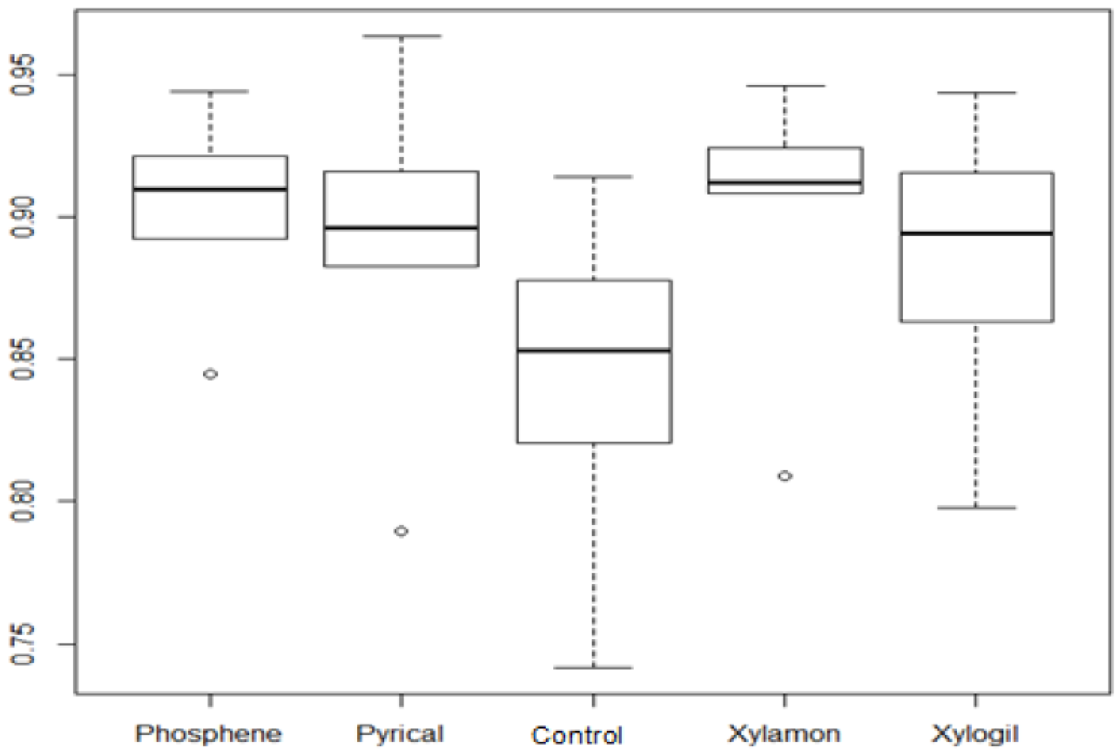

Figure 9: Levels of protection of wood boards against the attacks of termites by the anti-termite chemicals expressed by weight loss

against termites.

DISCUSSIONS

According to Fouquet (2000) degradation caused by termites on wood are of two types, either perforations corresponding to track of termites looking for food or a partial or complete destruction of the woods for their feedings.

The significance differences observed between white wood (Samba, Frake) and red wood (Dabema, Kotibé) can be explained by the fact that in general, white woods are very light and soft (Class S) and were considered to be susceptible to termites attacks compared to red wood which have average durability (class M) and were hard therefore less susceptible to termites (CIRAD, 2012).

The white timbers seem to be more protected against termites than red timbers. This can be explained by the fact that red timber woods by their hardness have low capacity of the chemical solutions while woods from white timbers absorb more chemical solution leading to more protection.

These results indicated that when we only consider the timber, the difference between the effects of the anti-termite chemicals fades; there was no more difference. This showed that there was an interaction between the concern timber and the anti-termite applied. Although the mode of application of the chemicals (painting or dipping) has no significant effect, the level of protection of each timber wood by anyone of the anti-termite seemed to be different. We can classify the order of protection of timber woods according to the following decreasing order: Samba> Fraké> Dabema> Kotibé. This means that, after application of the anti-termites, white wood (Samba Fraké) were less sensitive to the attacks of termites than red woods (Dabema, Kotibé), applications

These results indicated that the treatment of wood by anti-termites by painting or dipping increased the resistance of the timbers against the attacks by termites compared to those which have not received any anti-termite. But the effect of the two modes of application of termite namely, painting and dipping products, are not different in the preservation of the different types of wood ($p = 0.61$).

CONCLUSION

This study was devoted to the evaluation of the effectiveness of wood preservatives against the attacks due to two species of wood-boring termites: *Cubitermes* spp. and *Trinervitermes trinervius*.

These results indicated that those timber woods that are not treated with anti-termite chemicals were more attacked than those who received the application of the chemicals. These attacks leaded to the perforations and partial destruction of some wood boards. This lead to a weight loss from 0.86 g to 0.90 g ± 0.5 ± 0.04 for the treated wood boards.

Our results indicated that the mode of application of anti-termite, by painting or dipping increases, regardless of the essence, the resistance of wood against the attack by termites compared to wood boards who did not receive anti- termites. For this reason, the effect of the chemicals was not affected by their mode of application. These results also showed that the use of any of the four chemicals increased the preservation of wood boards against the attacks due to termites compared to the untreated wood (control) but the efficiency varies from one product to another.

These results showed that white wood (Samba, Frake), which are considered to be susceptible to termites because of the softness, were significantly protected against termites compared to red wood boards which are considered hard. It will therefore more beneficial and cost effective to treat white timber wood with anti-termites than red timber wood. The chemicals would be more effective on white wood because they possess the capability to absorb more anti termites' solution. In the contrary, red woods which are comparatively harder are difficult to impregnate with the chemicals.

These results indicated that there was no difference in the efficacy against termites among anti termite sold in local grocery than those sold in specialty stores. Besides, the efficiency against termites seemed to be of equal strength whereas they are labeled and authorized or not. The problem resides on the use of chemicals that contain banned active ingredients such as aldrin and lindane which are organochlorine insecticides highly persistent in the environment. For precaution, it is desirable that these wood preservatives containing active ingredients that are toxic to humans or may have harmful effects on the environment to go through an approval process in order to protect users such as it is done with agrochemicals

Above all, most of the anti-termite are formulated with very volatile solvent. Because of that, it is desirable that when applied, minimal precautions be taken to avoid exposure of applicators. They could, for example, wear gloves or cover nose and wash their hands with soap after the application.

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