

Natural Durability of Eucalyptus Clones against Termite Attack

Grace Namujehe^a, Lawrence J. B. Orikiriza^{b*}

^aVEDCO, Kamuli District, Uganda

^bSchool of Forestry, Environmental and Geographical Sciences, Makerere University, Kampala, Uganda

^aEmail: gnamujehe@yahoo.com

^bEmail: orikiriza@forest.mak.ac.ug

Abstract

As essential components of the soil ecosystem, termites improve soil pH, organic carbon content, water content and soil porosity by cycling dead organics. However, termites also cause damage to food crops and trees. In Uganda, termites are major pests to Eucalypts including eucalyptus clones. This study assessed the natural durability of two Eucalyptus clones (GU 7 and GC 796) against termite attack. The specific objectives were to (i) identify the termite species that attack the wood from different parts of eucalyptus clones (ii) determine the weight loss of wood due to termite attack and (iii) determine the variation in termite resistance between the wood from the axial direction of the two clones. Two Eucalyptus clones GU 7 and GC 796 of four years old from Masaka district, central Uganda were cross cut into two proportions (at breast height and upper height). These were further plain sawn to samples of dimensions 20 x 20 x 20 mm size along the grain from the heartwood for the termite tests. Samples were taken to Olobai village, Kisoko County in Tororo district for field testing with termites. This area had been identified as a major site for termites in preliminary studies. The termite species that attacked the wood were identified and weight loss determined. The results showed that *Macrotermes bellicosus* and *Pseudocanthotermes militaris* attacked and damaged the wood. The mean weight loss was higher (26.8%) in GU 7 than in GC 796 (19%). Termite activity in Eucalyptus wood affected the axial position of the trees. The wood from the lower part of the trees in axial direction exhibited the most resistance to termites with 13 – 20% weight loss. Therefore, GC 796 is more resistant to termites than GU 7. We postulate that GC 796 resistance is mostly inherited from the parent land race *Eucalyptus camaldulensis*. More studies on natural durability should be done for other Eucalyptus clones.

Keywords: Eucalyptus clones; Natural resistance; Termite damage.

* Corresponding author. Tel.: +256-772-570-985.
E-mail address: orikiriza@forest.mak.ac.ug.

1. Introduction

As population increases, the demand for fuel-wood and wood products for construction and fencing increases [1]. The existing natural high forests and woodlands cannot cater for such demand resulting in deforestation thus degrading the environment. Currently Uganda cannot meet the demand for transmission poles for energy and telecommunications sectors from locally grown trees. Poles are imported from Tanzania and South Africa [2]. Indigenous trees are slow-growing and cannot keep up with the demand for wood and wood products. It is estimated that Uganda will become a net importer of fuel-wood in the 2020s [3]. Future increases in demand for wood and wood products will need to be met from planted forests rather than natural woodlands. Commercial tree growers want returns on their investment and implying that they need high quality planting materials with desired properties such as fast growth and resistance to pests and diseases. The most promising option is to grow Eucalyptus hybrids using clonal forestry technology [4]. Eucalyptus clones were introduced in Uganda due to their extraordinary growing features: high growth rate, columnar shape and natural ability of auto pruning. In addition to the cultivation properties, this species generally presents good technological properties of timber, making it suitable for multiple purposes: poles, wood furniture, particle boards, glue-laminated timber beams and sawn timber [5]. However it is important to note that serious pest problems have emerged on exotic Eucalyptus species. Termites have been identified as one of the most damaging pests to plantation and agroforestry trees in eastern and central Africa. Exotic trees such as different Eucalyptus species, *Grevillea robusta* and *Leucaena leucocephala* species are especially susceptible to termite damage [6]. The growing of Eucalyptus clones has expanded the possibilities of utilization of timber but at the same time the necessity to characterize the wood material obtained from new genetic sources has increased, in order to orient its use to optimal purposes [7]. Natural durability is the inherent degree of resistance of wood to wood deteriorating agents. It is a desirable property of wood that allows it to resist bio deterioration caused by fungi, termites and other wood deteriorating agents without treatments by preservative chemicals or coatings [8, 9]. Variations in natural durability occur between species and within the same species [10]. Such variations may be due to proportions of sapwood or heartwood. The differences in natural durability are generally associated with variations in the content of extractives [11]. However there are many non-durable eucalypts, so choosing the right species is important if naturally durable products are the aim [7]. Examination of durability variations within Eucalyptus clones indicated that there were significant variations between species and clones within species [7]. This study investigated the natural durability of two Eucalyptus clones (GU 7 and GC 796) against termite attack in order to ensure that good planting stock which is relatively resistant to the major pests in Uganda is adopted. We hypothesized that: (i) There is no wood weight lost due to termite attack, (ii) The amount of wood lost due to termite attack is independent of the height from which the wood was obtained.

2. Materials and methods

2.1 Sample Selection, collection and preparation

Two four year old Eucalyptus clones GU 7 and GC 796 free from growth defects and biotic infestation from Masaka district central Uganda were cut. Their mean diameters at breast height were 39.2 cm and 40.6cm respectively; these were selected for the study because of their increased adoption in Uganda. These clones are commonly selected for planting due to their small branches and clean poles suitable for inter-planting with agricultural crops, a practice which is common in Uganda [2]. The trees were cross cut into two proportions and samples collected from two heights (breast height- 1.3m and upper height - >1.3m). One meter length billets were prepared from the two sampling heights. The billets were further plain sawn into samples of dimensions 20mm x 20mm x 20 mm size along the grain for each tree clone and subjected to the termite tests, with care being taken to represent the heartwood region. The heartwood was used because it is said to be highly resistant to termite attack [12]. In total 160 samples were prepared. The samples were randomly selected and labelled appropriately by end painting with different colours for easy identification. In order to take into consideration the principle of replication, two sets of specimen were used for each tree clone in a given region. This implies that 20x2 samples were obtained from each part of the tree. The samples were air-seasoned (Figure 3.1a) for two weeks to about 20% moisture content and their initial weight W_1 after air seasoning was taken.



Figure 2.1(a). Samples being air dried (b) Samples after painting for easy identification

2.2 Field exposure of wood samples to subterranean termites

In order to determine weight loss, the test specimens were then exposed to termites in the field for a short duration. The short duration field test method (32 days) was preferred because it offers a fast field test for screening of promising lesser known timbers against termites [13]. In addition, field tests were preferred to laboratory studies because they allow the collective and cumulative effects of all kinds of abiotic and biotic deterioration factors to be evaluated [5]. They also give reliable data regarding natural resistance of wood [15]. The field site was Olobai village, Kisoko county in Tororo district an area where termite infestation was detected earlier in preliminary studies [16]. The wood samples were buried randomly 150mm into the ground 12 meters away from the active termite mounds (Figure 3.2) but in an area with termite tunnels [13, 17] for 32 days during the dry months of July and August. This is the period when termites are most active.



Figure 2.2. Active termite mounds found in the field site

The peak of termite attack on crops and trees occurs during dry periods [18]. Experiments on subterranean termites in Arizona showed that termite foraging was highest in the summer months and lowest in the winter months [19]. He also noted that the number of termites seen foraging was strongly correlated with temperature. In order to identify the termite species that attacked the wood samples, test specimens in the field were inspected daily, though infestation was observed after 4 days of exposure. The termites that attacked the specimens were collected (Figure 2.3) and taken to the laboratory for identification. After 32 days of exposure, the remaining wood samples (Figure 3.3) were cleaned, and oven dried at 60°C for 18 hours. These were then conditioned to Equilibrium moisture content and then weighed to get their final weight W_2 .



Figure 2.3 Some termites that were collected from the field

2.3 Methods for identification of termites that attacked the wood

The termite species that attacked the wood samples in the field were collected from and taken to National Forestry Resources Research Institute (NaFORRI) laboratory for identification. The soldier and worker castes were collected and preserved in 80% ethanol. Taxonomic identification for collected samples was done at family, sub-family, genus using standard determination keys and where possible to species' level using termite records by [16].

2.4 Data Collection and Analysis

The percent weight loss for the individual wood specimens was determined according to D1413 American standards (2003):

$$\text{Percent weight loss} = \frac{100(W1-W2)}{W1}$$

Where W1 = Weight of test specimen before exposure to termites.

W2 = Weight of test specimens after exposure.

To determine the termite resistance the Termite Resistance corresponding to natural durability classes of wood in BS EN 350-1(1994) below was used

Durability class	Percent weight loss
Durable	0 -- < 5
Moderately durable	5-- < 20
Susceptible	More than 20

Descriptive statistics was used to determine the modal attack on wood sampled from different heights of the Eucalyptus clones.

3. Results

3.1 Termite species that attacked the wood specimens

Two termite species attacked the wood samples. The first species had medium sized and dark alates. The soldiers were of two types where one type was medium-sized with red heads and the other type was small and dark. The workers were small with a big abdomen. The features confirmed *Pseudocanthotermes militaris*. The second species to be identified had alates that were medium-sized and dark brown. They were two types of soldiers that were small in size. The workers were medium-sized with dark brown heads and the soldiers produced a characteristically ‘sharp’ smell when rubbed between thumb and first finger. The above features are for *Macrotermes bellicosus*.

3.2 Weight loss due to termite attack on wood samples from GU 7 and GC 796

The mean weight losses for GU 7 and GC 796 Eucalyptus clones from the lower region were 20% and 13% respectively after 32 days of exposure to termites. The average weight losses for the samples from the upper heart wood region for both species were 33% and 25% respectively (Figure 3.1). The overall average weight loss for GU 7 was 27% while GC 796 was 19% (Table 3.1).

Table 3.1 Natural durability test on Eucalyptus clones **GU 7** and **GC 796** in both the lower and upper positions of the trees.

Eucalyptus clone	Weight loss (%)			Durability
	Upper wood	Lower wood	Over all weight loss	
GU 7	30.5	19.5	26.8	Susceptible
	36.2	21		
GC 796	26	12.8	19	Moderately durable
	24	13.5		

3.3 Variation in durability in the axial direction of the Eucalyptus clones GU7 and GC796

Generally the weight losses in the wood samples obtained from the lower portions of the wood was less than the weight loss obtained from the samples in the upper regions of the tree clones as. The average weight losses obtained from the two positions of the wood for each clone in both the upper and lower positions of the trees were 33% and 20% for GU 7 clone and 25% and 13% for GC 796 respectively (Figure 3.1).

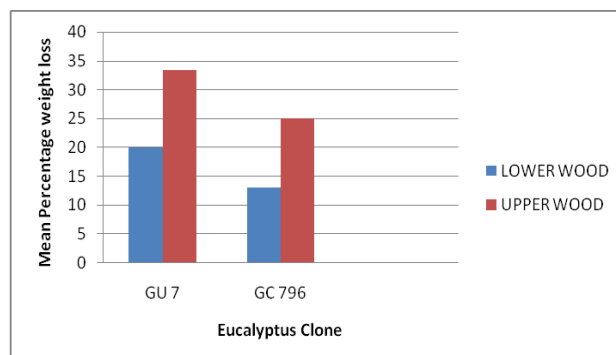


Figure 3.1 Weight loss of Eucalyptus clone wood in axial positions, in **GU 7** and **GC 796**

4. Discussions

4.1 The termite species that attacked the wood

Termite species that mainly attacked the wood samples were *Macrotermes bellicosus* and *Pseudocanthotermes militaris*. This finding confirms previous studies that identified *Macrotermes bellicosus* and *Pseudocanthotermes* species as Uganda's main pests for the Eucalyptus species [6]. Different termite species can attack the same tree species at the same time [20]. In this study, it is probably because termites in their search for food could have landed on the same food source. However it was noted that after 10 days of exposure to termites, *Pseudocanthotermes militaris* was no longer attacking the wood samples. This could probably be due to the fact that natural chemical substances are present in some woods in sufficient quantities to drive away termites while other woods may only have sufficient amounts to repel termites after eating away a considerable amount. *Macrotermes bellicosus* is reported to be aggressive [16] and this termite pest was identified to be one of the most serious pests in Tororo district. The serious damage on Eucalyptus species by these termites is probably because these termites have fixed nests, with populations numbering in the millions, from which the workers move out in search of food and return with their spoil [21]. Thus, the rapidity and scale of their attack on new food source (wood) is much more than that of other termites. This group of termites constructs earthen tunnels over impenetrable foundations and walls to maintain the moist soil environment between nest and food [21]. It is also important to note that over 90% of the termite damage in agriculture, forestry, and urban settings was attributed to members of the Macrotermitinae [18], which build the large mounds.

4.2 Weight loss due to termite attack

The lower percentage losses in weight of GC 796 compared to GU 7 indicated that GC 796 was moderately resistant to termite attack while GU 7 was found to be susceptible to termite attack. This is because for the genus Eucalyptus there is a great variability in the natural durability of heartwood among different species and also within the same species and varieties [7]. The relatively higher resistance of GC 796 to termite attack is most likely inherited from the parent land race of *Eucalyptus camaldulensis* which was found to be resistant to termite attack in previous studies [1]. There could be other factors that enhance durability of the GC 796 clone; probably density could be one of them. Other factors such as decreased moisture content, reduced rate of diffusion and deposition of gums and resins also play an important role in determination of the higher durability of the heartwood though not investigated in the present study.

4.3 Variations in natural durability axially in Eucalyptus clones GU 7 and GC796

Considerable naturally occurring variability in durability was observed in wood samples taken from different locations axially within trees and from different trees. Such high variability in the termite resistance of heartwood within and between trees of the same species is agrees with previous observations of these and other wood species [9]. This could possibly be due to the fact that the distribution of the repellent substances (extractives) in the living trees is uneven [22, 23]. In the axial direction, the lowest mean percentage loss in weight values were detected in the lower part of the trees indicating that the lower part exhibited the greatest resistance against termites. With teak trees the bottom part of the teak tree was more resistant to termite attack than the upper part [24]. The author reported that. It is also possible that the greatest weight loss (%) in the upper wood could be due to the greater juvenile wood portion and lower extractive content. This was expected because the top part is assumed to be more susceptible to termite attack i.e., the latest formed wood which contains less toxic components (extractives).

5. Conclusions and recommendations

The termite species that attacked the wood samples are *Pseudocanthotermes militaris* and *Macrotermes bellicosus*. Wood resistance was greater in the lower part of the tree in both Eucalyptus clones. The most resistant parts (lowest weight loss) occurred in the lower wood of Eucalyptus trees. GC 796 was found to be moderately resistant while GU 7 was susceptible to termite attack. Preliminary trials to ascertain the best compromise between resistance and

growth rates for particular areas are necessary before scaling up the cultivation of Eucalyptus clones especially newly introduced species.

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