Maderas-Cienc Tecnol 21(1):2019
Ahead of Print: Accepted Authors Version

DOI:10.4067/S0718-221X2019005XXXXXX

Effectiveness of Copper Chrome Arsenate and used engine oil in protecting fencing posts of Ugandan grown eucalypt clone GC550 and *Phoenix reclinata* against termite attack

P. Mugabi, E. Otuko
Department of Forestry, Biodiversity and Tourism, Makerere University, P.O. Box 7062, Kampala, Uganda
Corresponding author: pkmugabi@gmail.com
Received: January 09, 2018
Accepted: August 20, 2018
Posted online: August 22, 2018

ABSTRACT

Eucalypts and *Phoenix reclinata* posts are the most commonly used species for fencing posts in urban areas of Uganda. Although eucalypts are known to be susceptible to termites, fencing posts are still used untreated. In this study, the effectiveness of Copper Chrome Arsenate and used engine oil in protecting Ugandan grown *Eucalyptus grandis* × *Eucalyptus camaldulensis* clone and *Phoenix reclinata* fencing posts against termite attack were assessed. The objectives were to determine (i) the incidence and (ii) severity of termite attack on *Eucalyptus grandis* × *Eucalyptus camaldulensis* and *Phoenix reclinata* fencing posts treated with Copper Chrome Arsenate or used engine oil. Ninety 2ft long samples of *Eucalyptus grandis* × *Eucalyptus camaldulensis* and *P. reclinata* posts were treated with Copper Chrome Arsenate or used engine and others left to act as control then buried in 1ft deep pits in the ground at a spacing of 1m by 1 in Eastern Uganda. The samples were visually inspected monthly for termite damage for 9 months. More than 80% of untreated samples of both species had been attacked by termites within the first month. Copper Chrome Arsenate treated *Eucalyptus grandis* × *Eucalyptus camaldulensis* and *Phoenix reclinata* samples were first attacked in the 8^{th} and 5^{th} months respectively. While used engine oil treated *Eucalyptus grandis* × *Eucalyptus camaldulensis* and *Phoenix reclinata* samples were first attacked in the $7^{th}$and 5^{th} months respectively. The modal severity for samples of both species treated with either Copper Chrome Arsenate or used engine oil was class 1 (less than 1% of the sample volume eaten) while for the untreated samples it was class 5 (above 60% volume eaten) for the 9 months of field exposure. It was concluded that untreated posts of *Eucalyptus grandis* × *Eucalyptus camaldulensis* and *Phoenix reclinata* were highly susceptible to termite attack and that the protection offered by used engine oil or Copper Chrome Arsenate managed to restrict damage by termites to only less than 1% of the sample volume , over the 9 months of exposure for most of the sample posts. It is recommended that the experiment be repeated for a much longer period in order to ascertain the exact service life of the posts under these circumstances. Penetration and retentions of the preservatives in the posts should also be studied in order to ascertain their effect on the efficacy.

Key words: Incidence, severity, treated posts, wood preservation, wood protection.

Accepted manuscript

INTRODUCTION

The need to improve quality of timber as well as shorten the rotation of trees has led to the development of a number of fast growing forest plantation timber species (Petit and Montagnini, 2004). Fast growing clonal eucalypts were introduced in Uganda from South Africa in 2002 by the National Forestry Resources Research Institute (NaFORRI) (Epila-Otara 2004). GC550, a hybrid of *Eucalyptus grandis* × *camaldulensis* is one of the of 12 eucalypt clones introduced in Uganda (Epila-Otara, 2004 quoted by Turinawe *et al*. 2014) that has been widely adopted for transmission poles and fencing posts (Turinawe *et al*. 2014). However, because of the relatively high cost of the eucalypt clones, *Phoenix reclinata* has been used as an alternative to the eucalypts for fencing posts, especially in Central Uganda despite being a palm (Ssembajjwe *et al*. 2005). *P. reclinata* is a widely planted ornamental palm tree in tropical and subtropical regions. Although its wood is reported as durable and resistant to attacks by termites and fungi (Segu 2012), it has been observed to be easily attacked by termites in Uganda albeit this is not backed by scientific data since there is little information available. Yet untreated *P. reclinata* fencing posts continue to be used in central Uganda.

Euclyptus has been found to be highly susceptible to termite attack in different parts of Uganda (Ssemaganda *et al*. 2011, Nyeko and Olubayo 2005). According to Soderlund (2013), three sub families; *Apicotermitinae, Macroermitinae and Termitinae* were found to be existent in Uganda. In Tororo district in Eastern Uganda, *Macrotermes bellicosus* and *M. subhyalinus* were considered the most abundant termite species attacking the widest range of trees and crops, and causing the most damage (Nyeko and Olubayo 2005). Whereas *Pseudacanthotermes militaris*, *Macrotermes subhyalinus*, *M. bellicosus*, *Nasutitermes arboreus* and *Eutermes arborum* were

Accepted manuscript

62 reported to cause severe damage to pasture grass, trees and/or crops in Nakasongola district
63 (Orikiriza *et al.* 2012) in Uganda.

64 According to Ssemaganda *et al.* (2011), some of the strategies to protect wood from termite
65 attack include using naturally resistant tree species and or applying biocides. A range of
66 different chemical treatments has been developed to enhance the durability and service life of
67 timber. In addition to conventional wood preservatives such as creosote and waterborne
68 preservatives, several authors (Pereira *et al.* 2015, Mattos *et al.* 2013, Ssemaganda *et al.* 2011)
69 have reported use of used engine oil as an effective alternative to improve the biological
70 resistance of wood in Uganda and Brazil. McKee and Plutin (1989) indicated that although fresh
71 gasoline engine oil and both the fresh and used diesel engine oil were noncarcinogenic, majority
72 of the used gasoline engine oils were carcinogenic and can, therefore, kill wood degrading agents
73 in contact. According to Mattos *et al*. (2012), easy access of used engine oil from motor vehicles,
74 its low cost and ease of application since pressure is not required, makes it suitable for
75 preserving wood in rural areas by soaking or brushing. Some plant extracts have also been
76 proved to be toxic and important in protection against termite damage. (Kadir 2017, Fatima and
77 Morell 2015). For this study, the effectiveness of used engine oil in protecting fencing posts was
78 investigated. Copper Chrome Arsenate (CCA) representing the conventional preservatives
79 chemicals was used for bench marking purposes. The objectives of the study were to determine
80 (i) the incidence and (ii) severity of termite attack on GC550 and *P. reclinata* fencing posts
81 treated with CCA and used engine oil.

82

83

Accepted manuscript

MATERIALS AND METHODS

Timber

Thirteen undebarked, defect free *P. reclinata* posts, 2.1m long and 8-10cm in diameter, were randomly selected from Ndeeba, a Kampala suburb that harbors one of the largest market centers for this species and cross cut to 45 samples of 0.6m length. Two defect free, 3 years old GC550 individual trees of Diameter at Breast Height (DBH) 10cm were randomly selected and felled from a wood lot in Bukaleba, Mayuge District, 120km east of Kampala. The trees were debarked and crosscut into 45 pieces of 0.6m length. The 0.6m long samples of both GC550 and *P. reclinata* were then air dried in ambient conditions until moisture content, measured by a moisture meter was 20% and then treated with CCA and used engine oil.

Treatment of Samples with preservatives

Out of the 90 samples i.e. 45 for GC550 and 45 for *P. reclinata*, 15 samples of each species were treated with CCA by steeping for 2 days. The formulation of CCA used to treat the specimens comprised of copper oxide (25.61%), chromium trioxide (41.24%) and arsenic pentoxide (33.15%), this was diluted to 4%. Fourty liters of used engine oil was mixed with 12 liters of kerosene in an open drum in order to reduce the viscosity of engine oil and increase its penetration into the samples, then another 15 samples of each species were then submerged separately in the preservative for 2 days as well. The remaining 30 samples i.e.15 for GC550 and 15 for *P. reclinata* were left untreated to act as control. The samples were then air dried and when the surfaces of the treated samples were dry enough for handling, they were transported to the field for exposure to termites.

Accepted manuscript

105 **Study area description**

106 The field site was in Miroi village, Kolir Sub-County, Bukedea district in Eastern Uganda where
107 a large infestation of termites had been detected earlier during the reconnaissance survey. It lies
108 between the longitudes of 33° 00 E & 33° 45 E, and latitudes 33° 00 E & 33° 45 E, and an
109 average altitude of 1,800 meters above sea level. The District has a land Area of 2256.5 km² of
110 which water and swamps cover 406 km². The main vegetation covering the district is wood land
111 and grass savannah. *Pinus carribea* is the most common tree species planted in the district.

112 **Setup of the experiment**

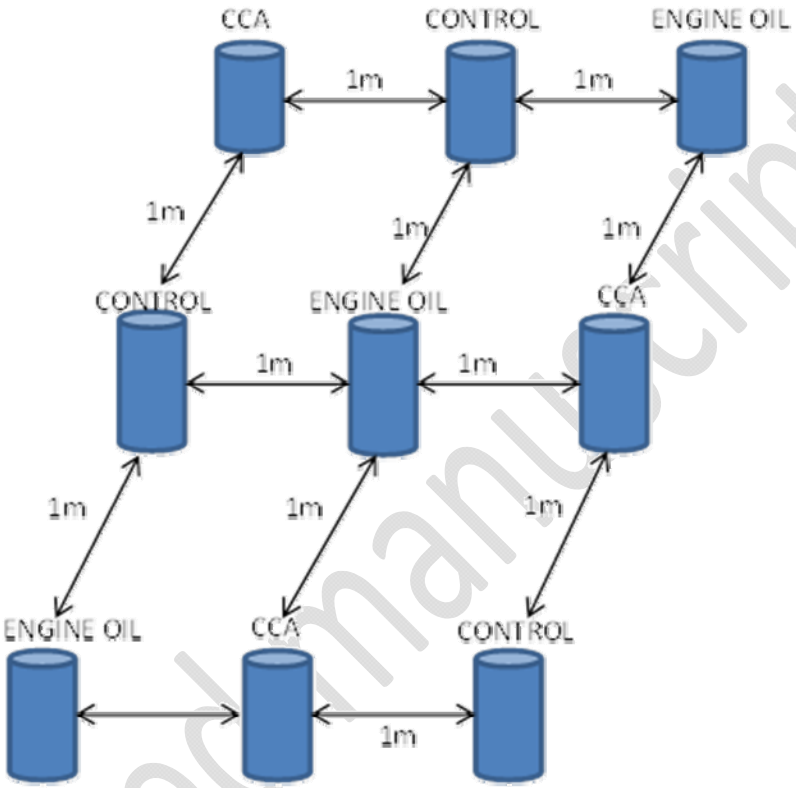
113 The experiment was carried out in an enclosure to keep away grazing animals and people from
114 tampering with the specimens. Ninety pits were dug at a spacing of 1m × 1m and the samples
115 were then buried in the pits with one foot height in the ground and the other one foot exposed.
116 The samples were placed systematically in the order: CCA treated followed by the control and
117 then the Engine oil treated sample (Figure 1).

118 **Data Collection Procedure**

119 Inspection of the samples was done every after 30 days for a period of 9 months starting from
120 28th March, 2016 in order to monitor and evaluate the level of termite damage on the samples. At
121 each time of inspection, specimens were removed from the ground and cleaned, and then the
122 damage assessed. The incidence of termite attack was recorded as follows: **A** representing
123 attacked and **N** represented not attacked. whereas the severity of the damage was recorded as
124 follows: **1** representing less than 1% of total wood volume eaten; **2** for 1-20% of total wood

Accepted manuscript

125 volume eaten; **3** for 21-40%; **4** for 41-60%; and **5** representing above 60% of total wood volume
126 eaten (Ssemaganda *et al.* 2011).



127

128 **Figure 1:** Arrangement of samples in the field.

129

130 **Data Analysis**

131 Descriptive statistics such as the modal incidence of attack, modal severity and the variations of
132 termite damage on samples with different treatments were used.

133

134

135

Accepted manuscript

RESULTS AND DISCUSSION

Incidence of termite attack

After one month of the experiment, none (0%) of the treated samples of GC550 or *P. reclinata* were attacked while over 80% the untreated samples of both GC550 and *P. reclinata* had been attacked by termites (Figure 2). No CCA treated GC550 samples were attacked for 7 months and only 1(0.67%) sample had been attacked by end of the 9 months. However, attack on CCA treated *P. reclinata* samples commenced in the 5th month and by the end of the experiment 20% of the samples had been attacked (Figure 2).The first engine oil treated GC550 sample was attacked in the 7thmonth, with only 1 sample attacked by the end of the 9th month. Similar to CCA, engine oil treated *P. reclinata* samples were first attacked in the 5th month but 40% of these were attacked by the end of the experiment (Figure 2).

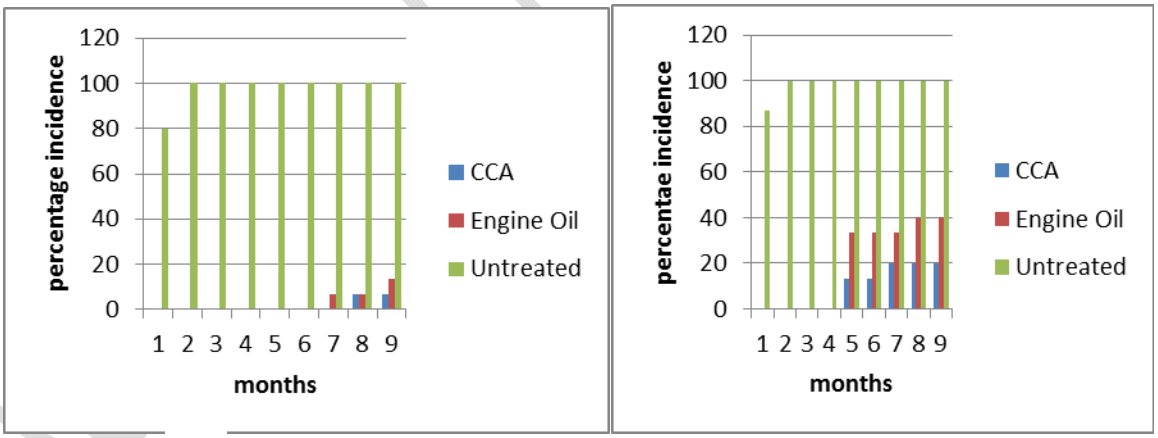


Figure 2: Percentage Incidence of termite attack on*a* (GC550) and *b* (*P. reclinata*) for each month.

Accepted manuscript

Severity of termite attack

For the entire period of the experiment i.e. 9 months, all samples of both GC550 and *P. reclinata* treated with CCA where still in class **1**. Whereas, GC550 samples treated with engine oil remained in class **1,** *P. reclinata* samples were in severity class **2** by 7th month (Figure 3 and 4).

However, for the untreated samples, just after 1 month of the experiment, 46.7% of the GC550 samples were in already in severity class 3 (Figure 3). More than half (53.3%) of the untreated *P. reclinata* samples, were in severity class 4, just after one month. By the end of the experiment, 14 of the 15 (93.3%) of untreated GC550 samples were in severity class 5 (Figure 3) while it took only 8 months for all the untreated *P. reclinata* samples to fall in class 5 of termite damage (Figure 4).

Modal Severity of the Samples

The modal severity for GC550 and *P. reclinata* samples treated with either CCA or used engine oil was class 1 for the entire 9 months of field exposure. For untreated GC550 samples, for the first four months the modal severity was class 3 and class 5 for the rest of the remaining months (Table 1).The modal severity was class 4 for the first month and class 5 for rest of months in untreated *P. reclinata* samples.

Accepted manuscript

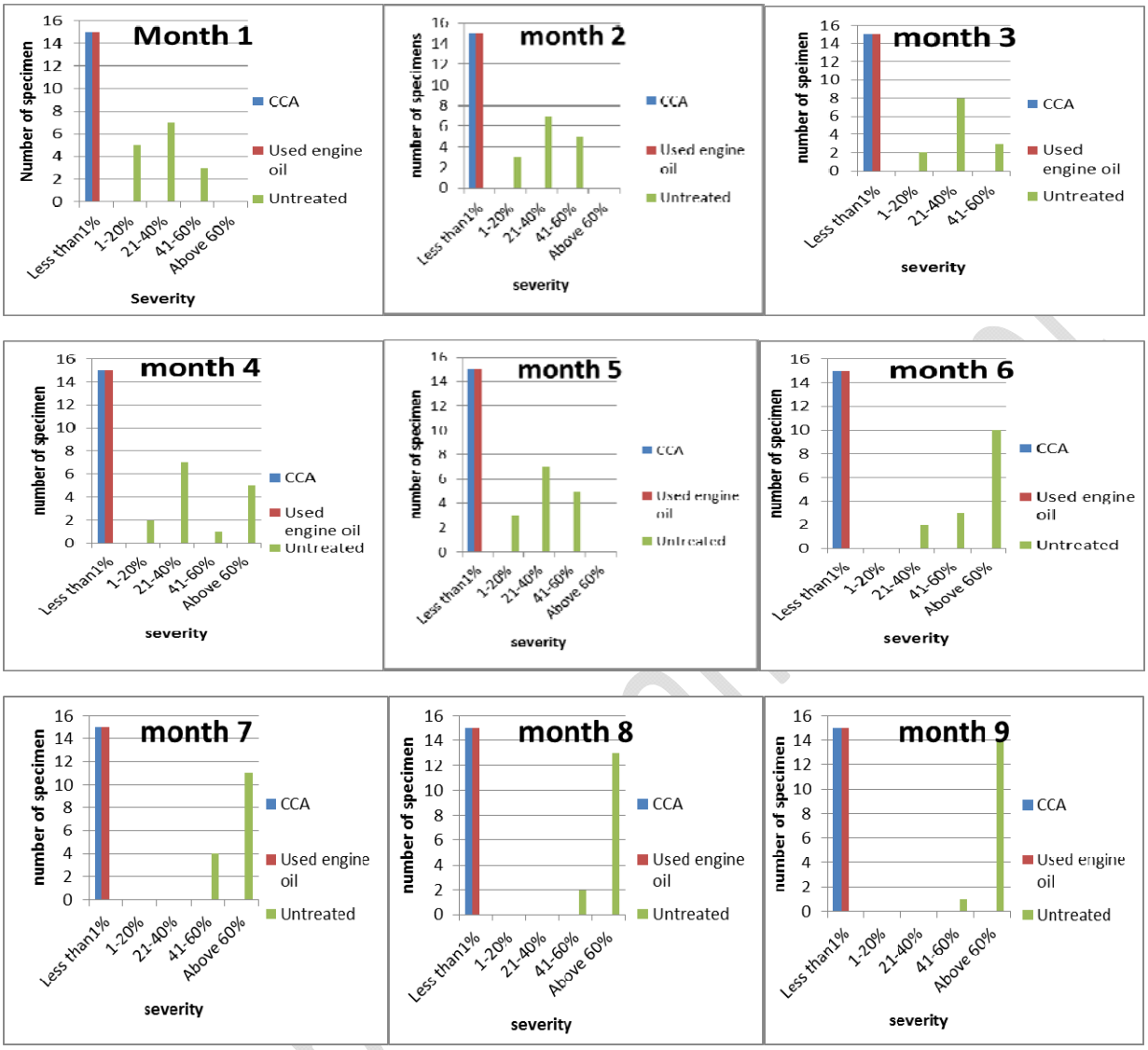


Figure 3: Number ofGC550 samples treated with CCA and used engine oil in different severity classes at different months after establishment of the experiment.

Accepted

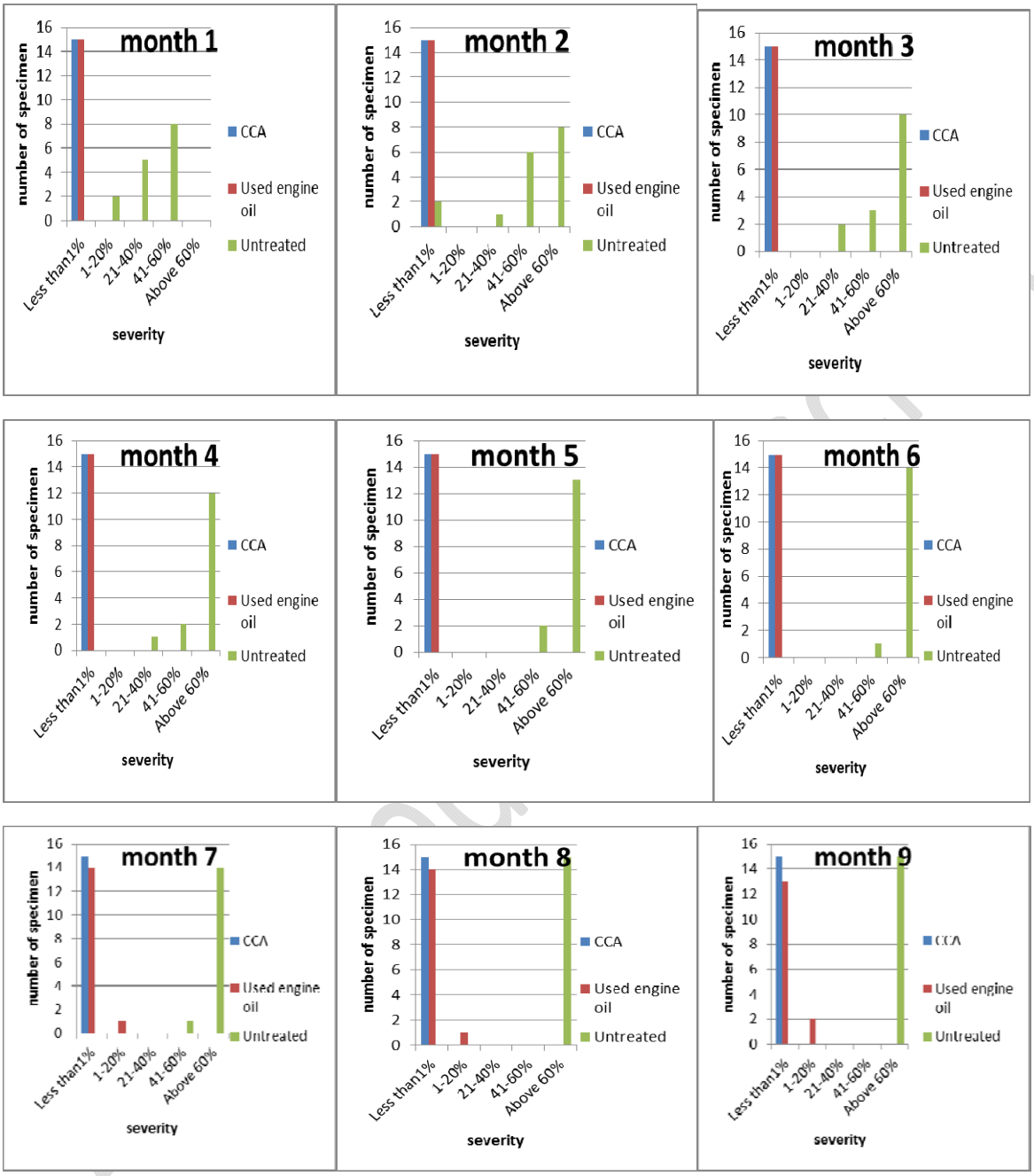


Figure 4: Number of *P. reclinata* samples treated with CCA and used engine oil in different severity classes at different months after establishment of the experiment.

Table 1: Modal Severity of termite damage for all the samples.

		Months								
Treatment	**Samples**	**1**	2	3	4	5	6	7	8	9
CCA	GC550	1	1	1	1	1	1	1	1	1
	Phoenix reclinata	1	1	1	1	1	1	1	1	1
Used engine oil	GC550	1	1	1	1	1	1	1	1	1
	Phoenix reclinata	1	1	1	1	1	1	1	1	1
Untreated	GC550	3	3	3	3	5	5	5	5	5
	Phoenix reclinata	4	5	5	5	5	5	5	5	5

Key: 1,2,3,4 and 5 are severity classes representing less than 1 %, 1-20 %, 21-40 %, 41-60 % and above 60 % respectively.

The fact that all the untreated samples of GC550 and *P. reclinata* were attacked by termites in the first month of the experiment shows that both of these species are highly susceptible to termite attack. For use in fencing, posts of the two species require preservative treatment yet the practice in Uganda is normally use of untreated posts. Untreated *P. reclinata* samples were marginally more susceptible to termite attack despite being preferred to eucalypts for fencing newly acquired land in Kampala. Even when treated with CCA or used engine oil, *P. reclinata* posts were still more susceptible to termite damage than GC550 treated with the same chemicals. Perhaps *P. reclinata* samples are softer and easier to tear by mandibles of worker termites compared to GC550 samples.

In GC550 samples, used engine oil was as good as CCA in giving protection against termites. At the end of the 9 months, all the GC550 samples treated with either used engine oil or CCA, were in severity class 1 (less than 1% of the total volume attacked) which is in agreement with Ssemganda *et al*. (2011) but in *P. reclinata*, CCA was marginally better than engine oil over the 9 months. This is probably because CCA was able to penetrate better in *P. reclinata* samples than used engine oil.

Accepted manuscript

CONCLUSIONS

- Untreated posts of both GC550 and *P. reclinata* were highly susceptible to termite attack although the severity of the damage was marginally greater in the *P. reclinata* samples at the end of the experiment.
- Treatment of GC550 samples with used engine oil or CCA delayed termite attack up to the 7months but in *P. reclinata* both preservatives could only delay termite attack up to the 5th month.
- After 9 months, most of the treated posts of both species had only less than 1% of their total volume eaten by termites, for both preservatives.

And it is recommended that:

- posts of GC550 and *P. reclinata* should only be used when treated to extend their service life since they are highly susceptible to termite attack;
- the mixture ratios, viscosity as well as retention and penetration in the two species be studied to establish the effect on the efficacy of the preservatives;
- the experiment be repeated for a much longer period in order to ascertain the service life of the poles;
- the same research be done on other *Eucalyptus* hybrid clones and other preservatives.

ACKNOWLEDGEMENTS

We appreciate the contribution of Busoga Forest Company in providing the samples used for this research.

Accepted manuscript

REFERENCES

Epila-Otara, J. 2004. Tree Biotechnology Project: Uganda's experience: In: Ngamau, C.; Kanyi, B.; Epila-Otara, J.; Mwangingo, P and Wakhusama, S., (Eds): Towards Optimizing the Benefits of Clonal Forestry to Small-scale Farmers in East Africa. International Service for the acquisition of Agri-Biotechnology Applications (ISAA). Nairobi, Kenya. No. 33.

Fatima, R.; Morrell, J.J. 2015. Ability of plant-derived oils to inhibit dampwood termite (*Zootermopsis augusticollis*) activity. *Maderas-Cienc Tecnol* 17(3): 685-690.

Kadir, R. 2017. Toxic effects of three selected Malaysian timbers plant extracts against subterranean termites. *Maderas-Cienc Tecnol* 19 (4) 417-432.

Mattos, B.D.; Gatto, D.A.; Missio, A.L.; Lourençon, T.V. 2012. Influência de Tratamentos preservativos na propagação da onda ultrassônicana madeira de eucalipto. *Scientia Plena, São Cristóvão* 8(4): 1-6.

McKee, R.H.; Plutnick, R.T. 1989. Carcinogenic potential of gasoline and diesel engine oils. *Fundamental and Applied Toxicology* 13: 545-553.

Nyeko, P.; Olubayo, M.F. 2005. Participatory assessment of farmers' experiences of termite problems in agro forestry in Tororo district, Uganda. Agricultural research and extension network. Network paper No. 143. www.odi.org.uk/publications. (Consulted 24/05/2018).

Orikiriza, L.J.B.; Nyeko, P.; Sekamatte, B. 2012. Farmers' knowledge, perceptions and control of pestiferous termites in Nakasongola district, Uganda. *Uganda Journal of Agricultural Sciences* 13 (1): 71-83

Pereira, P.A.C.; Stangerlin, D.M.; Neto, V.R.A.; Rodrigues, D.A.; de Melo, R.R.; Corassa, J.N., Calegari, L. 2015. Efficiency of used oil engine as preservative of Amazonian woods submitted to xylophagous termites. *Ciência da Madeira* 6(3): 176-182.

Petit, B.; Montagnini, F. 2004. Growth equations and rotation ages of ten native tree species in mixed and pure plantations in the humid neotropics. *Forest Ecology and Management* 199(2-3): 243-257.

Ssemaganda, I.E.; Mugabi, P.; Tumwebaze, S.B. 2011. Effectiveness of selected preservatives in rotecting Ugandan grown *Eucalyptus grandis* wood against termite attack. *Maderas-Cienc Tecnol* 13(2) 135-142.

Soderlund, S. 2013. Ants and termites in small-scale plantain farms in Uganda. A comparison between agroforestry and non-agroforestry farms. Bachelors thesis submitted to the Department of Ecology, Swedish University of Agricultural Sciences.

Segu, K. 2012. Phoenix reclinata jacq. In: Brink, M. and Achigan-Dako, E.G. (Eds.), Plant Resources of Tropical Africa 16. Fibres. Pp 359-362: PROTA Foundation. Wageningen.

Ssembajjwe, G.; Banana,Y. A.; Bahati, J.; Namubiru, E.; Mukasa, C.; Waiswa, S.; Matovu, S. 2005. Mugomba Forest Reserve Site Report. Third Visit. Uganda Forestry Resources and Institutions Center. Kampala Uganda.

Turinawe, H.; Mugabi, P.; Tweheyo, M. 2014. Density, calorific value and cleavage strength of selected hybrid eucalypts grown in Uganda. *Maderas-Cienc Tecnol* 16(1): 13-24. DOI:10.4067/S0718-221X2014005000002.

Accepted manuscript