Field experiment was set up in November 2011 and continued up to March 2013 on 324 m² backyard garden plot of a farmer’s residential area. The experiment was laid in 6 m × 6 m Latin square design. The treatments were polyethylene bag covered wooden sticks, chlorpyrifos 48% E.C. treated and polyethylene bag covered wooden sticks, *Masea lanceolata* treated and polyethylene bag covered wooden sticks, chlorpyrifos 48% E.C treated planting hole, *M. lanceolata* treated planting hole and untreated check. Every three months, termite infestation, damage and damage severity were recorded. The chlorpyrifos 48% E.C. treated polyethylene bag covered wooden sticks (0.2) and the chlorpyrifos 48% E.C. treated planting hole (0.2) protected termite infestation and damage throughout the study period starting from six months after application of treatment. In the rest of the treatments, damage progressed towards the end of the experiment with no significant difference amongst them. The severity of damage was significantly lower in chlorpyrifos 48% E.C. treated polyethylene bag covered wooden sticks (3 and 1.3) and chlorpyrifos 48% E.C treated planting hole (4.4 and 2.3) than the other treatments starting from twelve to eighteen months after application of treatments. Conclusively, chlorpyrifos 48% E.C. treated polyethylene bag covered wooden sticks and chlorpyrifos 48% E.C treated planting hole protected the wooden construction materials from both genera of termites. However, the chlorpyrifos 48% E.C. treated polyethylene bag covered wooden sticks was superior in providing longer duration of protection and reduction of environmental hazards. In the former treatment, no chemical was in contact with soils that saves not only contamination of soils and ground water but also reduced the rate of the biodegradability of the chemical.

**Key words:** *Masea lanceolata*, polyethelene bag, chlorpyrifos.

**INTRODUCTION**

With few exceptions, the main food of all termites consists of wood, the chiefly utilized being cellulose (Harris, 1971). Termites cause economic loss by damaging structures such as buildings, bridges, dams, and even roads or by damaging crops, forest trees, or rangelands (Harris, 1971; Pearce, 1997; Gurusubramanian et al., 1999). They are major pests of all kinds of woods and products of wooden origin. They also attack living...
plants (Metcalf, 1967). Non-cellulose materials such as plastic pipes, electric and telegraph cables are also damaged by termites (Harris, 1971; Hickin, 1971). In vast tropical areas no wooden article is safe, especially if termites can gain direct access to it from the earth (Klots and Klots, 1959). Termites attack on field and tree crops and on forest trees especially in the semi-arid and sub-humid tropics. They cause significant losses and often a major constraint on reforestation (Logan et al., 1990).

Local houses are constructed using mud and termites can tunnel through these structures and eat wooden roof supports or thatching. Thatching in African houses can be expected to last 5 to 6 years. Wooden or bamboo poles incorporated in the mud or cement walls of traditional houses offer an easy means of entry to termites from floor level to other areas. In all kinds of buildings good design is important but this may still not stop termites invading (Pearce, 1997).

Ethiopia, as one of the tropical countries, suffers from termite damage to buildings, seedling and saplings for reforestation; loss of timber and agricultural crops and forestry trees. Termite damage is particularly serious in Western Ethiopia than other regions (Abdurahman, 1990, 1995).

In Western Ethiopia where it is common practice to build houses and fences on untreated wood and grasses without proper foundation, thatched grass roof huts are destroyed in about five years while corrugated iron sheet houses survived about eight years. About 50% of the houses and fences require maintaining every year. Similar maintaining is required for stores, bridges crossing streams, electric and telephone poles and many others. As a result trees are cut frequently to replace structures destroyed by termites. Such practice would undoubtedly lead to deforestation and ecological disaster (Abdurahman, 1990). One could also imagine that labor force engaged and money spent in maintaining the structures destroyed by termites annually. These losses of labor, money and forest resources would obviously be very striking had it been properly estimated and reported as has been done elsewhere.

Generally, termite damage to buildings, electric and telephone cables, bridges crossing streams, standing trees, transplanted seedlings and so on in Western Ethiopia is apparent to anyone though significant research was not undertaken in the past and recently. Therefore, field experiment was conducted with the objective of evaluating chemical, mechanical, botanical and their combination on termites damaging wooden structures to address the urgent needs of the inhabitants of the Ghibimi district.

**MATERIALS AND METHODS**

Field experiment was set up in November 2011 on 324 m² backyard garden plot of a farmer’s residential area. Wooden sticks of 1.25 m long with a diameter of 15 cm cut from six years old Eucalyptus tree were prepared for the experiment. The experiment was laid in 6 m × 6 m Latin square design. It required 36 wooden sticks each at 3 m intervals from one another 0.6 cm × 0.6 cm × 0.5 cm hole was dug for each wooden stick. A 19 m × 2 m twenty five micro polyethylene bag was prepared. The polyethylene bag was cut into 0.75 m × 1 m pieces (Figures 1 and 2).

Materials such as two 15 L plastic buckets and a 15 L Knapsack sprayer were prepared to begin the experiment. About 12.5 ml chlorpyrifos 48% E. C. was dissolved in one liter of water. Lower part of the six wooden sticks, each about 0.75 cm was sprayed with 12.5 ml chlorpyrifos 48% E. C. in a bucket and covered with polyethylene bag. The sprayed and covered wooden sticks were planted in their respective holes and any leftover chemical from each treatment was added to the hole and tightly covered with soil. Similarly, the same amount of the chemical was sprayed in another respective six holes and barren wooden sticks were planted and covered with soil. Another six untreated wooden sticks but that were covered with polyethylene bag were also planted in their respective holes and covered with soil. The fourth group of six wooden sticks each sprayed with 125 g M. lanceolata leaf powder in the same way with the chemical and covered with polyethylene bag and planted in their respective holes and covered with soil as usual. Another six holes each was also sprayed with 125 g M. lanceolata leaf powder in a similar manner to the chemicals but uncovered wooden sticks were planted and covered with the soil. Finally six uncovered and untreated wooden sticks were planted in their respective untreated holes for use as a control. Each wooden stake represents one experimental unit. The treatments were:

1. Polyethylene bag covered wooden sticks.
2. chlorpyrifos 48% E. C. treated and polyethylene bag covered wooden sticks.
3. M. lanceolata treated and polyethylene bag covered wooden sticks.
4. chlorpyrifos 48 % E. C. treated planting hole.
5. M. lanceolata treated planting hole.
6. Untreated check.

Every three months, the sticks were removed for inspection. A visual examination of the sticks was made during each observation period. Termite infestation, damage and damage severity were recorded. Hand lens was employed in the identification of smaller termites and termite damage. Termite specimens were collected and preserved in labeled vials filled with 80% alcohol for later identification in Insect Sciences Laboratory of Addis Ababa University. The collected data were analyzed using NCSS software for analysis of variance.

**RESULTS AND DISCUSSION**

The wooden sticks were infested with two genera of termites namely Macrotermes and Microtermes spp. Damage to the wooden sticks did not differ significantly among treatment means until six months after treatment. However, the damage on wooden construction material progressed in time from third month to six month after application of treatment as shown in Table 1 and Figure 1. The chlorpyrifos 48% E.C. treated polyethylene bag covered wooden sticks (0.2) and the chlorpyrifos 48% E. C. treated planting hole (0.2) protected termite infestation and damage throughout the study period starting from six months after application of treatment. These two
Figure 1. Chlorpyrifos 48% E. C. treated bare planted (A), untreated but polyethylene bag covered (B), chlorpyrifos 48% E. C. treated and polyethylene bag covered (C) and lastly untreated and bare planted (D) wooden sticks.
treatments did not differ significantly in protecting the wooden construction material from termite attack. In the rest of the treatments, damage progressed towards the end of the experiment with no significant difference amongst them. But chlorpyrifos 48% E.C. treated polyethylene bag covered wooden sticks seems to have better protection over extended period of time as compared to the chlorpyrifos 48% E. C. treated planting hole and thus requires extended time of investigation. The polyethylene bag covered wooden sticks and *M. lanceolata* treated polyethylene bag covered wooden sticks did not give any protection from both genera of termite attack.

Polyethylene bag coverage did not protect termite attack. Nevertheless, termites were observed feeding on the botanical and the polyethylene bags themselves which was in accordance with Harris (1971), Hickin (1971) and Pearce (1997) who reported that termites feed on non cellulose materials such as plastic pipes, electric and telegraph cables. It also agreed with Sileshi
Table 1. The effect of different treatments on presence of termite damage on wooden construction material starting from three months after application of treatments (starting from February 2012: Mean± se).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Three</th>
<th>Six</th>
<th>Nine</th>
<th>Twelve</th>
<th>Fifteen</th>
<th>Eighteen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethelene bag covered wooden sticks</td>
<td>0.2±0.1a</td>
<td>0.7±0.1a</td>
<td>0.8±0.1a</td>
<td>0.7±0.1a</td>
<td>0.8±0.1a</td>
<td>0.7±0.1a</td>
</tr>
<tr>
<td>Chlorpyrifos 48% treated polyethelene bag covered wooden sticks</td>
<td>0.0±0.1a</td>
<td>0.0±0.1a</td>
<td>0.2±0.1a</td>
<td>0.2±0.1a</td>
<td>0.2±0.1a</td>
<td>0.2±0.1a</td>
</tr>
<tr>
<td><em>M. lanceolata</em> treated polyethelene bag covered wooden sticks</td>
<td>0.3±0.1a</td>
<td>0.3±0.1a</td>
<td>1.0±0.1a</td>
<td>1.0±0.1a</td>
<td>0.8±0.1a</td>
<td>0.8±0.1a</td>
</tr>
<tr>
<td>Chlorpyrifos 48% treated planting hole</td>
<td>0.0±0.1a</td>
<td>0.1±0.1a</td>
<td>0.2±0.1a</td>
<td>0.4±0.1a</td>
<td>0.2±0.1a</td>
<td>0.2±0.1a</td>
</tr>
<tr>
<td><em>M. lanceolata</em> treated planting hole</td>
<td>0.2±0.1a</td>
<td>0.7±0.1a</td>
<td>0.8±0.1a</td>
<td>0.8±0.1a</td>
<td>0.8±0.1a</td>
<td>1.0±0.1a</td>
</tr>
<tr>
<td>Untreated check</td>
<td>0.2±0.1a</td>
<td>0.8±0.1a</td>
<td>0.7±0.1a</td>
<td>0.8±0.1a</td>
<td>0.8±0.1a</td>
<td>0.8±0.1a</td>
</tr>
</tbody>
</table>

Means with in a column followed by the same letter (s) are not significantly different at 5% Tukeys, studentized range test (HSD).

Table 2. The effect of different treatments on termite damage severity in percentage on wooden construction material (starting from May 2012: Mean± se).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Six months after application of treatments</th>
<th>Twelve months after application of treatments</th>
<th>Eighteen months after application of treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethelene bag covered wooden sticks</td>
<td>5.3 (29.1) ±0.3b</td>
<td>6.8 (46.8) ±0.7a</td>
<td>8.0 (66.9) ±0.8b</td>
</tr>
<tr>
<td>Chlorpyrifos 48% treated polyethelene bag covered wooden sticks</td>
<td>0.0 (0.0) ±0.3b</td>
<td>3.0 (13.6) ±0.7a</td>
<td>1.3 (9.1) ±0.8a</td>
</tr>
<tr>
<td><em>M. lanceolata</em> treated polyethelene bag covered wooden sticks</td>
<td>5.3 (29.1) ±0.3b</td>
<td>7.1 (49.7) ±0.7a</td>
<td>7.2 (53.5) ±0.8b</td>
</tr>
<tr>
<td>Chlorpyrifos 48% treated planting hole</td>
<td>0.0 (0.0) ±0.3b</td>
<td>4.4 (20.9) ±0.7a</td>
<td>2.3 (10.6) ±0.8a</td>
</tr>
<tr>
<td><em>M. lanceolata</em> treated planting hole</td>
<td>5.3 (29.1) ±0.3b</td>
<td>6.9 (48.9) ±0.7b</td>
<td>7.7 (60.4) ±0.8b</td>
</tr>
<tr>
<td>Untreated check</td>
<td>5.7 (33.3) ±0.3b</td>
<td>7.6 (62.1) ±0.7b</td>
<td>8.4 (69.1) ±0.8b</td>
</tr>
</tbody>
</table>

Means with in a column followed by the same letter (s) are not significantly different at 5% Tukeys, studentized range test (HSD). Data are square root transformed and numbers in parenthesis are actual values in percentage.

et al. (2009) who recommended that management of termites in future should be built on farmers’ indigenous knowledge and adequate understanding of the ecology of the local termite species. The current findings is in agreement with James et al. (1990) who recommended the use of appropriate cultural methods combined with minimal modern pesticides in an integrated approach.

The severity of damage done to the wooden construction material was analyzed starting from six months after application of treatments and continued at six months intervals. The severity of damage was significantly lower in chlorpyrifos 48% E.C treated polyethylene bag covered wooden sticks (13.6 and 9.1%) and chlorpyrifos 48% E.C treated planting hole (20.9 and 10.6%) than the other treatments starting from twelve to eighteen months after application of treatments as shown in Table 2. The severity of damage increased starting from six months after application of treatments except for the two treatments. The least damage severity (9.1%) was recorded in the chlorpyrifos 48% E.C treated polyethylene bag covered wooden sticks and the highest damage severity was in the control plot (69.1%) toward the end of the investigation period indicating the promising effect of the Chlorpyrifos 48% E.C treated polyethylene bag covered wooden sticks over extended period of time that however requires further investigation.

Conclusively, chlorpyrifos 48% E.C treated polyethylene bag covered wooden sticks and chlorpyrifos 48% E.C treated planting hole protected the wooden construction materials from both genera of termites. However, the chlorpyrifos 48% E.C. treated polyethylene bag covered wooden sticks was superior to the chlorpyrifos 48% E.C treated planting hole in two major aspects. These two treatments showed longer duration of protection and reduction of environmental hazards. In the former treatment, no chemical was in contact with soils that saves not only contamination of soils and ground water but also reduced the rate of the biodegradability of the chemical since it was not exposed to moisture and other elements in the soil that may facilitate the biodegradability of the chemical. Nonetheless, the duration of efficiency requires further investigation.

**Conflict of Interests**

The authors have not declared any conflict of interest.

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