Management of Termite (*Microtermes adschaggae*) on Hot Pepper Using Powdered Leaves and Seeds of Some Plant Species at Bako, Western Ethiopia

Aschalew Sisay*1, Ahimad Ibrahim1 and Tadele Tefera2

1 Bako Agricultural Research Center, P O Box 03, Bako, Ethiopia
2 Haramaya University, Department of Plant Sciences, P O Box 42, Ethiopia

Abstract: A study was conducted to evaluate the field efficacy of eleven pesticidal plants against termites on hot pepper at Bako, western Ethiopia during the 2001, 2003 and 2004 cropping seasons. The powdered leaves and seeds of the pesticidal plant species were applied at the rate of 50 g per 12.6 m² plot size. In all years, plants with the least termite damage were recorded from plots treated with *Maesa lanceolata*, *Azadirachta indica* and the insecticide diazinon 60% EC (2.5 lit ha⁻¹). The highest stand count and yield were also obtained from plots treated with the same plant species and diazinon. Treatment with *Shinus mollis* and *Ficus vasta* appeared to have the lowest effect on termite damage protection. Consequently, there was low plant population at harvest. The use of *M. lanceolata* and *A. indica* should be promoted as part of an integrated management system of termites on hot pepper, particularly by poor farmers.

Keywords: *Azadirachta indica; Maesa lanceolata; Pepper; Termite*

1. Introduction

Termites have been regarded as serious insect pests that attack a wide range of agricultural crops, forest trees and buildings in western Ethiopia. Most of the prevailing termite species are *Macrotermes subhyalinus* (Rambur) and *Microtermes adschaggae* (Sjosted). They are subterranean in nature and only a few species are mound forming and are difficult to locate and destroy. Termite attacks caused up to 62% and 36% reduction in yields of hot pepper and maize respectively in the region (Abdurahaman, 1983; Abraham, 1990; Devendra et al., 1998). This devastating insect pest also causes soil degradation by reducing vegetation and leaving the soil surface barren and exposed to erosion (Abraham, 1990; Devendra et al., 1998). As a result, farmers are forced to abandon their farmlands and migrate to other places (Abraham and Adane, 1995). In addition, the consequences of termite infestation reduced farm productivity, increased land degradation and vulnerability of resource poor farmers (Altieri, 1984; Devendra et al., 1998).

Use of cultural control methods such as mound destruction, removal of the queen, flooding, use of hot ash, are not effective against termites. As a result, termite control methods depend heavily on synthetic chemicals, especially organochlorines such as aldrin (Abdurahaman, 1990). Many plant species have been reported to posses insecticidal and repellent properties against termites; however, only *Azadirachta indica* and *Ipomea fistulosa* products have been field-tested. According to Listinger et al. (1978), incorporating such plants and their derivatives into the annual cropping system may provide an ecologically-sound method of termite control. Hence, the present study reports on the field efficacy of some plant products against subterranean termites.

2. Materials and Methods

2.1. Description of the Study Site

The experiment was conducted at the Bako Agricultural Research Center (BARC), western Ethiopia. The center lies between 9° 6’ N latitude and 37° 09’ E longitude, 1650 meters above sea level. The mean annual rainfall is 1217 mm and its pattern is unimodal. The rainy period is from April to October. It has a warm humid climate with mean minimum, mean maximum and annual mean temperatures of 13°C, 28°C and 18°C respectively (Table 1). Sixty percent of the soil is reddish brown Nitosols with a pH range of 5.0 - 5.31.

Table 1. Total rainfall, temperature, relative humidity at Bako, western Ethiopia during the 2001 and 2003 cropping seasons.

| Year | Total Rainfall (mm) | Temperature °C | Relative Humidity (%) |
|------|---------------------|----------------|-----------------------|
|      |                     | Min. | Max. | Mean   |                     |
| 2001 | 1452                | 12.0 | 27.0 | 19.5   | 75.6                |
| 2003 | 1041                | 13.8 | 29.0 | 21.4   | 58.6                |

2.2. Trial Design and Management

The experiment was conducted for two years, i.e. during the 2001, 2003 and 2004 cropping seasons. Eleven different species of plants (Table 2) were evaluated, together with the insecticide diazinon 60% EC and untreated checks to determine their efficacy against the termite *Microtermes adschaggae* (Sjosted). The experiment was laid out in randomized complete block design (RCBD) with three replications in 2001 and 2003. The plot size was 4.2 m long and 3 m wide, with the intra row spacing of 0.3 m and inter row spacing of 0.70 m. There were eight rows per plot. In 2004, a verification trial with the two most promising plant species, *M. lanceolata* and *A. indica* was conducted on 85m² plot size per treatment without replication. Plots treated with diazinon 60% EC and untreated checks were included. DAP and Urea were
applied at the rates of 207 kg/ha and 137 kg/ha respectively. Hand weeding was done three times.

Table 2. List of pesticidal plants evaluated against termite on hot pepper in 2001 and 2003 cropping seasons at Bako, Western Ethiopia.

| Scientific name           | Plant part used |
|---------------------------|-----------------|
| Maesa lanceolata          | Leaf powder     |
| Chenopodium sp.           | Leaf powder     |
| Azadirachta indica       | Seed powder     |
| Croton macrostachys       | Leaf powder     |
| Tagetes minuta            | Leaf powder     |
| Datura stramonium         | Leaf powder     |
| Vernonia amygdalina       | Leaf powder     |
| Phytolacca dodecandra     | Leaf powder     |
| Nicotiana tobacum         | Leaf powder     |
| Shiness molle             | Leaf powder     |
| Ficus vasta               | Leaf powder     |

2.3. Treatment Application

The leaves of the selected plant species were collected, dried and ground into fine powders. The powders of the plant species were applied at the rate of 50 gm /plot as a basal or root application at the transplanting and pod setting growth stages. Likewise, the recommended rate of diazinon 60% EC (2.5 lit /ha) was applied at the transplanting and pod setting growth stages. Untreated check plots were neither treated with the insecticide nor with leaves and seed powders of plants species.

2.4. Data Collection and Analysis

Two weeks after the first treatment application and every two weeks thereafter until physiological maturity, ten plants were randomly sampled per plot to assess for termite-damage. The mean of termite-damaged plants was expressed as a percentage of the total samples. To avoid double counting, tags were placed on sampled plants.

Stand count was taken at harvest. The six middle rows were harvested at physiological maturity. Dry pod yield per plot was converted to kg ha⁻¹. The percentage of termite-damaged plants and stand counts at harvest were square-root transformed to stabilize the variances. One-way analysis of variance was used. The data were analyzed using MSTAT and the Least Significant Difference (LSD) was used for mean separation at P<0.05. Yield advantage in Table 5, was calculated by comparing the untreated check plots with the treated plots.

3. Results and Discussion

In all the years, lower termite-damaged plants were recorded from plots treated with M. lanceolata, A. indica and diazinon 60% EC than from the remaining treatments (Tables 3 and 4). The highest stand count and yield were also obtained from plots treated with the same plant species and diazinon 60% EC. This was further verified in the large area in 2004 (Table 5). Treatment with S. molle and F. vasta appeared to have the least effect on termite damage protection. Consequently, there was low plant population at harvest. Aschalew et al. (2005), reported that C. macrostachys and T. minuta have repellent properties against termites while D. stramonium, F. vasta, A. indica leaves and Chenopodium sp. had shown insecticidal effects. On the other hand, Gold et al. (1991) and Epilla et al. (1988) reported that these plants possess insecticidal, repellent, or antifeedant properties. Several species of plants have been reported as being toxic or repellent to termites. However, only A. indica and I. fistulosa products have been field-tested. Fekede and Kedir (2004) reported that M. lanceolata also had fungicidal properties comparable to the fungicide, thiram, used against sorghum head smut. The fact that these botanicals reduced the damage level of termites might be attributed to their antifeedant, repellant, insecticidal effects or a combination of them.

Table 3. Effect of treatment with leaves and seed powder from different plant species on termite damage, stand count at harvest and dry pod yield of hot pepper at Bako, Western Ethiopia in 2001 cropping season.

| Treatments                | Percent damaged plants | Mean stand count at harvest | Dry pod yield kg/ha |
|---------------------------|------------------------|-----------------------------|---------------------|
| Maesa lanceolata          | 2.8 ± 1.2*ef           | 56.0 ± 1.5a                 | 670 ± 39a           |
| Chenopodium sp.           | 10.6 ± 0.9cde          | 47.0 ± 0.6cde               | 400 ± 37b           |
| Azadirachta indica       | 5.0 ± 1.2ef            | 54.0 ± 1.5ab                | 650 ± 19a           |
| Croton macrostachys       | 8.3 ± 0.6def           | 41.7 ± 3.3ef                | 420 ± 66b           |
| Tagetes minuta            | 8.3 ± 0.6def           | 39.3 ± 3.7f                 | 330 ± 27bc          |
| Datura stramonium         | 10.6 ± 0.9cde          | 50.3 ± 1.2bcd               | 350 ± 99bc          |
| Vernonia amygdalina       | 9.4 ± 1.8cde           | 39.7 ± 2.2f                 | 360 ± 50bc          |
| Phytolacca dodecandra     | 8.9 ± 1.7de            | 43.7 ± 0.7ef                | 280 ± 17bc          |
| Nicotiana tobacum         | 15.0 ± 1.7bc           | 29.0 ± 0.6g                 | 310 ± 81bc          |
| Shiness molle             | 12.8 ± 1.6bcd          | 29.7 ± 0.9g                 | 370 ± 61b           |
| Ficus vasta               | 16.7 ± 1.5b            | 28.0 ± 3.5g                 | 310 ± 45bc          |
| Diazinon 60% EC          | 5.6 ± 1.2ef            | 52.0 ± 1.0abc               | 580 ± 17a           |
| Untreated check           | 23.9 ± 0.9a            | 31.6 ± 3.8g                 | 230 ± 25c           |
| LSD (0.05)               | 5.6                    | 5.4                          | 1.5                 |
| Mean                     | 10.5                   | 40.5                         | 4.00                |

* Means with the same letter in a column are not significantly different at P<0.05.
Table 4. Effect of different pesticidal plants treatment against termite damage, stand count at harvest and dry pod yield (kg/ha) of hot pepper at Bako, Western Ethiopia in 2003 cropping season.

| Treatments               | Percent damaged plants | Stand count at harvest | Dry pod yield kg/ha |
|--------------------------|------------------------|------------------------|---------------------|
| *Maesa lanceolata*       | 12.2 ± 1.3g            | 52.0 ± 1.5a            | 250 ± 22ab          |
| *Chenopodium spp.*       | 40.0 ± 2.6bc           | 36.0 ± 2.6bcd          | 170 ± 44bcd         |
| *Azadirachta indica*     | 13.9 ± 0.8fg           | 51.3 ± 0.6a            | 290 ± 26a           |
| *Croton macrostachybus*  | 26.7 ± 1.5de           | 39.3 ± 2.2bc           | 190 ± 38bcd         |
| *Tagetes minuta*         | 25.5 ± 1.7de           | 36.0 ± 2.1bcd          | 170 ± 30ede         |
| *Datura stramonum*       | 23.3 ± 1.0def          | 39.7 ± 0.3b            | 90 ± 16e            |
| *Vernonia amygandalina*  | 25.6 ± 3.7de           | 41.0 ± 0.6b            | 190 ± 20bcd         |
| *Phytolacca dioecandra*  | 38.3 ± 1.1bc           | 33.3 ± 2.9cd           | 190 ± 14bcd         |
| *Nicotiana tobaccom*     | 31.7 ± 2.9cg           | 36.7 ± 3.2bcd          | 140 ± 21de          |
| *Shinus molle*           | 46.7 ± 0.6b            | 32.0 ± 1.2d            | 160 ± 21e           |
| *Ficus vasta*            | 57.2 ± 0.5a            | 25.3 ± 1.1e            | 160 ± 21e           |
| Diazinon 60% EC          | 16.7 ± 1.5fg           | 49.0 ± 1.5a            | 230 ± 31abc         |
| Untreated check          | 45.0 ± 1.3b            | 33.0 ± 1.2d            | 190 ± 5bcd          |
| LSD (0.05)               | 10.1                   | 6.3                    | 70                  |
| Mean                     | 30.5                   | 39.2                   | 180                 |

* Means with the same letter in a column are not significantly different at P<0.05.

The highest yield of pepper was obtained from treatment with *M. lanceolata, A. indica* and diazinon 60% EC (Tables 3 & 4). The other treatments, however, did not differ in yields from the untreated check except the treatment with *C. macrostachybus* and *S. molle* in 2001. In the 2004 verification trial, yield advantages of 109 to 150% over the untreated check were recorded in plots treated with *M. lanceolata* and *A. indica* respectively (Table 5). Brown (1962) reported that incorporating such plants and/or their derivatives into the annual cropping system may provide ecologically-sound methods of termite control. Similar findings were reported by Gold et al. (1991), Logan et al. (1999), and Schroth et al. (1992), where *A. indica* and *I. fistulosa* mulches were found to reduce termite activity for seven weeks and this should be given due consideration in termite control strategies.

Several plant species have been reported as being toxic or repellant to termites. However, only *A. indica* and *I. fistulosa* products have been field-tested (Gold et al., 1971). On the other hand, Gold et al. (1991) reported that *A. indica* and *I. fistulosa* mulches reduced termite activity for seven weeks after treatment. In conclusion, the use of *M. lanceolata* and *A. indica* should be promoted as part of an integrated management system of termites on pepper, particularly by (resource) poor farmers.

Table 5. Verification trial on the effects of *Azadirachta indica* and *Maesa lanceolata* on the percentage of damage, stand count at harvest and dry pod yield (kg/ha) of hot pepper at Bako, Western Ethiopia during the 2004 cropping season.

| Treatments               | Percent damaged plants | Stand count at harvest | Yield kg/ha |
|--------------------------|------------------------|------------------------|-------------|
| *Azadirachta indica*     | 16.38                  | 335                    | 1382        |
| *Maesa lanceolata*       | 14.64                  | 344                    | 1654        |
| Diazinon 60% EC          | 14.39                  | 345                    | 1595        |
| Untreated check          | 39.45                  | 241                    | 662         |

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