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 Ibrahim[1] and Tadele Tefera[2]
[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 m^2 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 molle* 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 *Macroterms 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 (Abdurrahaman, 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^o 6' N latitude and 37^{o}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^{o}C, 28^{o}C and 18^{o}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 ^{0}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 inters 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 85m^2 plot size per treatment without replication. Plots treated with diazinon 60% EC and untreated checks were included. DAP and Urea were

*Corresponding author. E-mail: aschaloosg@yahoo.com

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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 macrostachyus	Leaf powder
Tagetes minuta	Leaf powder
Datura stramonium	Leaf powder
Vernonia amygadalina	Leaf powder
Phytolacca dodecandra	Leaf powder
Nicotiana tobaccum	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. mole* 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. *macrostachyus* 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*f	56.0 ± 1.5a	670 ± 39a
Chenopodium spp.	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 amygadalina	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
Shinus 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 macrostachys	26.7 ± 1.5de	39.3 ± 2.2bc	190 ± 38bcd
Tagetes minuta	25.5 ± 1.7de	36.0 ± 2.1bcd	170 ± 30cde
Datura stramonium	23.3 ± 1.0def	39.7 ± 0.3b	90 ± 16e
Vernonia amygadalina	25.6 ± 3.7de	41.0 ± 0.6b	190 ± 20bcd
Phytolacca dodecandra	38.3 ± 1.1bc	33.3 ± 2.9cd	190 ± 14bcd
Nicotiana tobaccum	31.7 ± 2.9cd	36.7 ± 3.2bcd	140 ± 21de
Shinus molle	46.7 ± 0.6b	32.0 ± 1.2d	160 ± 21cde
Ficus vasta	57.2 ± 0.5a	25.3 ± 1.1e	160 ± 21cde
Diazinon 60% EC	16.7 ± 1.5efg	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. macrostachyus* and *S. mole* 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 repellent 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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6. References

Abdurahaman, A. 1983. Termite control campaign in Wollega. Committee of *Ethiopian Entomologists' Newsletter* 3(2): 6-7

Abdurahaman, A. 1990. Foraging activity and control of termites in western Ethiopia. A thesis submitted for the degree of Doctor of Philosophy of the University of London and for the Diploma of the Imperial College. Department of Pure and Applied Biology, Imperial College of Science, Technology and Medicine. SilwoodPark Ascot.

Abraham, T. 1990. Termites: Problems and possible methods of their control in agriculture with reference to the Ethiopian condition. *In:* Proceeding of the 10th Annual Meeting of the Ethiopian Entomologists (CEE). 7-9 February 1990. Addis Abeba, Ethiopia. pp.50-74.

Abraham, T. and Adane, K. 1995. The effect of seed dressing with aldrin on termite in maize western Ethiopia. In: Second Proceeding of Crop Protection Society of Ethiopia 26-27 April 1995. Addiss Ababa, Ethiopia. pp.23.

Altieri, M.A. and Letourneau, D.K.1984. Vegetation diversity and insect pest outbreaks. *CRC Critical Review in Plant Sciences* 2:131-169.

Aschalew, S., Diriba, G., and Demisse, A. 2005. Termite in Mana-Sibu District of Oromiya. Special Research Report. Ethiopian Agricultural Research Organization. Addis Ababa, Ethiopia.

Brown, K.W. 1962. Termite control Research in Uganda with particular reference to control of attacks in Eucalyptus plantations. Eighth British Common wealth Forestry Conference. Entebbe, Government publication, Uganda Protectorate. pp. 9.

Devendra, G., Ayo- Odongo, J., Kit, V., Lemma, G. and Mulugeta, N. 1998. A Participatory systems analysis of the termite situation in west Wollega, Oromiya Region, Ethiopia .

Epilla, J.S.O. and Ruyooka, D.B.A. 1988. Cultural methods of controlling termite attacks on cassava (*Manohot esculanta*) with *Vitex doniana*: A preliminary study. *Sociobiology* 14: 291-297.

Fekede, A. and Kedir, W. 2004. The effect of some potential botanical plants in the control of sorghum covered smut at Bako, Ethiopia. Crop Protection Society of Ethiopia annual Conference. Program Abstract. 11-12 August, 2004. Addis Ababa, Ethiopia.

Gold, C.S., Wightman, J.A. and Pimbert, M.P. 1991. Effect of mulches on foraging behavior of *Microtermes obese* and *Odontotermes* spp. *Insect Science and Its Application* 12: 297-303.

Listinger, J.A., Price, P. and Herrera, R.T. 1978. Filipino farmer use of plant parts to control rice insect pests. International Rice Research News Letter 3: 15-16.

Logan, J.M.W., Cowie, R.H. and Wood, T.G. 1999. Termite (Isoptera) control in agriculture and forestry by non-chemical methods: A Review. *Bulletin of Entomological Research* 80:309-330.

Schroth, G., Zech, W. and Heinmann, G. 1992. Mulch decomposition under agro forestry condition in sub humid tropical savanna: Processes and influence of perennial plants. *Plant and Soil* 147:1-11.