Research Report

CONTROL OF TERMITES IN TEA (*Camellia sinensis* L(O) Kuntz) PLANTATIONS OF BARAK VALLEY, ASSAM, (INDIA)

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ABSTRACT

Termites cause serious damage to tea plantations in Barak Valley, Assam (India) especially during the dry season (i.e. September-March). Tea plantations in the southwest facing slopes are worst affected possibly due to poor soil moisture and shade. Termites also cause considerable damage to the vegetation growing in and around tea plantations. Both chemical and phytopesticides were effective for the control of termites. Among chemical pesticides, endosulphan, chloropyriphos and phorate were equitoxic. Crude neem oil and the extracts of Andrographis paniculata *controlled the termite infestation and reduced the severity of termite damage.*

Keywords: *India; inorganic pesticides; live-wood eating termite; organic pesticides; scavenging termite*

INTRODUCTION

Tea, *Camellia sinensis* L. (O) Kuntze, being a perennial crop attracts insects and mites that thrive and flourish on tea. In the tea areas of Barak Valley, termites are the major and predominant pests causing considerable damage to tea (Das, 1962; Barbora, 1994).

According to Das (1962) at least 15% of the total crop loss in tea is due to termite attack, though Sands (1977) mentions that crop losses in agricultural fields could be 50% or more over a period of 10 years. Das *et al.* (1982) reported more termites on poorly shaded hot slopes of Cachar *tillahs* (hillocks of Barak Valley). Termite infestation may be as high as 90% in old tea areas of Barak Valley (Choudhury, 1999).

Tea growing areas of Barak Valley have unique environmental conditions, soil characteristics and pest (i.e. termite) diversity (Choudhury, 1999). Therefore, this work attempts to study the distribution of termites with special reference to their control under conditions unique to Barak Valley (Assam) India.

MATERIALS AND METHODS

Study Site

Location: The Barak Valley is surrounded by the North Cachar hills and Jaintia hills in north, Manipur in east, Mizoram in south, and Tripura and Sylhet district of Bangladesh in west. The area with an altitude of 39.6 m above MSL is located between 24°8′ - 25°8′ N and 92°15′ - 93°15′ E. Barak is the main river in the valley; its important tributaries are Jiri, Chiri, Madhura and Jatinga in the north and Sonai, Dholeswari and Katakhal in the south (Dutta, 1995).

Climate and vegetation: The distribution of annual rainfall ranges from 10 mm in January to 573 mm in July. Since variable topography and soil

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conditions influence soil moisture status, despite high rainfall, Cachar suffers from drought during the dry season and is lashed by high intensity rains during the monsoon. The temperature ranges from 33°C during August to a mean minimum of 8.9°C during January. The relative humidity during December-January varies between 53% in the afternoons to 98.7% in the mornings (Choudhury, 1999; Saha and Dutta, 2001).

The soil in general has a dark brown (1O YR, 4/3) to yellowish brown (10 YR, 5/6) colour. The vegetation is dense tropical semi-evergreen forest in the Borail hilly range. Bamboo is the key plant species of this area (Saha and Dutta, 2001).

Degree of Infestation

The damage caused by live-wood eating termite (e.g, *Microtermes obesi* Holmgreen; *Ancistrotermes pakistanicus* Ahmed) to young tea and scavenging termite (e.g, *Odontotermes feae* Wasmann; *O. horni*, Wasmann; *Hypotermes obscuriceps* Wasmann; *Macrotermes hopni* Roonwall and Sen-Sarma) to mature tea was high. A comparative study on the degree of infestation of live-wood eating and scavenging termites was done taking 10,000 tea bushes in each case. In both the cases preliminary surveys were done to assess the severity of infestation and population intensity at the specific termite infested sites in tea estates that were representatives of the area.

The degree of infestation/population intensity of live-wood eating termite (*Microtermes obesi* Holmgreen) and scavenging termite (*Odontotermes feae* Wasmann) was studied under four categories.

Uninfested : No infestation observed/zero population

Mild : + (1-33% of the sections of tea infested)

Moderate : ++ (34-66% of the sections of tea infested)

Severe : +++ (67-100%) of the sections of tea infested)

Since both types of termites infest or colonise collar region of tea stem, infestation and population were determined by sampling the stems and collar regions of the bushes.

Clonal Susceptibility

To determine the variation of clonal susceptibility of termites, this study was laid using 12 tea varieties (viz. TV 1, TV 14, TV 16, TV 17, TV 18, TV 19, TV 20, TV 22, TV 23, TV 24, TV 25 and TV 26) was made at a typical tea estate of Cachar. The topsoil (0-6") of the study area had pH 5.1, C content 1.56%, K_2O 300 ppm, sulphur 29.5 ppm, organic matter 2.7%, N 0.13% and P_2O_5 50 ppm. Sample blocks of each variety comprised of 50 bushes of old tea, (8-9 years). There were three replicated plots for each variety. The percentage of infestation of tea varieties was used as a criterion to determine clonal susceptibility/resistance to termite species.

Estimation of Termite Population

The methods suggested by Lee and Wood (1971) are broadly divided into two categories viz. (a) estimating the density of the mounds, and (b) estimating the population within the mounds. Thus the mound was taken as a whole unit, and the termite populations within were counted. In the study site the nests of termites (called termateria) were recorded from a depth of 10 cm below the surface soil (Plate II/2) down to 2.5 m below. For studying the density of termite population in the present work, the entire tea bush was taken as a whole unit, and two separate methods were used for counting the termite population. These were (a) in stem under the earth-run, and (b) in the collar region under the surface soil. Five heavily infested bushes were selected and estimation of termite population for both stem and collar regions were done from the same bush.

Estimation from stem region (population of *Microtermes obesi*, Holmgreen): Aqueous solution of the fumigating agent, methyl-iso-butyl ketone was made in the ratio of 1:10. This chemical solution was sprayed on the termite-infested bushes with the help of a hand sprayer. The knock down effect of the chemical helped in arresting the movement of the pest temporarily. The bush was then shaken vigorously for 2-3 minutes. As a result, the termites got detached from the bushes and fell at the collar region, where a big-sized cardboard encircling the collar region of the bush was placed. These termites were then collected and counted. The total number of termites (soldiers and workers together) collected were counted to estimate the total population.

Estimation from collar region: Weeds around the collar region were removed and light forking was done to a depth of 5 cm. Aqueous solution of the aforesaid fumigating agent was subsequently sprayed on the forked soil, where termites start dispersing in the disturbed soil in the collar region. As a result of this spraying the movement of the termites is stopped. The termites, along with the soil, are then collected on a large cardboard, and the soil is removed by hand sorting. The termites that remained on the cardboard are then counted. From the pilot experiment it was ascertained that this method can be used as reliable means for estimation of termites in tea fields.

Control Measures

Termite infested areas were treated with two inorganic insecticides namely, endosulphan 35EC and chloropyriphos 20% in three different concentrations (1:100, 1:200 and 1:300). A synthetic pyrethroid (fenvalerate 20 EC) was also used in two different concentrations (1:250 and 1:500) in water. 500 ml of the diluted chemical was sprayed around the collar region of each bush. Phorate granules (10%) were applied @ 2.5 gm, 5 gm and 10 gm per bush. The experiment was conducted during early part of September in all three consecutive years using a randomized block design (each block consisting of 40 bushes) with three replications. Post treatment observations were taken at monthly interval. Data were analyzed (ANOVA) to find values of CV and CD.

Besides treatment with insecticides, the extracts of *Chromolaena odorata*, *Andrographis paniculata*, *Lantena camara* var *aculeata*, *Curcuma* sp. and *Allium sativum* were also applied in separate experimental areas within the same tea estate having comparable degrees of infestation. A randomized block design was used with observations made in the same way as with insecticide treatment.

In the third series some infested areas (Site II) were treated with crude neem (*Azadirachta indica*) oil applied in concentrations of 1:50, 1:20 and 1:10 by water dilution during the first year and 1:20, 1:10 and 1:5 in the second year. Ritha powder (*Sapindus mukorossi*) was used for emulsification of the oil. The emulsified material was applied to the collar of infested bushes using painting brush. Three sets of replications with one untreated series were maintained. Post treatment monitoring and statistical analyses were done in the same way as earlier with the two other series on control aspect.

RESULTS

Live-wood eating termite (*Microtermes obesi*, Holmgreen): Live-wood eating termite often causes damage to tea bushes by consumption of main conducting vessels and pith. Mortality of the young tea plants (1 wk – 5 yrs old) due to live-wood eating termite was common in most tea estates of Barak Valley (Plate I/1-6) though the degree of damage showed considerable variation (Fig. 1).

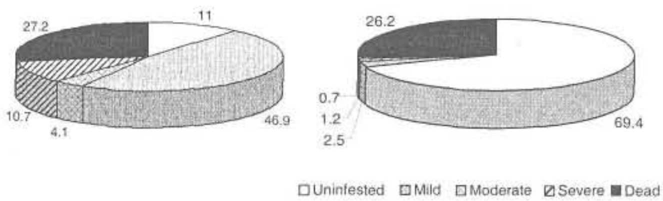
In one experimental site (Site I) about 27% plants were killed due to termite damage within three years of planting (Fig. 1A). In the fourth year after planting the degree of damage increased considerably, with 89% of the young tea being affected by the live wood eating termites in varying degrees on a mortality scale, i.e. dead 26.2%, severely infested 0.7%, moderate infestation 1.2% and mild infestation 2.5%.

These results suggest appropriate care and treatments in the first 3-4 years would ensure high survival of young teas from live-wood eating termite attacks and would help these plants in becoming productive.

Scavenging termite (*Odontotermes feae*, Wasmann): Scavenging termites survive on the dead plant tissues and start damaging through the wood exposed due to heavy pruning (Das, 1962; Das *et al.*, 1982; Chakravartee 1996; Choudhury, 1999). Plate II shows successive stages of infestation in the tea bushes. In the scavenging termites (*Odontotermes* sp.) infested areas at five different tea estates, wide range of variation in infestation was noted. The severity of damage was 62% in the hillocks (Fig. 3A), 81% in the flat areas (Fig. 2A), moderate to severe in the hot slope (south/southwest facing areas, Figs. 2B & 3B) but least in cold slopes (north/northeast facing areas, Fig. 2C& 3C).

Degree of Infestation

Fig. 1. A comparative analysis of live-wood eating termite infestation in two tea estates of Barak Valley



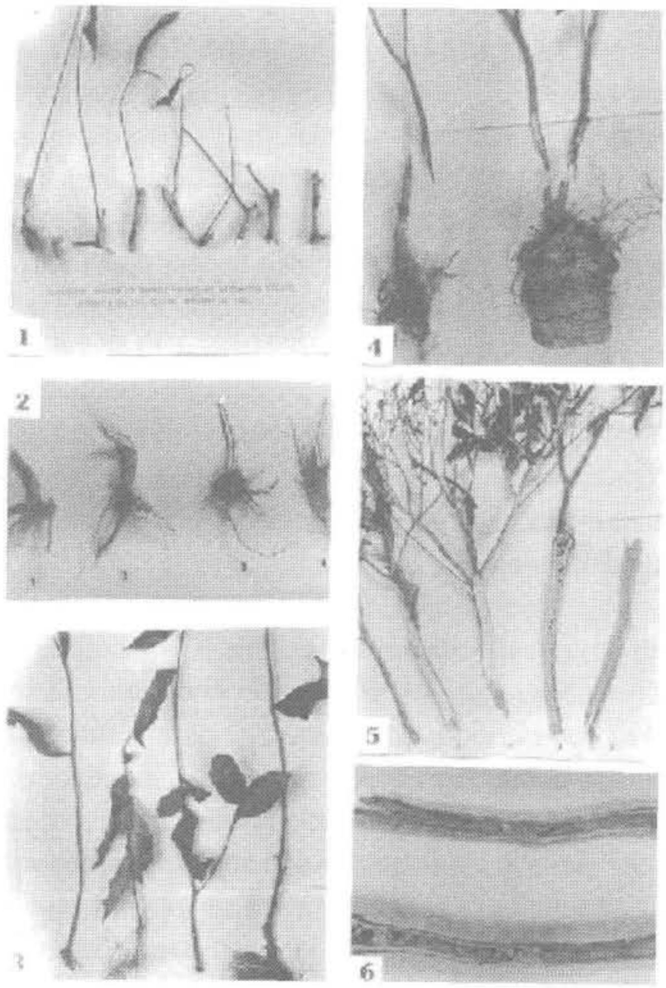


Plate I. Damage caused by live-wood eating termite at different stages of growth of young tea plants

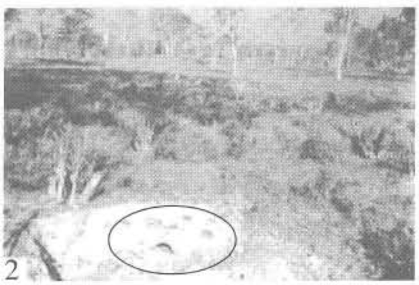
1. Damage in the callousing bed in the clonal nursery
2. Damage caused at the initial stage of planting

3 & 4 Damage caused in the young tea (< 1 yr)

5 & 6 Damage of the heart wood in the young tea bushes (< 2 yrs)

Plate II. Termite mounds and Termateria in Tea Plantations.

1. Termite mound at a tea plantation area



2. Termateria in the tea plantation areas (oval mark) located 10 cms below the surface soil

Fig. 2. Scavenging termite infestation in Study Site I

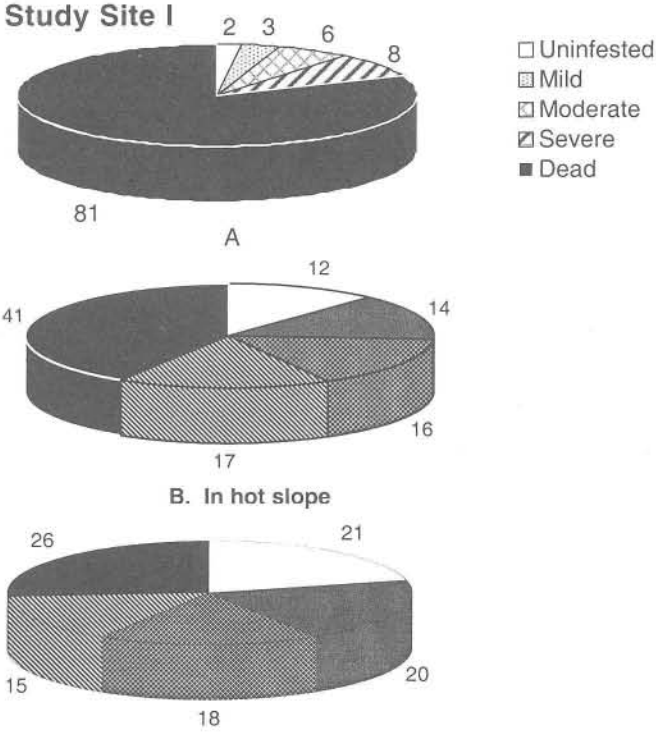
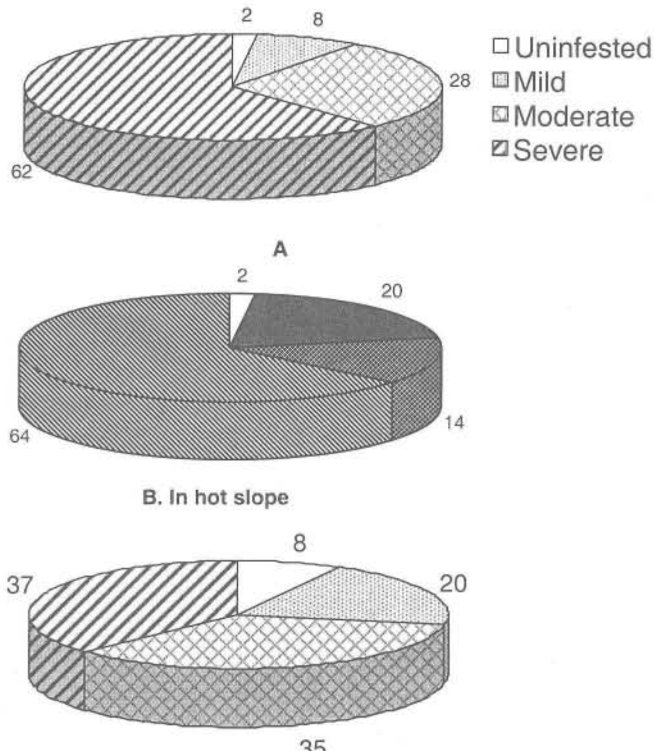


Fig. 3. Scavenging termite infestation at Study Site III



The differences in susceptibility of the bushes in hot and cold slopes can be attributed to the shade status of the area because in the well shaded tea areas the uninfested tea bushes were more than those in unshaded/poorly shaded areas.

The scavenging termite infested areas had matured tea bushes (40-70 years old) with large vacancies. The consequent poor moisture level in the soil in the hot slopes may be responsible for higher termite activity as observed earlier by Das *et al.* (1982). The shade trees help to retain higher moisture content in the well-shaded areas. In some of the areas scavenging termite mounds also occur which grow up to a height of 5-6 m (Plate III) (*Image on next page*).

Variation in Clonal Susceptibility

All clones under study were found to be varyingly susceptible to live-wood eating termite (*M. obesi*). TV 25, TV 1 and TV 20 were more susceptible (97.3%, 95.3% and 88.7% respectively) than TV 16, TV 17, TV 26, TV 24 and TV 18 which were moderately susceptible (69.7%, 69%, 62%, 56%, 49% and 48.7% respectively). TV 23, TV 22 and TV 19 (44.3%, 38.7% and 35% respectively) were least susceptible. This variation was significant (F = 61.78, CD $t_{0.05\%}$ = 8.07, Error df = 22; Total df = 35). The highly susceptible clones (TV 1, TV 16, TV 17, TV 20, TV 25 and TV 26) should be given more attention than others.

Plate III. Shows successive stages (1-4)of scavanging termite infestation in the tea bushes.

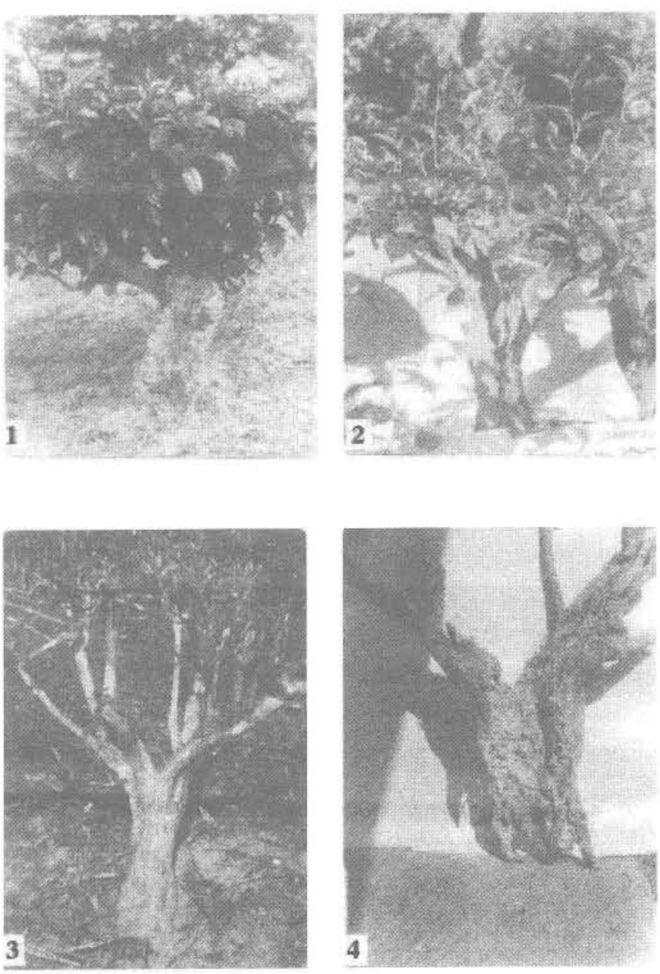
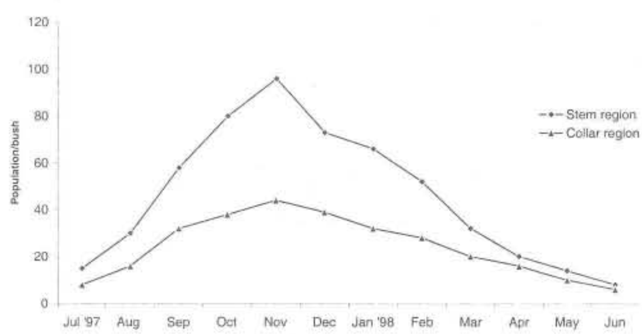


Table 1. Tea varieties susceptible to live-wood eating termites.

TV		Infestation (Mean %)
1		95.30
14		56.00
16		69.70
17		69.00
18		48.70
19		35.00
20		88.70
22		38.70
23		44.30
24		49.00
25		97.30
26		62.00
CV		7.58
F value (for interclonal variation)		61.78
CD	$t_{0.05}$	8.07
	$t_{0.01}$	11.00

Estimation of Termite Population of Live wood Eating Termite (*Microtermes obesi* Holmgreen)
Termite population was present all throughout the years but with higher population on the stem, especially during the winter months (August to March) compared to the collar region (Fig. 4). Although population of termite was low in the collar region, it was 8-10 times more in the surface soil. From September the termite population increased gradually reaching the highest point in November. The population of termites declined from March onwards till June.

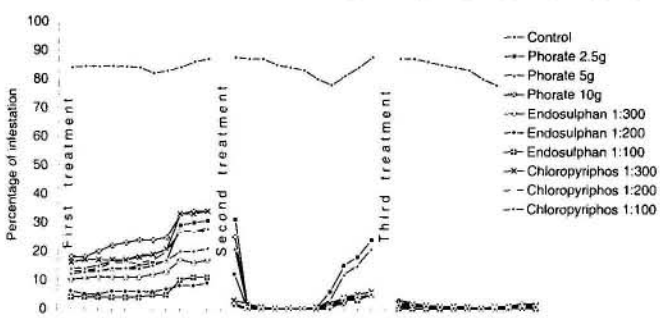
Fig. 4. Live-wood eating termite population in south/south-west facing hot slope



Control Measures

Effect of inorganic (chemical) pesticides: In the areas of experimental Site I treated with endosulphan, chloropyriphos and phorate the percentage of infestation declined after the first treatment. The low range of infestation persisted till the onset of next winter. During second year the percentage of infestation increased again, and hence the treatment was repeated that caused low degree of infestation. Identical treatments in the third year caused a gradual decline in the severity of infestation in the treated area (Fig. 5).

Fig. 5. Effect of inorganic pesticide on the infestation caused by live-wood eating termite



The data, therefore, showed that all chemical treatments were effective over the control series in significantly reducing the infestations caused by the sympatric population of termites.

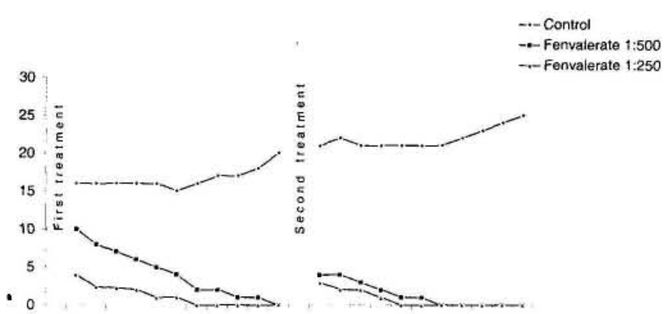
Paired 't' test (for assessing the need of treatment revealed that the table value of 't'$_{0.05}$ for 8df for one tailed test is 1.86. The calculated value of 't' ($t_{0.05}$ for 8df was 21.58 in the first year, 3.18 in the second year and 3.32 in the third year) is significant. Pesticide treatments had, therefore, significant effect in reducing the infestation caused by termite. Similar results were also obtained in the second experimental site.

With application of fenvalerate the percentage of infestation declined after the first treatment. The low degree of infestation continued till August/ September, following which the infestation increased again. Consequently the treatments were repeated for the second year when degree of infestation gradually declined to the minimum (Fig. 6).

Table 2. Pesticides and their active ingredients

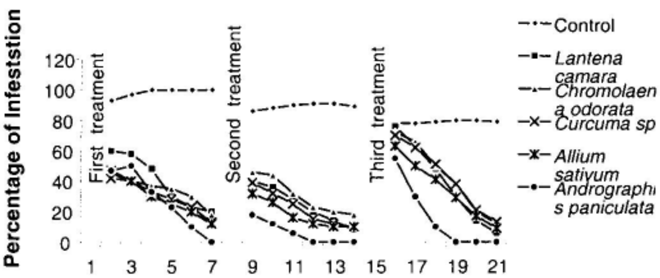
Pesticides	Active ingredient
Chemical pesticides	
Endosulphan	Chlorinated hydrocarbon (a.i. 6, 7, 8, 9, 10, 10 hexachloro 1, 5, 5a, 6, 9, 9a-hexahydro 6,9 methano2,4,3 benzodioxathiepin 3 oxide)
Chloropyriphos	Diethyl 3,5, trichloro-2-pyridyl phosphorothioqte
Phorate	0,0, diethl 5-2 (ethylthio) ethyl phosphorodiethionate
Fenvalerate	Synthetic pyrethroid [a.i. 4 chloro-α-(1 methyl ethyl) benzoacetic acid, cyano (3-phenoxyphenyl) methyl ester]
Plant extracts	
Andrographis paniculata	Andrographolide
Allium sativum	1) Allyl propyl disulphide 2) Diallyl disulphide 3) Allicin 4) Allisatin-I 5) Allisatin-II
Lantena camara var aculeata	1) Camarene 2) Isocamarene 3) Micranene
Curcuma sp.	1) Zingiberine

Fig. 6. Effect of synthetic pyrethroid on the infestation caused by live-wood eating termite



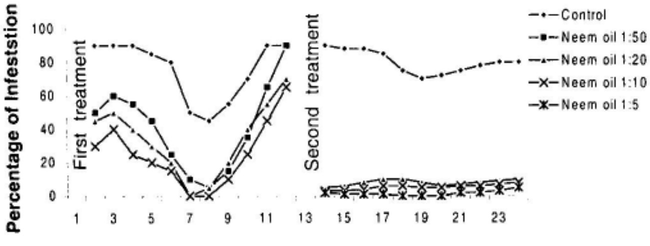
Effect of plant extracts and organic pesticides: Plant extracts considerably decreased percentage of infestation (Fig. 7). In the second and third years the experiment was repeated. In all the three years the percentage of infestation decreased with time. The efficacy of *A. paniculata* was the best among all the plant extracts used for the control of termite.

Fig. 7. Effect of plant extracts on the infestation caused by live-wood eating termite



Treatment with crude neem oil caused decline in infestation from 50% to 5%. In the untreated (control) areas, during the same period, a natural decline (from 90% to 45%) in infestation was observed. With the approach of winter (i.e., water stress period), the efficacy of neem oil declined and the percentage of infestation gradually increased upto 65-85%. At this stage the treatment was repeated causing the percentage of infestation to decrease considerably. This low range of infestation in the treated areas persisted almost throughout the year (Fig. 8).

Fig. 8. Effect of crude need oil on the infestation caused by live-wood eating termite



ANOVA showed that the plant extracts and organic pesticides (i.e., crude neem oil) were significantly effective over the control (untreated plots) in reducing the infestation by termites in the experimental plots.

DISCUSSION

Termites, (both live-wood eating and scavenging species) are serious pests in major parts of tea growing areas of Barak Valley, specially during the water stress periods. Logans *et al.* (1990) reported that many plant species are toxic to termites and have better prospects for termite management. The present observation conforms to this finding. Since both the live-wood eating and scavenging termites have their nests under the ground at depths ranging from 10 cm to 2.5 m below the soil surface (Choudhury, 1999) in the field, the pesticides can be effective only on the section of population that remains near soil surface on the infested site of the tea bushes. They are less effective for the control of subterranean population. Perhaps irrigation following the pesticide treatments could help by increasing the rate of percolation/infiltration of the pesticides used, thus giving better efficiency for control by covering the segment of population beneath the ground level.

In this study almost all the plant extracts showed promising results in bringing down the infestation. This suggests their potential as efficient alternatives to their inorganic counterparts. Being biodegradable, they can be used in combination with the traditional inorganic pesticides as an aid to the IPM strategy.

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