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Bioassay of Some Plant Oils against Termite, *Odontotermes obesus* (Isoptera: Termitidae)

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A B S T R A C T

A laboratory bioassay was carried out to determine LC_{50} and relative toxicity of three plant oils along with check chlorpyriphos 20EC and control against termite, *Odontotermes obesus.* The data on mortality of *Odontotermes obesus* revealed that among the plant oils tested neem oil showed the lowest LC_{50} value (0.241) followed by karanj oil (0.636) and jatropha oil (2.130) after 72 hours exposure period. Considering the relative toxicity of chlorpyriphos as unit value the comparison of relative toxicity revealed that neem oil, karanj oil and jatropha oil were 0.066, 0.025, 0.008 times less toxic than chlorpyriphos after 72 hours exposure period respectively. The order of relative toxicity was found in the following manner; neem oil >karanj oil >jatropha oil.

Introduction

With over 1 million different species in the world, insects have successfully colonized a great diversity of habitats. Particularly the soil is an ideal niche for insects providing protection from heat and cold, drying and heavy rains and natural enemies such as birds etc. Termite is one of the most important agricultural pest belong to the same habitat soil. A total of 2650 termite species found all over the world, in which 300 species have been recognized as pests (Kambhampati and Eggleton, 2000). They live in a nest or colony and each individual have different functional role according to the "caste system". They hold two positions from the economic point of view by damaging buildings, forestry, pastures and wide range of crops including cash crops also and at the same time beneficial in the conversion of dead trees and other plant products to substances that can be utilized by plants. Termites cause agricultural damage in several ways, firstly infest the crop itself and limit the yield (wheat, coconut, chili, mango, sorghum, sugarcane, cotton etc.). Secondly it can interfere with farming infrastructure such as by destroying poles that support fencing. Thirdly the termite can destroy containers used to ship agricultural products.

Control of termites has largely relied on broad spectrum and persistent organochlorine insecticides (Logan *et al.*, 1990). Application of such synthetic insecticides in soil leads to an enormous side effects causing degradation of the soil health and thus affect the crop yield. In recent years, searching for environmentally safe methods to control insect pests have been carried out by using plant derivatives with significant insecticidal effects, which have been considered as new source of pesticides with negligible side effects on the environment (Balandrin *et al.*, 1985).

Plant oils especially their important compounds offer promising alternatives for conventional insecticides and also act as excellent contact insecticides (Tapondjou *et al.*, 2002), antifeedant or have repellent effects (Geer, 2005) and may also affect important biological parameters, such as growth rate, life span and reproduction (Rahmat *et al.*, 2006). Keeping in view the above facts, the present investigation has been carried out with the following objective.

To determine LC_{50} and relative toxicity of some plant oils and chlorpyriphos against termite, *Odontotermes obesus.*

Materials and Methods

Details of plant oils

The laboratory experiment was conducted in 2015-16 with four treatments which included three plant oils and one standard check along with untreated control. Termites (*Odontotermes obesus*) were collected from farm nearby sugarcane field of Assam Agricultural University.

The details of the treatments are presented below:

T_1. Neem oil (*Azadirachta indica*)
T_2. *Karanj* oil (*Pongamia pinnata*)
T_3. Jatropha oil (*Jatropha curcas*)
T_4. Chlorpyriphos 20EC
T_5. Untreated control

Bioassay method

For determination of LC_{50} values, the plant oils collected were considered as standard (100%) and stock solution of known strength as well as the subsequent concentrations was prepared following flow chart. The bioassay was carried out using residual film method.

For this the different concentrations of each plant oils and chlorpyriphos 20EC was applied on the cellulose filter paper disc (size 4.5 cm dia) which was placed on the petriplate (5 cm dia). Thin and uniform film of treatments was prepared by taking 1 ml of plant oils and chlorpyriphos to the cellulose filter paper.

Ten (10) numbers of worker termite were released in to each petri plate, served as one replication. Three replications for each concentration of plant oils and chlorpyriphos was maintained. The solvent from the treated filter paper was air dried at room temperature. The filter paper treated with acetone only was used for control. The petri plates with covers then were placed into the incubator at 25$\pm$1°C and 80±5% RH and after 24, 48 and 72 hours, mortality counts were made.

The per cent mortality in each treatment was worked out and if there were mortality in the control, the observed mortality was corrected by using Abbott's formula (1925).

Statistical analysis

The experimental data were subjected to "Probit analysis" as described by Finney

(1971). The median lethal concentration (LC_{50}) was obtained from the regression equation. The values of relative toxicity of neem oil, *karanj* oil, jatropha oil and chlorpyriphos were calculated as follows:

$$\text{Relative toxicity} = \frac{LC_{50} \text{ value of chlorpyriphos}}{LC_{50} \text{ value of plant oils}}$$

Results and Discussion

The data on mortality of *O. obesus* revealed that neem oil @ 2 per cent caused highest mortality of 61.02, 72.55 and 83.35 per cent after 24, 48 and 72 hours whereas 2.50 per cent karanj oil caused mortality (58.35%) at 24 hours as well as at 48 hours (62.87%) and at 72 hours (70.05%). For jatropha oil, mortality recorded was as 50.03, 67.66 and 71.92 per cent after 24, 48 and 72 hours at 4.00 per cent, respectively. The data on mortality of worker termite was revealed that chlorpyriphos caused highest mortality in comparison to other treatments with 70.05, 83.33 and 90.33 per cent after 24, 48 and 72 hours, respectively at 0.04 per cent (Table 1).

The regression equation, LC_{50} values, relative toxicity, fiducial limit and the order of toxicity using plant oils and chlorpyriphos after 24,48 and 72 hours are calculated.

From the table it was found that neem oil and jatropha oil recorded lowest (24h=1.296, 48h= 0.627 and 72h=0.241) and highest (24h=4.054, 48h=2.986 and 72h=2.130) LC_{50} whereas karanj oil reported 1.933,1.426 and 0.636 as LC_{50} value after 24, 48 and 72 hours respectively (Table 2 and Fig. 1).

The comparison of relative toxicity revealed that neem oil was 0.023, 0.032 and 0.066 times less toxic than chlorpyriphos when exposed for a period of 24, 48 and 72 hours, respectively. Karanj oil was 0.016, 0.014 and 0.025 times less toxic than chlorpyriphos whereas jatropha oil was 0.007, 0.006 and 0.008 times less toxic than chlorpyriphos when exposed for a period of 24, 48 and 72 hours, respectively.

The order of toxicity with respect to LC_{50} was chlorpyriphos>neem oil >*karanj* oil >jatropha oil for all the above mentioned exposure period. From the above Probit results, it was clear that all the tested plant oils were effective for controlling termite but neem oil was the most effective one.

The toxicity of neem, karanj and jatropha may be due to the presence of active chemical compound in these plants that shows toxicity against the insects.

The present works are in conformity with the work of Verma *et al.,* (2011) who reported that the active ingredient karanjin of *Pongamia pinnata* and phorbol ester of *Jatropha curcas* at 0.5 gm/ml can cause 100 per cent mortality of termite after 6 hours and 12 hours, respectively. The LC_{50} levels of karanjin and phorbol esters fractions were 0.038 and 0.071 g/ml, respectively, after 24 h at a 95 per cent (0.05) confidence limit.

Similarly works of Sharma *et al.,* (2011) are in conformity to the present findings where he studied termicidal potential of non-edible oil seed cakes (jatropha, karanja, neem and mahua) and their crude active components (phorbol esters, karanjin, saponins and azadirachtin) *in vitro* and *in vivo* against termite, *Odontotermes obesus* at 1.25, 2.5 and 6.25 per cent concentration and reported that cold water extract of neem cake is better than hot water extract and cause 100 per cent mortality of termites at all concentration after 72 hour. Crude karanjin extract induced 83.3 per cent mortality after 2 h and 100 per cent after 4 h.

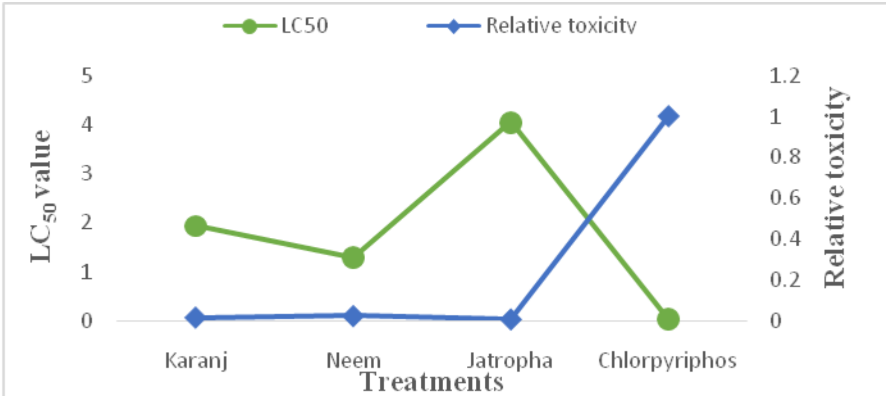
Table.1 Per cent mortality of *Odontotermes obesus* caused by several plant oils and *Chlorpyriphos* at different exposure period

Treatment	Concentration (%)	Post-treatment mortality		
		24h	48h	72h
Karanj oil	2.50	58.35 (49.46)	62.87 (52.18)	70.05 (56.72)
do	2.00	51.94 (45.56)	52.26 (46.21)	62.26 (52.19)
do	1.50	42.33 (40.54)	48.11 (43.63)	59.46 (50.35)
do	1.00	35.88 (36.16)	41.86 (40.54)	52.93 (46.89)
do	0.50	28.47 (32.01)	36.22 (36.87)	48.33 (43.63)
do	0.25	23.76 (29.14)	34.11 (35.45)	39.11 (38.32)
S.Ed(±)		6.24	3.01	3.74
CD(P=0.05)		13.40	6.39	7.92
Neem oil	2.00	61.02 (51.26)	72.55 (58.32)	83.35 (65.92)
do	1.50	52.26 (46.05)	60.27 (50.35)	64.44 (53.13)
do	1.00	41.99 (40.32)	52.92 (46.74)	62.26 (52.19)
do	0.50	33.28 (35.17)	46.67 (43.00)	59.13 (50.17)
do	0.20	23.76 (29.08)	36.06 (36.87)	48.59 (44.11)
do	0.10	18.11 (25.15)	25.33 (30.19)	39.36 (38.83)
S.Ed(±)		5.65	4.03	5.88
CD(P=0.05)		11.99	8.54	12.46
Jatropha oil	4.00	50.03 (44.99)	67.66 (55.29)	71.92 (57.89)
do	3.50	46.02 (42.69)	55.52 (48.07)	62.26 (51.99)
do	3.00	40.09 (39.20)	48.84 (44.27)	57.26 (49.11)
do	2.50	31.51 (34.12)	38.56 (38.31)	50.48 (45.15)
do	2.00	26.80 (31.13)	34.58 (35.94)	43.73 (41.38)
do	1.50	21.16 (27.32)	27.24 (31.40)	36.93 (37.37)
S.Ed(±)		5.00	4.70	4.09
CD(P=0.05)		10.61	9.98	8.69
Chlorpyriphos	0.040	70.05 (56.72)	83.33 (65.78)	90.33 (71.81)
do	0.035	56.10 (48.42)	71.05 (57.46)	80.35 (63.64)
do	0.030	44.10 (41.61)	62.66 (52.28)	73.90 (59.20)
do	0.025	41.83 (40.24)	55.51 (48.07)	64.44 (53.32)
do	0.020	37.99 (38.02)	48.85 (44.27)	59.45 (50.35)
do	0.015	28.91 (32.48)	40.77 (39.57)	50.18 (44.99)
do	Control	3.33 (9.79)	6.66 (14.83)	10.00 (18.42)
S.Ed(±)		4.69	5.83	6.18
CD(P=0.05)		9.94	12.34	13.10

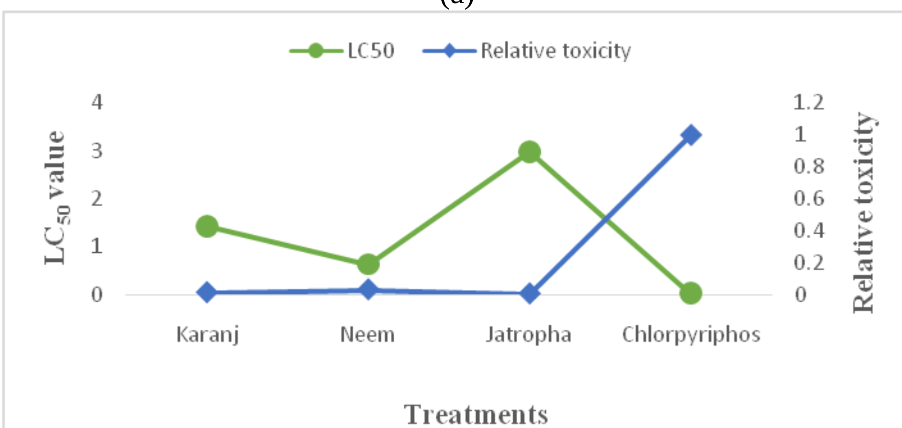
Table.2 Estimated LC50 value, regression equation, heterogenety (χ2), fiducial limit and order of relative toxicity for three plant oils and chlorpyriphosat 24,48 and 72 HAT

Treatment	Regression Equation	Heterogenety χ^2	LC_{50} (%)	Fiducial limit	Relative Toxicity	Order of Toxicity
			24 hour			
Karanj	Y=0.261+ 0.910 X	43.159	1.933	1.447 3.042	0.016	II
Neem	Y=.099+ .883X	34.874	1.296	0.984 1.871	0.023	I
Jatropha	Y=1.193+ 1.962X	21.997	4.054	3.594 4.897	0.007	III
Chlorpyriphos	Y=2.787+ 1.845X	22.738	0.031	0.028 0.035	1.000	-
			48 hour			
Karanj	Y=0.103+ 0.670 X	15.356	1.426	1.162 1.835	0.014	II
Neem	Y=0.166+ 0.818X	15.771	0.627	0.530 0.746	0.032	I
Jatropha	Y=1.194+ 2.514X	31.891	2.986	2.746 3.301	0.006	III
Chlorpyriphos	Y=3.600+ 2.129X	34.313	0.020	0.017 0.023	1.000	-
			72 hour			
Karanj	Y=0.141+ 0.718 X	15.564	0.636	0.497 0.774	0.025	II
Neem	Y=0.470+ 0.761X	41.928	0.241	0.147 0.340	0.066	I
Jatropha	Y=.994+ 3.027X	54.020	2.130	1.880 2.569	0.008	III
Chlorpyriphos	Y=4.961+ 2.772X	58.856	0.016	0.013 0.019	1.000	-

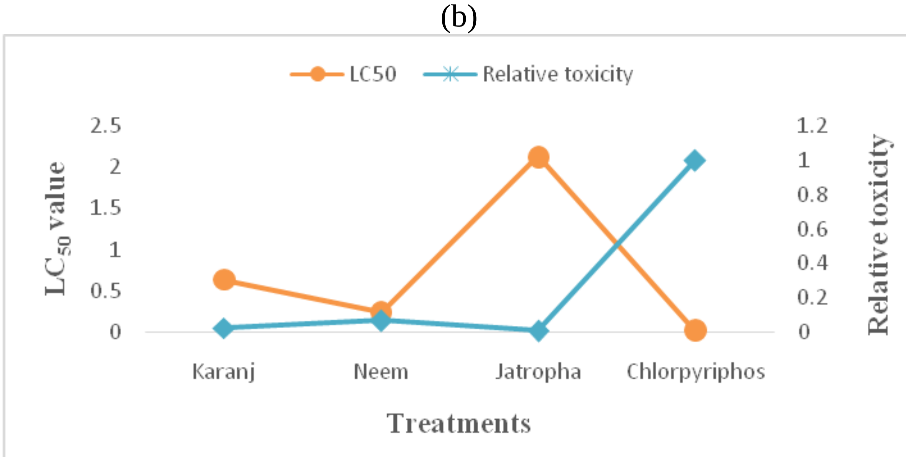
Fig.1 LC50 values and relative toxicity of three plant oils against termite, *O. obesus* at 24 hours (a), 48 hours (b) and 72 hours (c) exposure period



(a)



(b)



(c)

It may be concluded that the plant oils used had direct toxic effect. Among the tested oils neem oil showed the highest toxic effect which was followed by karanj oil and jatropha oil and most importantly these plants were available throughout India. So farmers can incorporate these oils for the management of termites in field condition. However, before releasing it as new technology further investigation is needed to confirm the result and more emphasis is to be given on studies associated with efficacy of plant and plant products against pests, their mode of action, identification of target sites and use of resistant strains.

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