TERMITES A MENACE TO FORESTRY AND AGRICULTURAL CROPS AND NEW CONCEPTS IN THEIR MANAGEMENT

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ABSTRACT

Studies were carried out on some new concepts for management of termites with methods other than the conventional chemical control. The new concepts in addition to chemical control for build up of a model of an integrated management of termites were population assessment, wood resistance trials, resistant wood extractive trials, influence of plant stress on termites infestation. Population assessment trial carried out in different localities showed the species wise distribution along with their strength. Wood resistance, trials showed the *Dalbergia sissoo, Cedrus deodara and Acacia nilotica* as the most resistant wood while *Salmalia malabarica and Populus x-euramericana* were found as the most susceptible woods. Extractive of the resistant wood were chemically obtained and *D. sissoo, C. deodara,* extractive have shown resistance against termites. The trials on the influence of plant stress on termite infestation showed that damage to roots of seedlings caused maximum stress while removal of foliage partly decreased stress on the seedling in the initial stages. All the dying and dead plants were found infested by termites while healthy plants were safe from termite infestation. Chemical control trials with chlorinated hydrocarbon insecticides afforded protection for more than 20 years while trials with pyrethroids are in progress and have shown efficacy for the last seven years.

INTRODUCTION

Termites cause heavy damage to wood and wood products in use and storage and all other materials of cellulosic origin. In certain stress situations termites have also been found to attack living plants and cause considerable mortality especially in transplants. The losses caused by termites run into millions of rupees every year. Keeping in view the losses caused by the termite the study of termite population, behaviour, their activities in different periods of the year, the resistance in various woods to termites, efficacy of wood extractive against termites and field trials of various chemical insecticides were carried out to avert colossal losses due to termite invasions.

In recent years work has been conducted on the termite caste determination (Wilson 1971, Luscher 1977), but understanding of the ecological importance of various caste form has progressed much more slowly (Brian 1978, Oster and wilson 1978). Quantitative information about seasonal variations in caste proportion within a colony is essential for such understanding. Previous studies have been restricted to the family termitidae or Kalotermitidae (Banerjee, 1966, Bodot 1969, Sands 1965, Sen-Srma and Mishra 1969). Present studies have been initiated with the object of gaining knowledge of the caste strength of various termite species in different ecological zones in different time period of the year.

Methods of testing natural termite resistance of timber in the laboratory under controlled conditions of temperature and humidity have been developed by many workers. Pence (1957) worked in prolonged maintenance of termite in the laboratory. Hardy (1961) described quick laboratory methods of determining the termites resistance of materials. Bampton et al (1966) tested 30 Nigerian timbers for their

4. Check no treatment block 5g in weight.

These treatments replicated thrice were put in earthen pits in randomized complete block design in order to expose them to termites found in nature and the earthen pits were covered over with tin plates and soil for recording the response of these treatments.

For study of the influence of plant stress on termites infestation, seedlings of *Eucalyptus camaldulensis* of equal size and vigour were taken out from the containers and their roots were washed. In order to create stress conditions half roots and 3/4 leaves were removed from the seedlings. The seedlings were planted in two separate randomized blocks, one with weekly and other with fortnightly irrigation at Kaharian and D.I. Khan.

An experiment laid out in February, 1974 was revived in February, 1985 for testing the efficacy of chlorinated hydrocarbon chemicals against termites.

Wooden stakes of 5 x 10 x 45 cm size of susceptible wood were installed in pits of 38 cm dia and 48 cm deep treated soil with 3, 6 litres each of 0.5% and 2.0% chlordane, heptachlor, aldrin and dieldrin.

The experiment in five replications under randomized complete block design was laid out at the National Park Lal-Sohanra (Bahawalpur), Peshawar and Maslakh (Quetta).

Similar trials were laid out during 1986-87 with Lorsban 40% EC a phosphatic insecticide and Dieldrin as standard insecticides against termites at Peshawar, Muzaffarabad, Sibbi and Karachi. Stakes of semul wood of 5 x 10 x 45 cm size were installed in pits of 38 cm dia and 48 cm deep treated soil with 3.6 liters each of 0.5%, 1.0% and 2.0% doses of Lorsban 40% EC and 0.5% EC as standard treatment.

RESULTS AND DISCUSSION

Termite-Population:

Table 1. Observations on Termites Population at various localities.

S.No	Locality	No. of soldiers and workers	Termites species
1	Peshawar Spot 1	1689	*Heterotermes indicola* Wassman (Rhino termitidae)
2	Peshawar Spot 2	4500	*Odontotermes lokanandi* Chatterjee and Takhur
3	Peshawar Spot 3	11126	*Odontotermes obesus* Rambur
4	Islamabad	3806	*Odontotermes hori* Roonwal and Chattoni
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resistance to subterranean termites in the field for one year. Butterworth et al. (1966) conducted laboratory trials with some Nigerian timber and building materials in China. Abramushkina (1973) and Panfilova (1973) have reported on the termite resistance trials in USSR. Tylor (1973) worked out termite resistance of wood plastic composites by exposing them to laboratory colonies. Kakaliev and Saparliev (1976) tested treated and untreated materials for termite resistance by these methods. Placing of test material, on the surface above ground attracted part of the nest termites after 2-3 days while those placed on soil around the nest or in soil around the nest attracted termites after 17-20 days. Carter and smith (1974) reported feeding and survival responses of *Reticulitermes flavipes* to materials from 11 US coniferous trees.

Beal *et al.* (1974) compared survival of *Coptotermes formosenus* on unextracted saw dust, solvent extracted saw dust and extractive from 24 tropical hard woods found no survival for 8 weeks on absorbent paper pads treated with extract from 14 woods. Rust and Reierson (1977) have reported that mathanol extract of least preferred woods were also least preferred when termites were confined to paper pads treated with their extracts, Carter *et al.* (1979) found that success in extracting antitermite substances varies with wood and solvents.

Work on this aspect was initiated at the Pakistan Forest Institute, Peshawar for evaluation of chemical extracts of woods for their antitermitic effects.

For control of termites selected chlorinated hydrocarbons, organophosphates and pyrethroids have been evaluated for efficacy as soil termiticides at a range of concentrations.

Termites cause damage to wood and wood products in use and in storage, under certain stress conditions living plants and bark of living trees are also attacked which cause growth losses, provide chances of borer and fungal attack and mortality to greater extent. In order to control termites selected chlorinated hydrocarbons, organophosphates and pyrethroids have been evaluated for efficacy as soil termiticides at a range of concentrations. Since 1980 Chlorpyrifos, Cyperethrin and Permethrin have been registered as soil termiticides by the EPA for prevention and control of sub-terranean termite infestation. Mauldin *et al.* (1987) have reported chlordane and heptachlor affording 100% control of sub-terranean termites for 20 to 30 years and recently registered termiticides (organophosphates and pyrethroids) generally have provided 100% control for the first 5 years and 80 to 100% control for years 6 through 10.

Dhamadhera and Rawat (1978) have reported termites as major pests of forests in India causing damage to roots and bark of standing trees. Soil application of 5% aldrin, chlordane or BHC, and the application of 1-2% DDT or BHC paste to the bark is recommended for control. Parihar (1981) found *Odontotermes quardaspurensis and O. obesus* damaging *Eucalyptus spp.* in the arid regions of Western Rajistan, India.

MATERIALS AND METHODS

Three sites were selected in Peshawar with termite activities for monitoring the termite population. Ten blocks of semul wood of 15 x 15 x 2.5 cm size were installed at interval of 13 meters, each in square earthen pits of 30 x 30 cm with variable depth of 45, 60 and 75 cm. At the bottom of each pit a semul wood block was placed and the pits were covered over with tin plates in order to avoid filling of the pits with soil and for convenience in collection of termites from the pits at the time of observation.

Similar trials were conducted at Islamabad in the horticulture nursery of capital development authority, Barani Agricultural College Rawalpindi and Islamic Research Center, Lahore.

Trials of wood resistance against termites were laid out by installing wooden stakes of 30 x 10 x 5 cm size of the common timber species of Pakistan in three replications on randomized complete block design at Peshawar. Similar trials were laid out at National Park, Lal-Sohanra (Bahawalpur); Agriculture Research Institute, Seriab (Quetta); Forest Rest House, Sibbi, Habibullah Colony, Abbottabad; Pakistan Forest Institute field station Shinkiara, Divisional Forest Officer Research Division, Muzaffarabad; Punjab Forestry Research Institute, Gatwala (Faisalabad); Karachi and Gilgit.

Wood extractive from sapwood, heartwood whole wood blocks of *Cedrus deodara* (Deodar), *Abies webbiana* (Fir), *Pinus roxburghii* (Chir), *P. wallichiana* (Kair), *Juniperus excelsa* (Juniper), *Picea smithiana* (Spruce), *Dalbergia sissoo* (Shisham), *Melia azadarach* (Bakain), *Platanus orientalis* (Chinar) and *Acacia nilotica* (Babul) were extracted in the chemistry laboratory of the Pakistan Forest Institute, Peshawar, using acetone and hexane as solvents, separately. The air dried woods were chopped and reduced to sawdust with the help of an electric sharp blade willy mill. The sawdust was then sieved through a sieve of 80-100 mesh per square inch. For each species, portions of milled wood were filled up in thimbles made of wattmann filter paper No. 1. The wood particles soaked in specific solvents were extracted successively in a soxhlet extractor of suitable capacity by heating on a water bath. The extracts were reduced to a suitable aliquot at low temperature to avoid the possible loss of volatile extractive fractions. The extracts from each wood sample were taken out, purified and dried over anhydrous sodium sulphate (Na_2 So_4). Moisture content was determined by drying the weighed quantities of fractions of each wood sawdust in weighing bottles and were kept at 105°C temperature in electric oven upto attaining constant weight.

Trials of wood extractive of *Platanus orientalis, Melia azadarach and Dalbergia sissoo* from broad leaved species and *Cedrus deodara, Pinus wallichiana, Abies webbiana, Picea smithiana, Pinus roxburghii and Juniper excels* from conifers were laid out during 1987-89 at the Pakistan Forest Institute, Peshawar and Forest Rest House, Sibbi (Baluchistan). In these trials the treatments replicated thrice were:

1. Extracted sawdust of test wood species 5g. in weight.
2. Unextracted sawdust of test wood species 5g. in weight.
3. Extractive treated semul wood block of 5g. in weight.
4. Solvent treated semul wood block.
5. Semul wood block (Check) no treatment.

Extractive of *Cedrus deodara, Pinus wallichiana, Abies webbina, Picea smithiana, Pinus roxburghii, Juniperus excelsa, Platanus orientalis and Melia azadarach* were extracted with solvent hexane in the chemical laboratories of the PFI. Peshawar. The quantity of the extractive extracted from 5 grams weight of each wood species was calculated as the weight of *Salmalia malabarica* wooden block used in the trial for testing the efficacy of the extractive was taken as 5 grams.

Extractive of these wood species equivalent to extract from 5g weight of the sawdust were applied on the semul wood blocks of 5g weight. In addition to this other treatments were;

1. Extracted sawdust 5g in weight.
2. Unextracted sawdust 5g in weight.
3. Solvent treated block 5g in weight.

4. Check no treatment block 5g in weight.

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Population monitoring trials revealed that at Peshawar colonies of *Heterotermes indicola* (wasmany) (Rhinotermitidae) and Odontotermes (Rambur) (Termitidae) are present. Each monitored colony comprised of 1689 workers and soliders at one spot. At another spot at Peshawar 3 distinct colonies of *Odontotermes lokanandi* were monitored comprising of 4500 workers and soldiers each. At spot 3 colonies of *Odontotermes obesus* Rambur (Termitidae) were monitored from which a total of 11126 workers, and soldiers were collected.

At Islamabad one termite colony of *Odontotermes hori* (Roonwal) and (Chattoni) give a total of 3806 workers and soldiers during the monitoring period. Similarly at Rawalpindi a colony of *Odontotermes lokanandi* (Chatterjee) and (Thakur). Termitidae gave a population of 140, 50 termites. At Lahore a colony of *Odontotermes obesus* Rembur gave a population of 15,408 termites through out the trial period.

Wood Resistance Test:

Table 2. Percent extent of Termite Damage of Stakes of various woods at various localities.

Wood	Localities										
	1	2	3	4	5	6	7	8	9	10	11
A. lebbek	34	17	3	5	13	50	0	7	1	25	15
A. nilotica	50	0	2	0	2	10	0	7	1	0	9
C. deodara	1	0	1	13	34	15	0	0	18	34	14
D. sissoo	3	0	0	17	2	0	0	0	27	28	8
E. camaldulensis	50	33	7	25	35	35	0	9	5	7	21
J. excelsa	53	2	0	70	0	45	0	0	54	0	28
M. alba	80	50	0	60	7	25	0	44	50	70	39
M. azadarach	80	13	0	35	19	14	0	1	55	34	25
S. malabarica	80	60	36	80	70	80	0	80	60	10	62
P. orientalis	70	43	0	60	28	80	0	80	50	17	43
P. x-euramericana	80	70	33	80	80	80	0	80	80	70	65
P. roxburghii	25	30	2	60	43	60	0	34	60	60	38
P. smithiana	80	15	7	0	0	40	0	0	0	55	39
P. wallichina	25	33	20	60	70	60	0	1	24	0	27

1. Peshawar
2. Abbottabad
3. Shinkiara
4. Muzaffarabad
5. CDA, Nursery, Islamabad
6. NARC, Islamabad
7. Gatwala
8. Bahawalpur
9. Sibbi
10. Karachi
11. Mean.

Table 3. Extent of damage in three replications (months after)

Treatments	Deodar	Kail	Fir	Spruce	Chir	Juniper	Chinar	Bakain	Shisham
	WOOD SPECIES								
PESHAWAR									
Extractive treated block	13^3 D_0	10^1 D_0	13^3 D_0	10^2 D_0	7^3 D_5	10^3 D_0	10^1 D_0	10^2 D_0	13^3 D_0
Unextracted sawdust	10^3 D_5	10^3 D_5	7^3 D_5	10^1 D_0	10^3 D_5	10^1 D_0	10^2 D_5	10^2 D_5	13^3 D_5
Solvent treated block	12^3 D_5	10^1 D_5	7^3 D_5	10^2 D_0	10^3 D_5	10^1 D_0	7^1 D_5	10^1 D_0	13^3 D_5
Extracted sawdust	6^3 D_5	5^3 D_5	7^3 D_5	7^2 D_5	7^3 D_5	10^3 D_5	9^3 D_5	10^3 D_5	6^3 D_5
Check	6^3 D_5	7^3 D_5	7^3 D_5	5^3 D_5	7^3 D_5	12^3 D_5	9^3 D_5	10^3 D_5	6^3 D_5
				SIBBI (BALUCHISTAN)					
Extractive treated block	31^3 D_0	--	31^3 D_0	--	--	--	31^3 D_5	31^3 D_0	31^3 D_0
Unextracted sawdust	31^3 D_0	--	24^3 D_0	--	--	--	18^3 D_0	18^3 D_0	18^3 D_0
Solvent treated block	31^3 D_0	--	31^3 D_0	--	--	--	18^2 D_0	24^3 D_0	18^2 D_0
Extracted sawdust	18^3 D_5	--	31^3 D_5	--	--	--	18^3 D_5	18^3 D_5	18^3 D_5
Check	18^3 D_5	--	31^3 D_5	--	--	--	18^3 D_5	18^3 D_5	18^3 D_5

D_0 = No. Damage D_1 = Surface nibbling D_2 = Light penetration
D_3 = Medium penetration D_4 = Heavy penetration D_5 = Major portion destroyed

It may be seen from the above table that various timber species were damaged to a very varied extent at different places. Very high activity of termites and resultant damage to wooden stakes has been noticed at Peshawar, Islamabad, Karachi and Sibbi.

The mean damage to various timbers show that *Dalbergia sissoo, Acacia nilotica and Sedrus deodara* have proved to be most resistant woods.

Salmalia malabarica and Populus x-euramericana are most susceptible woods out the tested lot.

Wood extractive test:

Observations recorded on the efficacy of extractive from different wood species against termites are given in Table 3.

The data in the above table show the extractive of *Cedrus deodara, J. excelsa, A. webbina, D. sissoo and Melia azadarach* applied on susceptible wood block of semul provided protection against termites at Peshawar and Sibbi during the trial period of 13 and 31 months respectively where as untreated check blocks of semul wood were heavily damaged by termites within 6 to 18 months.

Influence of plant stress

Table 4. % Mortality of plants due to stress at Kharian (Three Months after planting).

Treatment				
		Weekly Irrigation		
	R-1	R-2	R-3	Mean
T^1 1/2 roots cut	50	60	10	40
T^2 3/4 root cut	10	80	80	56.7
T^3 1/2 leaves removed	0	20	40	20
T^4 3/4 leaves removed	10	30	10	16.8
T^5 Check no treatment	30	30	50	36.7
		Fortnightly Irrigation		
T^1 1/2 roots cut	40	60	20	45
T^2 3/4 roots cut	40	70	40	50
T^3 1/2 leaves removed	10	10	10	10
T^4 3/4 leaves removed	10	40	0	10.9
T^5 Check no treatment	10	40	10	20

It may be noted that damage to roots or seedlings caused maximum stress while removal of foliage partly decreased stress on the seedlings in the initial stages. All the dying and dead seedlings were found infested by termites while healthy plants were quite safe from termite infestation. Due to casual rains in the spring and early summer irrigation treatment showed no marked effect.

Table 5. % Mortality of plants due to stress (Three Months after planting) at D.I. Khan.

Treatment	Weekly Irrigation			
	R-1	R-2	R-3	Mean
T^1 1/2 roots cut	100(0)	90(10)	100(10)	96.9(6.6)
T^2 3/4 root cut	100(10)	90(10)	90(10)	90(13.3)
T^3 1/2 leaves removed	80(10)	100(10)	90(0)	90(6.6)
T^4 3/4 leaves removed	100(20)	100(10)	100(10)	100(10)
T^5 Check (no treatment)	100(10)	100(0)	100(10)	100(6.6)
	Fortnightly Irrigation			
T^1 1/2 roots cut	10)	100(10)		
T^2 3/4 roots cut	70(20)	100(0)	100(0)	90(6.7)
T^3 1/2 leaves removed	80(30)	90(0)	100(0)	90(10)
T^4 3/4 leaves removed	90(10)	100(10)	90(10)	90(10)
T^5 Check (no treatment)	100(0)	80(20)	100(20)	93.3(10.3)

Figures in brackets show % plants infestated by termites. The data reveal that 70-100% seedlings died in various treatments at D.I. Khan but termite infestation was recorded in 0.30% plants only. It clearly indicates that termites were not the cause of mortality of plants.

Chemical Control

Table 6. Number of years insecticides have provided protection to wooden stakes placed in treated soil.

Insecticides	Dose	Peshawar	Bahawalpur	Maslakh
Aldrin 40% EC	0.5	20	15	15
	1.0	20	15	20
	2.0	20	15	20
Chlordane 37% EC	0.5	20	20	20
	1.0	20	20	20
	2.0	20	20	20
Heptachlor 32.1% EC	0.5	16*	20	20
	1.0	20	20	20
	2.0	20	20	20
Dieldrin 20% EC	0.5	20	20	20
	1.0	20	20	20
	2.0	20	20	20

The data in the above table reveal that all the chlorinated hydrocarbon insecticides remained effective throughout the trial period of 20 years with the exception of aldrin which could afford protection in all the three doses upto 15 years at Bahawalpur and in 0.5% dose at Maslakh for the same period.

Similarly heptachlor 32.1% EC in 0.5% dose afforded protection for 16 years at Peshawar and dieldrin in 0.5% EC for 15 years at Maslakh.

CONC. :SION

Termites the pest of saplings, trees and dimentioned wood, can be controlled by safe use of insecticides, by use of resistant wood species as well as proper care during new plantations.

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