International Journal of Wood Science, Technology and Forestry Vol. 5 (2), pp. 104-110, February, 2018. Available online at www.advancedscholarsjournals.org © Advanced Scholars Journals

Full Length Research Paper

Extensive survey of termites in different forests of the Punjab

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Accepted 05 January, 2018

Termites were surveyed in seven forests (plantations) of Punjab (Bhagat, Kamalia, Chichawatni, Changa Manga, Jallo Forest Park, Daphar and Attock) in 2008. Twelve termite species were observed from soil, dead logs, and live wood and living trees. Host trees were also identified. The percentage of infested trees in Kamalia, Bhagat, Chichawatni, Changa Manga, Jallo Forest Park, Daphar and Attock forests were 22.5, 20, 19.6, 15.5, 10, 20 and 12.1% respectively. Examination of dead wood in seven forests showed that an average of three quarters of wood pieces was attacked by termites. The number of termites per unit volume of dead wood was also determined in these forests and it was almost similar (0.4 per cm^3) in all the forests. It was also investigated that the size of colony was correlated with the volume of dead wood and it ranged from 26 to 2,784 termites, the soldier caste ranged from 2.1 to 20% of the total population of termite colony. In all these forests, 20% of dead wooden logs and branches showed signs of subterranean termite.

Key words: Termite species, forests, Punjab, colony size, volume of dead wood.

INTRODUCTION

Termites are the most economically important wood destroying pests in the world. Termites contribute significantly to world ecosystems by recycling the materials resulting in the maintenance of nutrient composition and balance. Previous researches report ecological role of termites in tropical forests and Savannas, where termites are rich in diversity and abundance. They are of great importance in recycling nutrients and soil fertilization in forest ecosystems (Pearce, 1997; Bignell and Eggleton, 2000). There has been extensive study on the influence of environmental factors such as carbon dioxide, methane, nitrogen balance, energy availability, temperature, soil type and moisture content, on assemblages of termites in Tropical forests and Savannas throughout the world (Bignell et al., 1997; Eggleton and Tayasu,; 2001 Davies et al., 2003).

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In subtropical and temperate parts of the world, termites are low in diversity, but still they play major role in forest ecosystem.

In Pakistan, forests are the main source of wood and wood products. Wood is a renewable natural resource mostly used for building, construction, and wood production. High quality wood products are often required by the customers, but physical or biological damage reduce the value of these wood products. Wood and wood products need to be protected during manufacturing, storage, transportation, and when in service (Uzunovic et al., 2008).

Keeping in view the important role of termites as ecosystem engineers, and the damages they cause to living trees and dead logs, twigs and branches, the present study was carried out in the seven main forests of the Punjab (Bhagat, Kamalia, Chichawatni, Changa Manga, Jallo Forest park, Daphar and Attock forest plantation) to know the extent of damages caused by termites and their ecology.

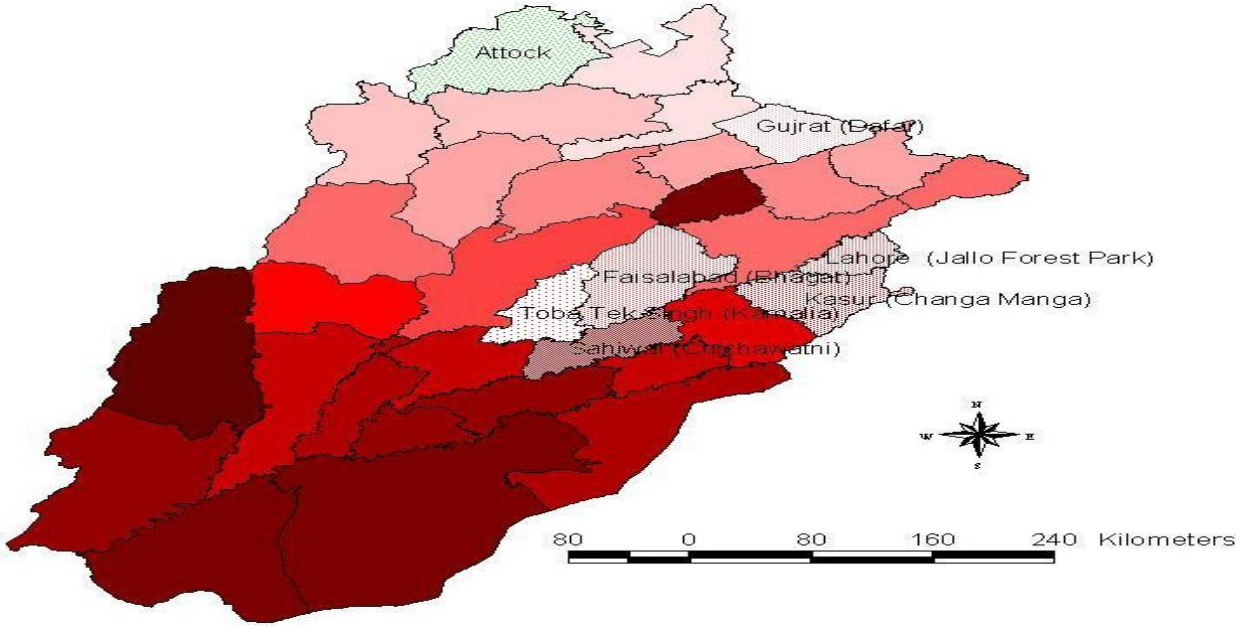

Figure 1. Location map of the study areas in districts of Punjab.

Study location

The geological formation of Kamalia forest, Chichawatni forest and Bhagat forests (Figure 1) is alluvium deposited by the river and forms a part of vast Indo-gigantic plain. The soil on the whole is a fine clay loam with high moisture retaining capacity. The average annual rainfall of these forests is 192.8 – 232.2 mm. The climate of the area is at the two extremes. It is very hot in summer and very cold in winter. The temperature ranges from 2 to 43°C under shade during the year. Cyclonic storms are practically unknown. Dust and sand storms however often come from April through August.

The Daphar plantation (Figure 1) is situated at the intersection of latitude 32 - 26° North and longitude 73 - 11º East. The soil of Daphar plantation is in general the gift of river action, being the alluvium with the varying proportions of sand and clay. The climatic conditions are semi arid and subtropical type. The average annual rainfall of these forests is 0.2 to 7.24 inches and the average temperature ranges from 10- 47°C throughout the year.

The Attock forest plantation (Figure 1) is situated between 33 and 34º North latitude, 71 - 45 and 73 -0 East longitude. The soil is fertile loamy clay along with dark coloured mineral soil capable of supporting good tree growth. The climatic conditions are true semi arid and sub humid, subtropical type. It is characterized by high summer temperatures with occasional hot dry winds and dust storms, cold nights in winter and two rainy seasons, one in late summer and other in winter. The average annual rainfall is 783 mm (30.83 inches). The climate is characterized by very hot summers and very cold winters. The maximum temperature reaches 40°C. The northern part is more humid with a relatively moderate climate as compared to the southern part.

Jallo Forest park and Changa Manga forest plantation (Figure 1) lying between 31°15 -31°45 N and 74°01 - 74°39 E, Temperatures ranges from 5.9 to 39.65°C . Rainfall varies from 12.0 to 609.0 (mm/month).

Objectives of the study

There have been relatively few studies (Kayani, 1983) on the ecology of termites in the forests of Punjab, so the main objective of this study was to carry out a survey of termites and to determine the economic problems caused by different species in these forests. It was the first extensive survey of termites in different forests of the Punjab; colonies of termites that live within the food source e. g tree trunks were identified. During swarming, winged imagoes (alates) appeared and this made it possible to collect an entire colony ranging from egg to adults. Another aim of this study was to determine colony size, caste composition and relationship between colony size and volume of dead wood from which colony was collected.

MATERIALS AND METHODS

A typical survey was conducted to detect the presence of termite species and activity in soil and trees in seven forests of Punjab. The study was carried out from January 2008 to December 2008 at Bhagat, Kamalia, Chichawatni, Changa Manga, Jallo, Daphar and Attock forest. During sampling period, data on humidity and

temperature was provided by meteorological department Lahore. Termite infestation studies: Termites were collected from standing or fallen wooden logs. Living trees were also inspected for termite activity. The different compartments of the forest were selected for the study. In each compartment, quadrates measuring 40 × 40 m was randomly positioned, within which living trees, dead wood logs, fallen branches and twigs were sampled for termite infestation. Assessment was based on visual rating scale that is 0% = no attack, 1-25% = low damage, 26-50% = moderate damage, 51-75% = high damage and 76-100% = very high damage. Termite samples were collected and preserved in 100% ethanol, brought to laboratory for identification with the help of key (termites of Pakistan, Chaudhary et al., 1974).The termites were identified to specie levels.

Volume of dead wood, colony size and composition

For determining volume of dead wood, colony size and composition, one plot was selected randomly in each forest. Each plot was 5.00 x 5.00 m. All dead wood (standing dead trunks, wooden logs or trunks on ground) were examined for termites activity e. g termite galleries, faecal pellets or any other evidence of infestation. Wood volume was calculated by measuring the logs diameter and length and applying the formula r^2L. Termite colony from dead wood was brought to laboratory and soldiers, workers, nymphs, alates, larvae and eggs were examined by microscope. Each category was counted exactly.

RESULTS AND DISCUSSION

Humidity and temperature of the study areas

The monthly average temperature and humidity during the sampling months from the various forests were shown in Figure 3. It is also evident from the figure that temperature and humidity play vital role in swarming and colony formation so maximum termite activity was observed during July to September when both temperature and humidity were high.

Termite infestation studies

The survey results of the seven forests of Punjab (Bhagat, Kamalia, Chichawatni, Changa Manga, Jallo, Daphar and Attock) revealed that the area was characterized by following major plantations: *Acacia arabica, Tamarix articulate, Dalbergia sissoo, Morus alba, Eucalyptus comadulensis, Melia azedarach, Abies pindrow, Tectona grandis, dry grass , Bombex siba, Arjun terminalia, Prosopis apiclgora, Ficus religiosa, Mangifera indica, Albizzia lebbak, Phyllanthus emblica, Syzygium cumini, Broussonetia papyrifera, Dendrocalamus atrictus ,Salmalia malabarica, Poplus sp. and* rubber tree. (Table 3)

Table 1 shows the percentage of plants attacked by termites in different forest. In Bhagat, out of 150 trees inspected for termite attack, 30 plants were found to be attacked by termites; in Kamalia forest, out of 200 trees inspected, 45 trees were attacked by termites; in Chichawatni forest, out of 250 trees inspected for termite attack, 49 trees were found to be attacked by termites. In Changa manga forest, out of 220 trees inspected, 40 trees were attacked by termites. When 140 trees were examined in Jallo forest park, 14 trees were subjected to termite attack, making up to the 10% of the total attack. Likewise, in Daphar forest, out of 230 trees inspected for termite attack, 46 trees were attacked. In Attock forest, there were only 12.10% trees attacked by termites. (Table 1)

Out of 200 termites samples collected from all the forests during survey, eleven species of termites: *Odontotermes obesus, Coptotermes heimi, Heterotermes indicola, Odontotermes guptai, Odontotermes horai, Odontotermes assmuthi, Microtermes obesi, Microtermes mycophagus, Microtermes unicolar, Odontotermes gurdaspurensis, Microcerotermes pakistanicus,* and *Bifiditermes beesoni* were recorded damaging forest trees and logs. *M. obesi* was the most common termite species (19%) and *B. beesoni* (1.5%) was least common species in forests of Punjab. Other identified species were: *H. indicola* (6%), *C. heimi* (2.5%), *O. horai* (10%), *M. pakistanicus* (7%), *M. unicolar* (5.5%), *O. asmuthi* (3.5%), *O. gurdaspurensis* (5%), *O. guptai* (10.5%), *M. mycophagus* (13.5%) and *O. obesus* (15.5%). (Table 2)

The collection and identification data also revealed dominant species in different forests. *M. obesi* was dominant species of the Kamalia, Chichawatni and the Bhagat forests, *M. obesi* was identified as dominant species of Changa manga and Jallo Forest plantation while *M. mycophagus* and *O. guptai* were collected as the prevailing dominant species of Daphar (Gujrat) and Attock forests respectively (Table 4). It was also seen that freshly fallen wood items had no signs of termite attacks but larger wooden logs were heavily infested by termites, containing full colony. When visual rating was done, high damage percentage (75-100%) was observed in wooden logs where there was high level of decay, particularly in humid days. Wang and Powell (2001) observed that subterranean termites prefer to live in larger wood items in forests in Mississippi. Lenz et al. (2000) also found in his study that increase in food source attracts a large number of termites. The study also reveals that the larger the volume of dead wood, the higher the food resource and more the number of termites. It was further observed that in forests, where there are larger dead wood logs, they contain large amount of cellulose so termite colony prefers to stay inside wood and this also stops the further foraging activity. In many wooden logs, galleries of termites were seen inside wood, there were also many visible signs for termite feeding.

Volume of dead wood, colony size and composition

The total volume of dead wood in Kamalia, Chichawatni and Bhagat in plot 1, 2 and 3 is shown in Table 4. It was

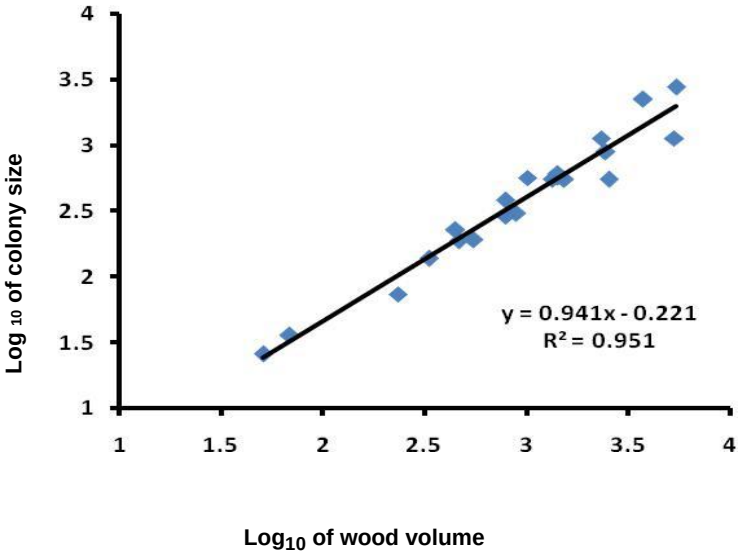

Figure 2. Regression showing relationship between wood volume and colony size.

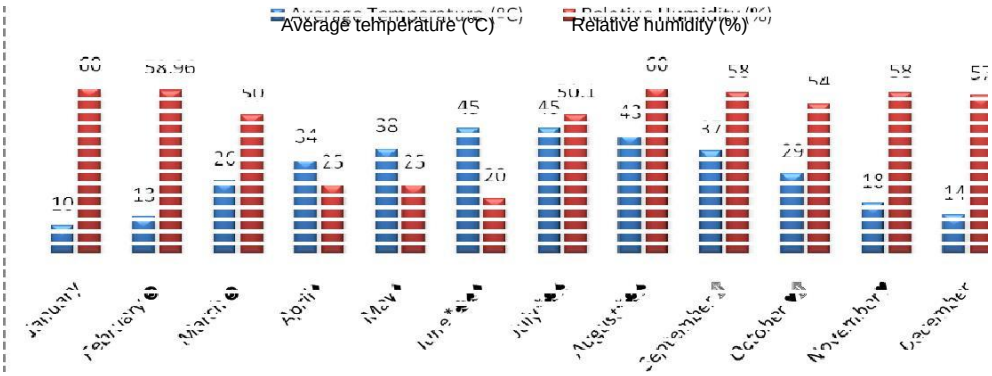

Figure 3. Monthly average temperature and humidity during sampling months from Kamalia, Chichawatni, Changamanga, Jallo, Daphar ,Attock, Bhagat.

Table 1. Percentage of trees attacked by termites in forests of Punjab.

Forest	Plants examined	Plants infested	Percentage of infested plants (%)
Bhagat	150	30	20.00
Kamalia	200	45	22.50
Chichawatni	250	49	19.60
Changa manga	220	40	18.18
Jallo Forest Park	140	14	10.00
Daphar	230	46	20.00
Attock	190	23	12.10

also seen that more than three quarter of dead wood showed signs of termite of attack. Total termite count, caste composition for the 21 colonies of dominant species of each forest is shown in Table 4. Colony data also indicated that colony number is linked to unit volume of dead wood as larger size of colony was in larger pieces of dead wood. Linear regression indicated a positive correlation between dead wood volume and colony size (Figure 2). So this study is also in conformity of previous research which indicates that size of mature dry wood termite colony is positively correlated with food source (Lenz, 1994). Present study also supports the

Table 2. Percentage of occurrence of different termite species in seven forests of Punjab.

Name of species	Percentage (%)
H. indicola	6.00
C. heimi	2.00
O. obesus	15.5
O. horai	10.00
O. gurdaspurensis	5.00
O. guptai	10.5
O.assmuthi	3.50
M. pakistanicus	7.50
M. mycophagus	13.50
M. unicolar	5.50
M. obesi	19.00
B. beesoni	2.00

Table 3. Feeding preference of different species of termites in Chichawatni, Bhagat and Kamalia (based on live plants)

Plant species	*H. indicola*	*O. obesus*	*C. heimi*	*M. championi*	*M. obesi*	*O. horai*	*O.gurdaspurensis*	*O. guptai*	*M. mycophagus*	*M. unicolar*	*B.beesoni*
A. Arabica	+	+	-	-	+	+	+	+	+	-	-
T. articulate	+	+	+	-	-	-	-	+	-	+	-
D. sissoo	+	+	+	-	+	+	+	+	+	+	+
M. alba	+	+	+	-	+	+	-	-	+	+	-
E. comadulensis	+	+	-	-	-	-	-	-	-	-	-
M. azedarach	-	-	-	-	-	-	-	-	-	-	-
A. pindrow	-	-	+	-	-	-	-	-	-	-	-
T. grandis	-	-	-	-	+	-	-	-	-	-	-
Dry grass	-	-	-	-	-	-	-	+	-	-	-
P. apiclgora	-	+	-	-	-	-	-	-	-	-	-
F. religiosa	-	+	-	+	-	+	+	+	-	-	-
M. indica A.	+	+	+	-	-	-	-	-	+	-	-
lebbak P.	-	+	-	-	+	+	+	-	-	-	-
emblica	-	-	+	-	-	+	+	+	+	-	-
Syzygium cumini myrtaceae	-	+	-	-	+	+	+	+	-	+	-
B. papyrifera	+	+	+	+	-	-	-	-	+	+	-
D. atrictus	-	-	-	+	-	-	-	+	-	-	-
S. malabarica	+	-	+	-	+	-	-	+	-	+	-
B. siba	-	+	-	-	+	+	-	+	-	-	-
A. terminalia	-	+	+	-	+	+	-	+	+	-	-
Poplus sp.	+	-	-	+	+	-	+	+	-	+	+
Rubber tree	+	+	+	-	+	+	-	+	+	+	-

+ve sign shows the presence of the termite species on the particular tree mentioned in the table; -ve sign shows the absence of the termite species on that particular tree mentioned in the table.

hypothesis that in dry wood forests, termites are more important wood decomposers than fungi (Chudnuff and Goyteia, 1972; Bultman and Southwell, 1976). Previous studies revealed that wide variety of plants serve as food

Table 4. Termite colony in dead wood in seven forests of Punjab.

Name of forest	Location (plot)	Species	Wood volume (cm)	Alates	Workers	Nymphs	Larvae	Sol
Kamalia	1	*M. obesi*	1340.9	15	400	20	15	
	2	*M. obesi*	2340.9	20	1055	30	10	
	3	*M. obesi*	892.2	7	255	15	3	
Bhagat	1	*M. obesi*	2542.1	18	459	20	10	
	2	*M. obesi*	3743.8	25	2150	30	15	
	3	*M. obesi*	2452.9	26	795	20	5	
Chichawatni	1	*M. obesi*	50.9	0	23	0	0	
	2	*M. obesi*	789.2	0	250	10	0	
	3	*M. obesi*	1432.9	21	525	12	7	
Attock	1	*O. guptai*	790.2	17	295	18	8	
	2	*O. guptai*	450.1	6	189	7	0	
	3	*O. guptai*	234.1	0	55	9	0	
Daphar	1	*M. mycophagus*	1012.9	10	498	20	9	
	2	*M. mycophagus*	1542.9	15	489	15	0	
	3	*M. mycophagus*	465.9	0	150	18	0	
Changa Manga	1	*O. obesus*	5445.9	20	2642	40	25	
	2	*O. obesus*	550.8	0	167	9	0	
	3	*O. obesus*	332.8	0	105	15	0	
Jallo	1	*O. obesus*	69.1	0	30	0	0	
	2	*O. obesus*	5324.1	20	989	41	23	
	3	*O. obesus*	1425.4	18	481	24	16	

for termites, including living plants and dead woods, grasses, herbaceous plants and their debris, fungi humus and cattle-dung (Lee and Wood, 1971). In habitat where most of these sources are available, a large proportion of the energy resource of the ecosystem is potentially available to termites. Little competition is encountered with other soil animals, since only a minority feed on freshly fallen plant debris or living plants (Lee and Wood, 1971). Since no previous work has been undertaken on the termite fauna of forests in Punjab, Pakistan, this study is important to know the ecological characteristics of the termites potentially able to attack wood. The species compos of trees of fore correlated with corroborates an (2002), which richness was disturbance gra

Africa.

In conclusion, this study revealed important termite species infesting live and dead trees, which is a new record for forests of Punjab. It was also concluded that subterranean termites select wood with larger diameter and with high moisture level. The findings of this study are very important for termite control studies.

ACKNOWLEDGEMENTS

The authors are very grateful to the Punjab Forest Department especially Syed Muhammad Ajmal Rahim Conservator of Forest for providing transportation to field sites and assistance with tree identification.

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