

Full Length Research Paper

Termites impact on different age of Cocoa (*Theobroma cocoa* L.) plantations with different fertilizer treatments in semi- deciduous forest zone (Oume, Ivory Coast)

Tra Bi Crolaud Sylvain¹; Soro Senan^{*1}, Yéboué Nguessan Lucie¹, Tano Yao² and Konaté Souleymane²

¹Université Jean Lorougnon Guédé, UFR Agroforesterie et UFR Environnement, Laboratoire de Biologie Animale, BP 150 Daloa, Côte d'Ivoire.

²Université Nangui Abrogoua, UFR des Sciences de la Nature, Laboratoire de Protection des végétaux et de Environnement, Abidjan, Côte d'Ivoire.

Corresponding author E-mail: soro_senan2000@yahoo.fr ; Cel: (+225) 03 48 89 13/ 00225 05 07 62 00

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Abstract

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This study was mainly aimed to put in evidence the effect of termite's attacks in cocoa plantations subjected to natural and anthropogenic factors. The observation of cut trunks, suckers, and cut slits showed the presence of 7 termites genera (*Ancistrotermes*, *Coptotermes*, *Microtermes*, *Microcerotermes*, *Nasutitermes*, *Pseudacanthotermes* and *Schedorhinotermes*). On a total of 160 cut trunks all fields combined, 38.75% are infested. The slits were abundant in the old cocoa plantations (25 and 30 years) with 38.18% and 25% occurrence, respectively. No significant difference ($p>0.05$) were observed on the termites activity between the cut trunks, the cut slits, and the suckers. The attacks of *Microcerotermes*, *Coptotermes*, *Nasutitermes*, and *Pseudacanthotermes* are influenced by the age of cacao plantation

Keywords: Cocoa cultivation, Suckings, Termites, Trunks, Slit

INTRODUCTION

Termites are an essential constituent of the soil (Donovan et al., 2001; Inoue et al., 2001). They can represent more than 95 % of the biomass of insects according to the nature of the environment and the structure of the soil (Bignell and Eggleton, 2000). They, sometimes attack cultivated plants causing damages (Roy-Noel, 1966; Leponce, 1996; Han et al., 1998; Akpessa et al., 2008). Their presence is not noticed all the time because of their appearance. The attack of the termites on cultivated plants may be favoured by hydrous stress, accidental cuts occurring during the upkeep of the plantations and the cutting down of suckers which grow on trunks and branches of the cocoa tree. We can add to that the slits frequently observed on the trunks or the branches of cacao trees. Their origins remain unknown so far. The split in the bark which widens as the cocoa tree grows is said to be caused by the farmer following an accidental cut during the harvest of pods or during the upkeep of the plantations. The cuts or cracks on the plants trunks constitute the entrance way of many bioattackers (Pollet et al., 1987). Studies on the attacks of the termites are

numerous in Côte d'Ivoire: (Han et al., 1998) on palm tree, (Koudou, 2000) on hevea and (Akpessa et al., 2008) on maize and rice. They have contributed to the description of the modes of termites attacks on these plants because of their importance in the Ivorian economy (10 % of the gross product) (Anonym, 2005). In order to show the importance of the damages caused by termites on plants grown in Côte d'Ivoire and facing with the lack of information on the attacks of these biotackers it was necessary to undertake these studies in order to show to the farmers and decision- makers the dangers threatening the mainspring of the Ivorian economy.

MATERIAL AND METHODS

Material

Study zone

The works have been conducted two years from 2011 to



Figure 1: Different plants showing the termites attacks on cocoa trees

2012 in 4 cocoa plantations in Oume (6°31 latitude North and 5°30 longitude west) in the center west part of Côte d'Ivoire. The region of Oume has an equatorial type climate. The total rainfall observed during the study in 2011 is 1698.7 mm against 1614.4 mm in 2012. The monthly temperatures vary between 24.6 °C and 28°C in 2011 then between 24.1 °C and 29.6°C in 2012. The soil is iron like (Angui et al., 2005). In this study, 4 different ages old fields (8, 20, 25 and 30 years) have been chosen at random. Each field cover a surface of 2500 m² (50 x 50 m). The number of trunks affected varies depending on the field. Chemical fertilizers were usually used on the field of 8 year old because of its immediate economic potential (pods production) (2 treatments/year). This is justified by the wood fragments found on the land. Therefore, the field of 20, 25 and 30 years old are all from primary forests. There, the litter is mainly composed of cocoa tree leaves. But, a recolonization by the herbaceous flora and a decrease of production due to a lack of up keeping were observed on this fields.

Method

Sampling method

The data sampling consisted in looking for the presence of termites in the slits, cut trunks, and suckers (Figure 1). A plant is said to be attacked if there are some galleries sheltering termites (Han and N'Diaye, 1996).

Identification of specimens

The identification of termites has been based on the caste of soldiers. The identification key of Bouillon and Mathot (1965) has been used to separate the specimens up to the genera.

Data analysis

A descriptive analysis (correlation, proportion) of the relationships between the attacks and the structures that

Table 1. List of termites sampling according to the treatment (age)

Family	Sub-family	Genera	8 years			20 years			25 years			30 years			TG
			CT	S	CS	CT	S	CS	CT	S	CS	CT	S	CS	
Rhinotermitidae	Coptotermitinae	<i>Coptotermes</i>				*	*		*	*				*	X
	Rhinotermitinae	<i>Schedorhinotermes</i>							*				*		X
Termitidae	Macrotermitinae	<i>Ancistrotermes</i>	*						*			*	*	*	M
		<i>Microtermes</i>	*						*	*			*		M
		<i>Pseudacanthotermes</i>											*		M
	Termitinae	<i>Microcerotermes</i>				*	*		*	*			*	*	X
	Nasutitermitinae	<i>Nasutitermes</i>	*		*				*	*			*	*	X
		Total		4	0	1	2	2	0	6	4	0	1	5	5

* = Presence of termites; **CT**: cut trunks; **C**: cracks; **CS**: cut suckers; **TG**: trophic group; **X**: wood eating termite; **M**: mushrooms eaters

Table 2. Attacks of termites on cracks and cut trunks by year

	8 years	20 years	25 years	30 years
Cut trunks	66	49	41	4
Infected cut trunks	21	13	27	1
Proportion of attacks (%)	31,81	26,53	65,85	25
Number of cracks	5	12	55	40
Attacked cracks	0	4	21	10
Proportion of attacks (%)	0	33,33	38,18	25

is the cut trunks, the suckers and the slits that can be observed on the cocoa trees has been realized. The correlation tests between the attacks and the structures have been done with the software statistica (version 6.0). The dendrogrammes of similarities have been realized to test the harvest behavior of the different trophic groups of termites on the trunks.

A variance analysis (ANOVA) has been done with the software R (version 2.8). It has permitted to test the effect of the field age and the plants structures on the termites attacks.

1 How does the termite eat woods.

2 A vast range of insecticides and fertilizers authorized are used by the farmers.

3 Tunnel used by the termites to reach the source of food (wood)

RESULTS AND DISCUSSION

Results

Generic diversity of termites

In total, 7 genera of termites have been found on the

cocoa trunks (Table 1): *Ancistrotermes* (Silvestri); *Microtermes* (Wasmann); *Nasutitermes* (Dudley); the *Coptotermes* (Wasmann); *Schedorhinotermes* (Silvestri); *Microcerotermes* (Silvestri) and *Pseudacanthotermes* (Sjöstedt). They can be divided into 2 groups and 5 sub-groups. The cut trunks from the 25 years plantations were the most attacked (6 genera) followed by the plantations of 30 years with 5 genera respectively present in cut trunks and splits.

Termites attacks on cut trunks

On 160 cut trunks all the cocoa plantations considered, termites can be found in 62 ones that is 38.75% of attacked trees. The most attacked plantation was the one of 25 years with 41 trunks cut that represent 65.85 % of attacks when the impact of termites is considered on trees. Then come the plantations of 8 and 20 years (Table 2). The plantation of 30 years, with 1 trunk infested over 4 cut trunks was the least affected.

Termites attacked on cracked trunks

The analysis of the splits infestations by the termites

Table 3. Attacks of non-cut suckers of cocoa trees by termites

Suckers	Aspect	8 Years	20 Years	25 Years	30 Years	All fields
Non cut	Non infested	5,14% (9)	9,14% (16)	41,71% (73)	44% (77)	98,31% (175)
	Infested	33,33% (1)	0,00% (0)	0,00% (0)	66,66% (2)	1,69% (3)
	Total	10	16	73	79	178

Table 4. Attacks of cocoa trees by termites

Suckers	Aspect	8 Years	20 Years	25 Years	30 Years	All fields
Cut	Non infested	0,00 % (0)	0,00% (0)	0,00% (0)	29,73% (11)	29,73% (11)
	Infested	0,00% (0)	10,81% (4)	48,64% (18)	10,81% (18)	70,27% (26)
	Total	0	4	18	15	37

shows that the 25 and 30 years old plantations with respectively 55 and 40 splitted trunks have been exposed to the attacks of termites (38.18 % and 25 % respectively). The cacao plantations of 20 years with a small number of splitted trunks (12 splits) have been infested (33.33 % of attacks). The 8 years plantation was the only one to be spared (Table 3). In total 32.71 % of the cracks have been attacked by the termites out of a total of 112 splitted trunks.

Termites attacks on suckers

In total, 215 suckers have been observed. Out of 178 suckers three have been infested (1.69 % of attacks) (Table 4). On the other hand 26 cut trunks have been infested on a total of 37 all areas considered (70.26 % of attacks) (Table 4). The detailed analysis of each plantation (Table 4) shows that, the proportion of non-cut and infested was rather weak. We noticed 2 (66.66 % of attacks) in the plantation of 30 years and 1 (33.33 % of attacks) in the plantation of 8 years. The infested cut suckers were numerous in the plantation of 25 years with 18 suckers on a total of 36 (48.64 % of attacks). They were low and identical in the plantations of 20 and 30 years with 4 suckers attacked (10.81 % of attacks) and 0 (0.00 %) in the plantation of 8 years.

Link between termite's attacks and the cocoa trees

The link between the attacks of termites and the number of splits shows that the number of attacks rises with the number of cracks (Figure 2A). Both variables are strongly related ($r=0.74$). Similar results have been observed between the attacks of the termites, the cut trunks and the suckers ($r=0.96$ and $r=0.78$) (Figure 2B and 2C).

Proportion of taxon infesting cocoa trees

The seven genera of termites counted during this study are all present on the cut trunks and in the cracks. On the other hand, we notice an absence of *Microtermes* and *Nasutitermes*. The infestation of the different field indicates that *ancistrotermes*, *Microcerotermes* and *Nasutitermes* are abundant in the cracks with 20.96 %, 32.25 % and 27.41% of attacks. These three genera are abundant in the cracks with 20.00 %, 22.85% and 40.00 % of attacks each. *Schedorhinotermes* and *Pseudacanthotermes* are less present with 1.61 % of attacks on the cut trunks. Both genera are less present in the splits (2.85 % of attacks each). The cut suckers are more infested by the termites. Only the *Ancistrotermes* genera dominates with 27.27 % of attacks. The other genera are present with 18.18 % of attacks each.

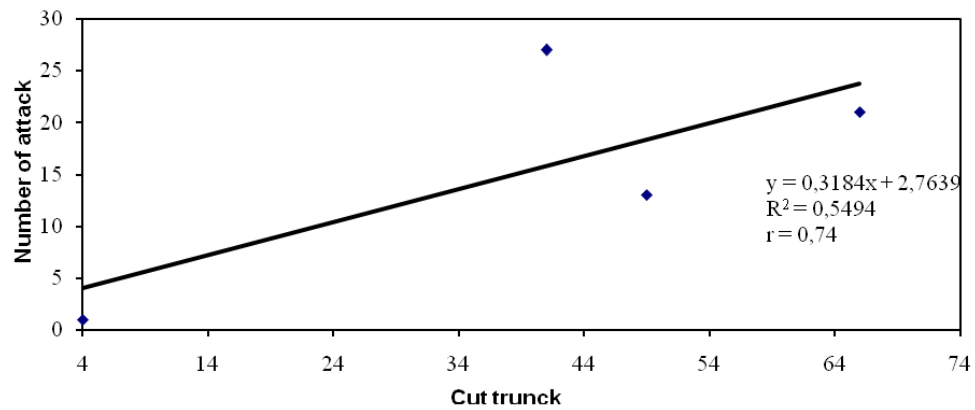
The attacks of termites on the cocoa trees according to the treatment and the environment shows that the cut trunks, the cut suckers and the cracks do not significantly affect the harvest behaviour of the termites whatever the genera ($p>0.05$) (Table 5). Thus the termite's indiscriminate attack the cocoa trees whatever their nature. But the plantation seem to have some effects on the attack of some taxons such as *Microcerotermes* ($p=0.001$), *Coptotermes* ($p=0.006$), *Nasutitermes* ($p=0.005$) and *Pseudacanthotermes* ($p=0.003$).

DISCUSSION

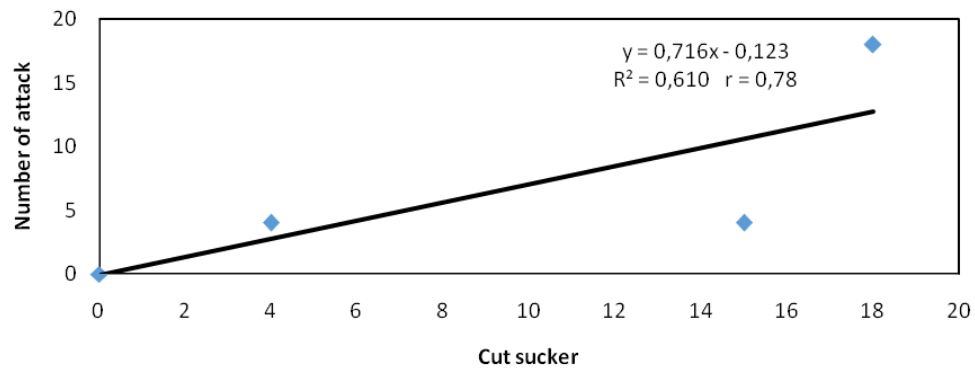
In total, 7 genera of termites have been found on all the cocoa trees. These genera have been studied by some authors in Côte d'Ivoire (Anonyme, 2005). The genera *Coptotermes* is described as a cocoa tree ravager by Harris quoted by Roy-Noël (1966). The mushrooms

Table 5. Presence of termites on cocoa trees according to the treatments

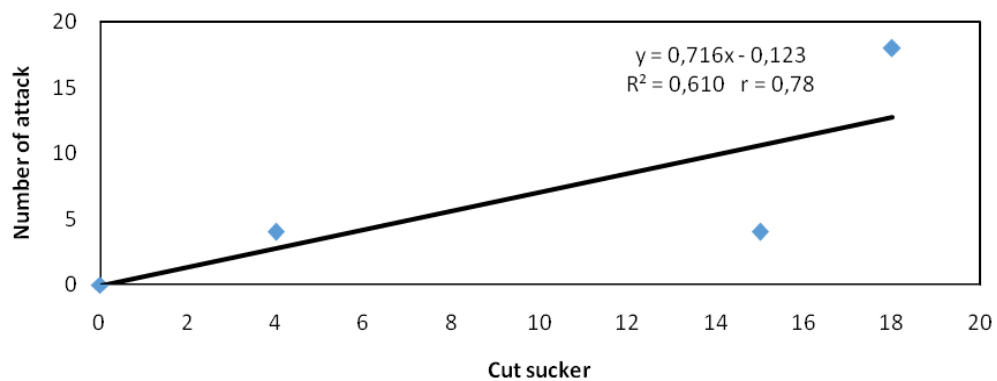
Genera	Cut trunks %	Cracks %	Cut suckers %
<i>Ancistrotermes</i>	20,96	20	27,27
<i>Coptotermes</i>	3,22	5,71	18,18
<i>Microcerotermes</i>	32,25	22,85	18,18
<i>Microtermes</i>	12,9	5,71	0
<i>Nasutitermes</i>	27,41	40	0
<i>Schedorhinotermes</i>	1,61	2,85	18,18
<i>Pseudacanthotermes</i>	1,61	2,85	18,18



A



B



C

Figure 2: relation between the number of termites attacks and cocoa plantation (n=4)

eating termites such as *Ancistrotermes*, *Pseudacanthotermes* and *Microtermes* have been signaled as ravagers of food crops and have been also found except *Microtermes* genera which is not found on the cut suckers (Akpesse et al., 2008). The termites attack the dried scars of the cut suckers. They spread toward the bottom and reach sound trunks (Bignell and Eggleton, 2000). The splits are overexploited by the wood eating termites, the *Nasutitermes* (40.00%) and *Microcerotermes* (22.85%), have showed that 84.00% of the *Ossopteryx febriginahollows* with a size of more than 2 meter are exploited by the wood eating termites and mushrooms eaters in the Lamto savannah. The quick access to cracks is facilitated by these galleries networks (Bignell and Eggleton, 2000) and specific enzymes (osidasas) that enable them to deteriorate the complex compositae of plants (lignine, cellulose hemicellulose). Leponce (1996) has observed in a coconut palm plantations in New Guinea some species of *Nasutitermes novarum* pv. *hebridarum* (Holmgren), *N. princeps* (Desneux) and *Microcerotermes biroi* (Hill) that attack dead coconut trees mainly. However, on the cocoa trees *Nasutitermes latifrons* and *Microcerotermes fuscotibialis* attack sound and weakened cacao trees. The absence of humivorous termites on cocoa trees highlights the link between the diet and the structures eaten by these organisms. In fact, these termites eat the humus and the organic particles more or less decomposed of the humus fraction of the superficial horizons of the soil (Brauman, 2000). In other aspects, Akpesse et al., (2008) in Booro-Borotou working on maize and rice have found that humus eating termites of the *Cubitermes* genera (Wasmann) don't attack these plants despite the massive attacks of mushrooms eating termites that are *Ancistrotermes*, *Microtermes*, *Pseudacanthotermes* and a wood eating termite, *Amitermes* (Silvestri). We also notice the influence of the age of the plantations ($p < 0.05$) on more than 50.00 % of the taxons (4 genera on 7 in total). The effect of the plantations age on the cocoa trees infestation by termites could be explained by the use of repulsive and harmful fertilizers during the periods of high productivity (8 and 20 years). For newly formed plantations the presence of wastes of precedent agricultural activities and deadwoods are food sources liable to direct the termites towards other sources of foods (Tondoh, 1992). Eggleton et al., (2002) and Jones et al., (2003) come to the conclusion that the installation and the trophic composition of termites in tropical ecosystems are strongly linked to the structure and the composition of the habitat.

CONCLUSION

This study has allowed us to highlight the attack behavior of termites in different situations due to

physical treatment of trees done by farmers. The cut trunks, the suckers and the splits are main ways used by the termites to attack the cocoa trees. These pillagers are attracted by cocoa trees that do not offer resistance when they are looking for food. Their action will affect the development and the production in the long run. Thus for a better management of these structures, it is advised to reduce the height of the remaining stems of the suckers by cutting them at the level of the trunk-sucker junction. It is also advised to disinfect regularly these apertures with appropriate fertilizers.

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