Attacks and Damage by Termites in Cassava (*Manihot esculenta* Crantz) Fields in the Department of Agboville (South-Eastern Côte d'Ivoire)

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Abstracts: Termites play an important role in tropical soils, but some species attack crops such as cassava. The present study, carried out in the department of Agboville (south-eastern Côte d'Ivoire) aims to assess termite attacks and damage in peasant cassava fields. Sampling for termites was done in three (3) age classes of plots; young (0 to 3 months), medium age (3 to 8 months) and older plots (8 to 18 months). For each age group, 3 cassava plots of traditional varieties, measuring 1 ha each, were chosen; or 9 plots in total. In these plots, 100 plants were chosen at random for observations. Each part of the cassava plant was prospected (leaf, stem, crown) and the observations focused on the health of the plant, the signs of attacks (galleries, soil veneers, holes and others) and the type of damage. Five (5) species of termites including 4 fungi (Ancistrotermes guineensis, Microtermes sp, Macrotermes bellicosus and Pseudacanthotermes militaris) and one (1) xylophage (Amitermes evuncifer) of the Termitidae family were collected in the different plots. The Ancistrotermes guineensis and Microtermes sp species, with respective attack rates of 47% and 29.7%, are the most aggressive on cassava. Termite attacks cause extensive damage that may affect the production of cassava. These results will allow growers to consider preventive cassava controls to avoid huge losses from termite damage.

Keywords: Termites, Attack, Damage, Manihot esculenta, Agboville

1. Introduction

Cassava is one of the major root and tuber crops in Africa. It derives its importance from its tuberous roots, which are rich in starch, which are an excellent inexpensive source of calories, especially in developing countries [1]. Global production in 2017 was over 258 million tonnes. Africa, with more than half of world production (around 57%), is the leader in the cassava sector [2]. Cassava is both a subsistence and cash crop because its cultivation and exploitation generate various activities that contribute to food security and help fight poverty [3]. There are a variety of cassava products used for food: foutou, attiéké, gari, tapioca, placali, croquettes, attoukpou, flour, etc. Industrially, cassava is used as a raw material in the production of starch, glue, ethanol, vinegar, adhesive and in textiles [4]. However, the average yield of this crop remains still very low in Côte d'Ivoire (7 t / ha) compared to that of certain ECOWAS countries such as Ghana (20 t / ha) which have almost the same climatic conditions.

According to N'zué et *al.* (2013) [5], the low cassava production in Côte d'Ivoire is linked to several factors, the most important of which are the use of low-yielding local cultivars and the incidence of diseases and pests. Among the pests of cassava are termites. Termites are one of the

major biotic components of tropical ecosystems where they represent true ecosystem engineers [6]. They participate in many ecosystem services, including the decomposition of organic matter and the evolution of the physico-chemical structure of soils [7-15]. However, despite their usefulness, some termite species pose a threat to crop plants causing losses in production. In Côte d'Ivoire, several authors have mentioned termite infestations in oil palm, rubber, rice, maize, cocoa, mango, etc. [16-21]. In Senegal, termite attacks against cassava have been reported [22, 23]. Given the critical role cassava plays in the country's food security, the study of termite attacks on cassava is therefore worthy of investigation. Thus, as part of a contribution to improving cassava productivity in Côte d'Ivoire, this study was conducted in the department of Agboville in order to highlight termite attacks and damage in fields.

2. Material and Methods

2.1 Study site

This study was carried out in peasant cassava fields located in the lower Ivory Coast, in the Department of Agboville, about 80 km from Abidjan (Figure 1). The climate of the Agboville region is of the Attiéen type and

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is characterized by 4 seasons (2 rainy seasons and 2 dry seasons) [24]. It is a very humid area where interannual rainfall is greater than 1500 mm [25]. Of medium fertility, these soils are rich in clay, silt and fine sand. The Agboville region is a predominantly agricultural area.

Export crops (cocoa, rubber, palm oil, sweet bananas) are grown there as well as food crops, the most important of which are plantains, cassava, yams and market garden crops.



Figure 1: Geographical location of the study area [26]

2.2 Sampling method

Sampling of termites was carried out according to an age gradient of cassava plots. Three (3) age classes were determined: young plots (0 to 3 months), middle-aged plots (3 to 8 months) and older plots (8 to 18 months). For each age group three plots of cassava of the traditional Manihot esculenta CRANTZ variety of 1 ha each were chosen, ie 9 plots in total. In each plot, 100 cassava plants are observed and prospected at the level of the organs (leaves, stem, crown). Observations focused on the state of health, signs of attack (galleries, earthenware, openings, etc.), the level of damage and the presence of termites. Ten (10) plants chosen from among the 100 were dug up and the underground part carefully observed (crown, fibrous roots and tuberous roots or tubers). All the dead plants were also dug up. The termites encountered on each plant were collected and stored in labeled pill boxes containing 70% alcohol and identified in the laboratory using a binocular magnifying glass and identification keys [27-31].

2.3 Identification of damage

The damage estimate is based on the density of veneers and termites, the depth of galleries at the level of different organs (stems, cuttings, roots) and the physiological state of the plant. Based on these criteria, three types of damage were identified.

- Type I (DI) damage: which is minor, negligible damage which does not affect the physiological condition of the plant (soil veneers without damage, shallow galleries, destruction of the outer bark of tubers, etc.).
- Type II damage (DII): this is major damage, likely to affect the physiological state of the plant (partial destruction of cuttings and stems)
- Type III damage (DIII): this is major damage, very severe which prevents the proper development of the plant and can lead to the death of the plant (total destruction of the cutting, stem or tuber).

2.4. Data analysis

The specific richness (S) of termites which corresponds to the total number of species recorded on cassava.

The termite attack rate which corresponds to the number of cassava plants attacked out of the total number of plants observed. It is calculated by the formula:

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T = \frac{\text{Nombre de plants attaqués}}{\text{Nombre total de plants observés}} \ge 100
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Analysis of variance: Analysis of variance is a statistical test for comparing means of several samples. In this study, the one-way analysis of variances (ANOVA, p < 0.05) was performed with Statistica software (version 7.1), then the homogeneous means were pooled using Newman-Keuls tests. This test made it possible to determine whether the

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attack rates were significantly different between the different environments studied.

3. Results

3.1. Species involved in the attacks

In total, 5 species of termites belonging to the Termitidae family were collected from the cassava plants. These are: *Ancistrotermes guineensis, Macrotermes bellicosus, Microtermes* sp, *Pseudacanthotermes militaris* and *Amitermes evuncifer* (Table I). Among these species, there are 4 fungi and a single xylophagus (*Amitermes evuncifer*);

Family	Sub family	Species	Trophic Group	
Termitidae Latreille	Macrotermitinae Kemner Termitinae Latreille	Ancistrotermes guineensis (Silvestri) Macrotermes bellicosus (Smeathman) Microtermes sp Pseudacanthotermes militaris (Hagen) Amitermes evuncifer (Silvestri)	C C C C X	
1	2	5	2	

Table 1. Termite	spacias	involved	in	attacks	in	cassava n	lote
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3.2. Termite attacks according to the age of cassava plots

Termite attacks on cassava are extensive and vary depending on the age of the cassava field. Young plots have the highest attack rate with 72.33 \pm 7.1%. They are followed by older plots. with an attack rate of 59.66 \pm 6.13%. The lowest attack rate was recorded in the middle-aged plots with 51.66 \pm 10.82%) (Figure 2). Analysis of variance (ANOVA; P < 0.001) indicates that there is no significant difference between the attack rates obtained in all the young cassava plots.

3.3. Termite attacks according to the organs

The termites attack on cassava relate to the cutting, stem and tuberous roots (tubers). However, regardless of the age of the cassava field, attacks on the cuttings remain the most severe. They represent 94%; 57.7% and 51.7% of attacks respectively in young, middle-aged and old plots (Table II). No termite attack on cassava leaves was observed in this study.



Figure 2: Termite attacks on cassava are extensive and vary depending on the age of the cassava field

Table II: Proportion of attacks according to the type of organ according to the age of the plots (in %)							
Type of organ	Young plots	Middle-aged plots	Aged plots				
Cutting	$94 \pm 1, 26$	$57, 7 \pm 3, 76$	$51, 7 \pm 5, 08$				
Rod	$6 \pm 0,35$	$27 \pm 9,41$	$30, 3 \pm 7, 33$	1			

 $15, 3 \pm 2, 13$

3.4. Termite damage in cassava plots

Tuberous root

Termite attacks on cassava cause extensive damage in the fields. The three types of damage were observed in each plot in varying proportions.

 0 ± 0

Type I damage is superficial (Figure 3). They are more abundant in the middle-aged plots and in the older plots with respective proportions of 62.7% and 47.4%. Young plots have the lowest type I damage rate (32%).

 $18 \pm 3, 37$

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Type II damage is severe (Figure 4). The highest proportions were recorded in young plots (41.6%) and older plots (35.6%). The middle-aged plots recorded the lowest proportion of type II damage (25.5%).

Type III damage is very severe damage that affects cassava production (Figure 5). Young plots (26.4%) recorded the highest proportion of this damage Middle-aged (11.8%) and old (17%) plots show low proportions.



Figure 3: Type I damage of termites in cassava plots (a: young; b: middle age; c: old)



Figure 4: Type II termite damage in cassava plots (a: young; b: middle age; c: elderly)



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Figure 5: Type III damage by termites in cassava plots (a: Young; b: middle age; c: elderly)

3.5. Methods of attacking termites pests of cassava

The mode of attack of cassava pest termites differs from one species to another (Figure 6)

-Ancistrotermes guineensis, the most aggressive species, attacks cassava stem and root cuttings. These termites attack cuttings from their ends in contact with the soil. They dig galleries inside the cuttings and empty their contents. As they move inside, they fill the cavity with dirt. Thus filled with soil, the cutting is gradually destroyed. Ancistrotermes guineensis attacks the tuberous roots by the outer bark, puncturing and destroying them completely. On the necks of the stems, in the old plots, these termites sometimes build veneers of earth under which we observe slight notches in the living bark.

-In *Microtermes sp*, the attacks are devious because they are completely underground. They are observed especially in young plots. Cuttings driven into the ground are attacked from their ends. They are dug and drained from the inside but are not filled with soil as in the case of the attack by *Ancistrotermes guineensis*. The plant wilts and

dies. They attack the tubers from the outer bark which they devour completely but do not get to the inside.

-Attacks by Macrotermes bellicosus and Pseudacanthotermes militaris are similar. They relate to cuttings in young plots and to stems in middle-aged and older plots. In young environment, these two species attack for a few days afterwards, the cuttings which have been planted in the ground. They cover the cuttings with large veneers of earth, in the shelter of which they puncture the bark and penetrate inside. In older plots, these termites build veneers of soil along the stem. The opening of these veneers shows a healthy organ. Attacks by Macrotermes bellicosus are also caused by the construction of overhead nests around cassava plants.

-In *Amitermes evuncifer*, the attacks in the young plots occur before the growth of the first nourishing roots and mainly concern the cuttings initially poorly planted and of poor quality (cuttings with dry bark). Attacks on *Amitermes evuncifer* are devious; they are done under cover, under the bark of the cutting, without any sign of termites outside. They gnaw the cutting and sometimes

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proceed to the stuffing of earth. These termites attack tubers which have previously been attacked by other pests (rodents, mites, fungi) which have altered their physiological state. They enter through openings made by previous attacks or puncture the damaged bark and get inside where they eat away at the parenchyma. Attack *by Amitermes evuncifer* shows a dark tinted biogenic structure, sometimes black.









Figure 6: Methods of attacking pest species (a: Ancistrotermes guineensis, b: Microtermes sp, c: Macrotermes bellicosus et Pseudacanthotermes militaris, d: Amitermes evuncifer)

4. Discussion

A total of 5 species of termites were collected from cassava plants in cultivated plots. They are: Ancistrotermes guineensis, Macrotermes bellicosus, Microtermes sp, Pseudacanthotermes militaris and Amitermes evuncifer. All of these listed species have been identified as being termites that damage crops in Côte d'Ivoire [32]; [17] [20], [21]. Other work has also identified termites as pests of cassava in Africa. Faye et al. (2014) [22] found the same number (5) of cassava pest species in cassava fields in Senegal. These species belong to the genera Macrotermes, Microtermes, Amitermes, Odontotermes and Psammotermes. A qualitative difference is noted by the presence of the genera Odontotermes and Psammotermes and by the absence of the genera Ancistrotermes and Pseudacanthermes.

In Malawi, several species of termites of the genus *Macrotermes, Microtermes* and *Odontotermes* have also been reported to be harmful to cassava. According to Peace (2006) [33], Macrotermitinae, such as *Macrotermes, Microtermes, Odontotermes* and *Ancistrotermes*, are among the most important genera that attack crops in Africa.

Termite attacks on cassava vary depending on the age of the plots. They are more important in the young plots (72.33%) than in the other plots. Sonko et *al.* (2019) [23] recorded an attack rate of 53.4% in young cassava plots (20 to 60 days old). Likewise, Atu (1993) [34] revealed that cassava termite attacks occur mainly on newly planted cuttings.

The importance of the attacks in the young plots could be explained by a poor recovery of the cuttings which are in a slow state of life when they are planted. Before the first roots sprout, the planted cutting uses its own nutrient reserves for its survival. When its reserves are exhausted and rooting is slow, the cutting dies and thus becomes a prime target for termites. The works of Frappa (1938) [35] confirm our observations. They reveal that termites cause

Volume 11 Issue 2, February 2022 <u>www.ijsr.net</u> Licensed Under Creative Commons Attribution CC BY extensive damage to cassava cuttings, especially when planting is not done in good time and the rains do not facilitate a rapid recovery. The attack rate in middle-aged plots is lower. This could be due to the maintenance of the plots by the peasants in order to allow the tuberization process which takes place during this period to run smoothly. According to Hauser et *al.* (2014) [36], weeds can stunt the growth and reduce the performance of cassava. Unlike middle-aged plots, older plots are no longer subject to maintenance. The development of the vegetation therefore leads to the invasion of termites which attack cassava plants, which would explain the high rate of attack in the old plots.

Regardless of age, the cutting remains the most damaged organ in cassava. This affinity could be justified by the high content of cellulose, the main source of food for many subterranean termites. Fungus growers represent 80% of cassava pest species. They attack cassava throughout its development cycle. The most aggressive are guineensis and Microtermes Ancistrotermes sp, responsible for the major damage likely to affect cassava production. The work of Sonko et al. (2019) [23] revealed the species Microtermes lepidus to be the most aggressive on cassava in cassava fields in Senegal. Tahiri et al. (2007) [17] in the same study region (Agboville) identified Ancistrotermes guineensis and Microtermes subhyalinus as the only species harmful to rubber cultivation. Iroko (1996) [37] also attests that Microtermes sp and Ancistrotermes guineensis still predominate in crop attacks. These underground species are considered by several authors to be the first species to destroy crops [38], [39], [18], [40], [18]. The importance of these two Fungus growers species in damage may be related to their diet and nesting locations. The low presence of Macrotermes bellicosus and Pseudacanthotermes militaris on cassava despite their abundance in the plots would indicate their low appetite for cassava. Wood-feeders plants are represented only by Amitermes evuncifer which has been identified as a rarely aggressive species. This species has only been observed on dead cassava plants. Which leads us to suppose that the action of Amitermes evuncifer is secondary. It only intervenes when the plant is already dead. This action is thought to be linked to the diet of the species, which consists of dead plants at different stages of decomposition.

The rate of major damage (DII and DIII) is higher in young plots than in other age groups. The work of Sonko et al. (2019) found a higher severity index in 40-day-old young plants (72%) than in one-year-old plants (1%). This sensitivity of young plants to attack could be explained by their fragility due to the fact that they still live under the reserves of cuttings due to their weak rooting.

5. Conclusion

This study, carried out in cassava fields in rural areas, identified 5 species of termites harmful to cassava. It has shown that cassava is strongly attacked by termites at all ages. However, young plants are more vulnerable to attack than older plants. At the young stage, 72% of attacks cause significant damage to cassava; which hamper the

proper development of the plant and are liable to considerably affects its production.

The Fungus growers *Ancistrotermes guineensis* and *Microtermes* sp have been shown to be the termite species most harmful to cassava. They are the cause of significant damage that affects the physiological state of the plant. To therefore improve cassava productivity in Côte d'Ivoire, termites must be taken into account in the development of the cassava technical route.

Thanks

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