



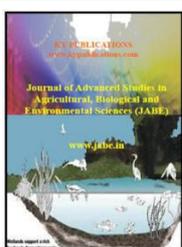
DAMAGE AND DYNAMICS OF *DIASTOCERA TRIFASCIATA* (COLEOPTERA: CERAMBYCIDAE) IN CASHEW ORCHARDS IN CENTRAL WEST (ZUENOULA: CÔTE D'IVOIRE).

N'DEPO O. R.^{1*}, TRA Bi C¹, BOYA Bi I¹. A. S, SORO S¹., SORO S¹.

¹Université Jean Lorougnon Guédé (Daloa), Laboratoire d'Amélioration de la Production Agricole, BP 150 Daloa (Côte d'Ivoire)

*Corresponding : osseyr_ndp@yahoo.fr

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ABSTRACT

The cashew crop is one of the cash crops of the northern region of the country. Unfortunately, this crop lodges a wide range of insect pests and diseases. Among these pests, *Diastocera trifasciata*, which causes the most damage in the orchard. This study was conducted in five orchards to describe and quantify the damage of *D. trifasciata* and monitor the dynamics of its population. Surveys were conducted in plots to assess the damage. The observations focused on the symptoms of insect attack in plantations. It appears that the damage is present in all the plantations visited. It is noted, a low attack rate in the Binzra 3 plantation with 46.67% of attacked trees and a high rate in the Binzra 4 plantation with 77.08% of trees attacked. The average attacked branches oscillates between 0.90 ± 0.09 and 2.30 ± 0.14 branches according to plantations with average diameters of severed branches ranging from 15.77 to 16.66 cm. The peak of outbreak is observed in January. This insect really threatens the cashew nut sector.

Key words: / Insects / cashew / *Diastocera trifasciata* / attack / damages /

Résumé

La culture d'anacarde est l'une des spéculations de rente de la région nord du pays. Malheureusement, cette culture héberge une large gamme d'insectes ravageurs et de maladies. Parmi ces ravageurs, figure *Diastocera trifasciata* qui occasionne le plus de dégâts en verger. Cette étude a été menée dans cinq plantations afin de décrire et quantifier les dégâts de *D. trifasciata* et suivre la dynamique de sa population. Des prospections ont été menées en parcelles pour évaluer les dégâts. Les observations ont porté sur les symptômes d'attaque de l'insecte dans plantations. Il ressort que les dégâts sont présents dans toutes les plantations visitées. On note, un faible taux d'attaque dans la plantation de Binzra 3 avec 46,67% d'arbre attaqués et un taux élevé dans la plantation de Binzra 4 avec 77,08% d'arbres attaqués. Le nombre moyen de branches attaquées oscille entre $0,90 \pm 0,09$ à $2,30 \pm 0,14$ branches selon les plantations avec des diamètres moyens de branches sectionnées allant de 15,77 et 16,66 cm. Le pic de pullulation s'observe en janvier. Cet insecte menace réellement la filière anacarde.

Mots clés : /Insectes/ anacardier/ *Diastocera trifasciata*/attaque/ dégâts/



1-Introduction

The cashew, *Anacardium occidentale* L. (Sapindales: Anacardiaceae), also called the brown gold, is a perennial plant cultivated approximately on an area of 7.5 million hectares distributed in 32 countries in the world in 2002. It is present in particularly in the tropics in America, Asia and Africa, where climatic conditions are favorable for its cultivation (FAO, 2002, Balogoun *et al.*, 2014). World cashew production is estimated at more than 2 million tons' (Djaha *et al.*, 2008). In Africa, this production is estimated at around 36% of world production of raw cashew nuts, of which 75% of raw nuts are exported mainly to India (Anonymous, 2012). In Côte d'Ivoire, the first cashew plantations started to the end of the 1950s in the hope of curbing the strong degradation of soils due to deforestation (Goujon *et al.*, 1973). Thus, this culture has developed spontaneously (Fig 1) so that Côte d'Ivoire occupies today, the first place in production of raw cashew nuts in front of India and Brazil (Afouda *et al.*, 2013, Balogoun *et al.*, 2014, Kouassi, 2017). But also the rank of the leading exporter of raw cashew (CNRA, 2012). Unfortunately, the yield of Ivorian orchards fluctuating between 350 and 500 kg / ha, remains low compared to India, Vietnam and Brazil whose production is reaching to 2 t / ha (Djaha *et al.*, 2010; Dandjinou, 2016). This situation is due to the use of non-improved plant material, still traditional production techniques and above all the persistence of phytosanitary problems, in particular the attacks of pests (Viana *et al.*, 2007). Cashew, like most arboreal crops, lodges a wide range of pests that infest its various parts (Asogwa *et al.*, 2011). Among these harmful insects the species *Diastocera trifasciata* Fabricius is present. This insect attacks directly the branches and / or stems of cashew trees (Adeigbe *et al.*, 2015, N'Depo *et al.*, 2017). However, there is very little information on the damage caused by *D. trifasciata* in cashew orchards in most of the country's production areas. The aims of this study is to evaluate the damage caused by *D. trifasciata* on cashew trees and to follow the fluctuation of its population in plantation.

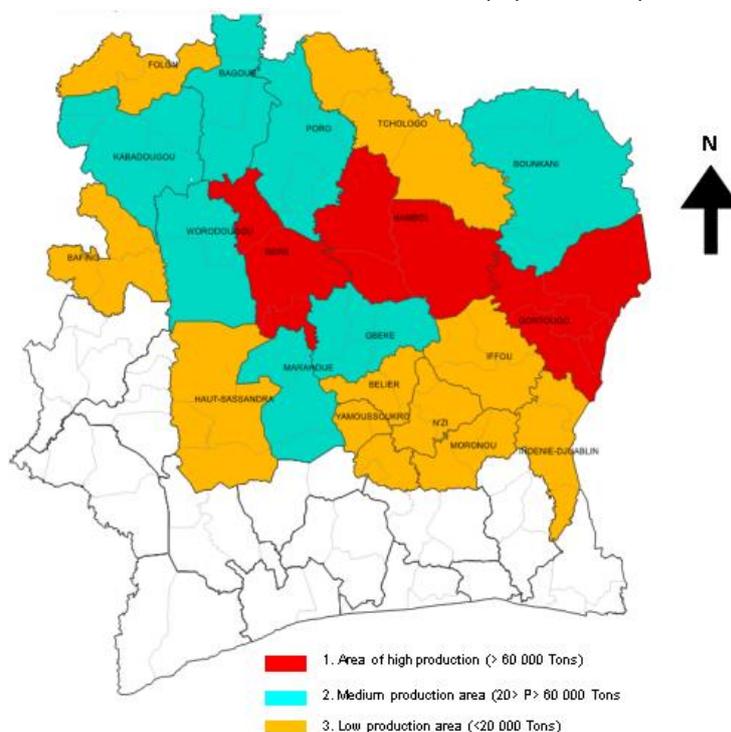


Fig 1: Production area of cashew in Côte d'Ivoire en 2015 (MINAGRI, 2017)

2- MATERIAL AND METHODS



2.1- Site of study

This study took place in plantations of Binzra and Gohifla located in Zuénoula locality. The town is located in the Marahoué region of West Central Côte d'Ivoire. Zuénoula is at 7 ° 30'0 "north latitude and 6 ° 0'0" west longitude. The climate is of baoulean type and characterized by two large seasons alternated by two small ones. The average annual rainfall is between 1800 and 2000 mm and the average annual temperature 25 to 30°C. Vegetation constituted of dense and wet forests and extensive savannah areas (Krikou, 2006). There are also food and cash crops such as cocoa and cashew (Uvicoci, 2018).

2.2- Material and methods

2.2.1- Choice and selection criteria for orchards

After a brief survey of some producers (60 people) cashew on the actual presence of the insect in the locality. Then five plantations were selected. There are four plantations in the village of Binzra and a plantation in the village of Gohifla. The criteria of selection orchard are the ease of access, sanitary maintenance, the distance between two orchard (1,5km) and the orchard superficies (2 to 3 ha). The plantations were codified Gohifla Binzra 1, Binzra 2, Binzra 3 and Binzra 4.

2.2.2- Sampling in orchards

Plantations at the different sites were visited twice a week for 60 days. At each visit, 20 trees were randomly selected from the plantations. The selected trees were prospected and marked with adhesive tape to avoid re-examination at the next visit. Twelve visits are recorded per plantation. In total, 240 trees sampled in each of the five orchards

2.2.3- Identification and assessment of damage in orchards

All attack symptoms of *D. trifasciata* on cashew trees were identified, described, and recorded. Severed branch were counted and measured. Cashew trees or attacked branches have the following characteristic marks:

- traces of superficial or deep incision on the structures of the plant;
- sawing the stem or branches;
- cut branches hanging;
- drop of severed branches.

2.2.4- Parameters measured in orchards

Each tree is prospected, looking for *D. trifasciata* or damage caused by it. The number of branches attacked and cut branches is counted at each tree to express the attack rate per plot. *D. trifasciata* population was recorded on all twenty trees sampled per visit to follow the population fluctuation. Diameter measurements were also made on the branches and stems cut using a tape measure from 1 cm of the cut edge.

2.2.5- Codification and damage assessment in orchards

Codes were assigned to the damage observed in the plantations and this according to the level of attack:

- D₀: Healthy trees;
- D₁: Attack but no sectioned branches;
- D₂: Number of attacked branches greater than number of severed branches;



- D₃: Number of attacked branches equal to number of severed branches;
- D₄: All branches are attacked.

As for the evaluation of the damage, it is determined on the basis of the ratio between the number of branches attacked and cut branches on number of branches per tree visited according to the following formula:

$$T\% = \frac{\text{Number of organs attacked}}{\text{Total organs observed}} \times 100$$

2.2.6- Statistical analysis of the data

The relative abundance of attacked trees, attacked branches, cut branches, and the circumference of cut branches at each site were subjected to an ANOVA at the 5% threshold using SPSS software (Version 20.0). The averages obtained are classified according to the Student Newman Keuls test.

3- RESUME AND DISCUSSION

3.1- RESULTS

3.1.1- Characteristics of the damage caused by *D. trifasciata*

D. trifasciata is a pest that saws branches and stems of cashew (Fig 2 a, 2b). The insect annihilates the branches or cashew stems by circling them, causing them to be slaughtered, to see death from the point of girdling (Fig 2c, 2d). Some ringed organs break at the point of girdling under the influence of the wind and remain attached to the tops of the cashew trees while others fall from the tree. The cutting of branches and stems by these beetles are so perfect that they are comparable to the action of a joiner's saw. In some cases, the strains of severed branches regenerate by producing disordered side shoots. Also the ragged cashew branch resists itself by producing a lot of gum exudate around the ringed portion (Fig 3), which hardens to heal the wound. The attacked or cut branches carry many scarifications (Fig 4). The formerly ringed branches have orifices covered with sawdust, of a light brown appearance. Some branches also have "rough" scratch marks made in places.

3.1.2- Assessment of damage caused by *D. trifasciata*

3.1.2.1- Orchard attack rate and relative abundance of attacked trees

The damage of *D. trifasciata*, has shown that the rate of attacked trees higher than more than 50% in most plantations. Binzra 3 recorded the lowest rate with 46.67% of attacked trees. The highest rates were observed at Binzra 1 with 65.42%, Gohifla (69.58%), Binzra 2 (71.67%) and Binzra 4 (77.08%) of attacked trees. The relative abundance of attacked trees in cashew orchards fluctuates between 0.47 ± 0.03 and 0.77 ± 0.03 trees. The highest values are observed at the Binzra 1, Gohifla, Binzra 2 and Binzra 4 sites. The analysis of variance reveals a highly significant difference ($P = 0.000$) between the average number of trees attacked (Fig 5).



Fig 2: Few damages of *Diastocera trifasciata* in cashew orchards

a: Branch of cashew cut by *D. trifasciata*, b: Cashew stem cut by *D. trifasciata*, c: Cashew branch cut by *D. trifasciata* and attached to the crown; d: Cashew stem ringed by *D. trifasciata*



Fig 3: Production of gum exudates after attack of the cashew tree by *D. trifasciata*



Fig 4: Scarifications caused by *D. trifasciata* on cashew branch

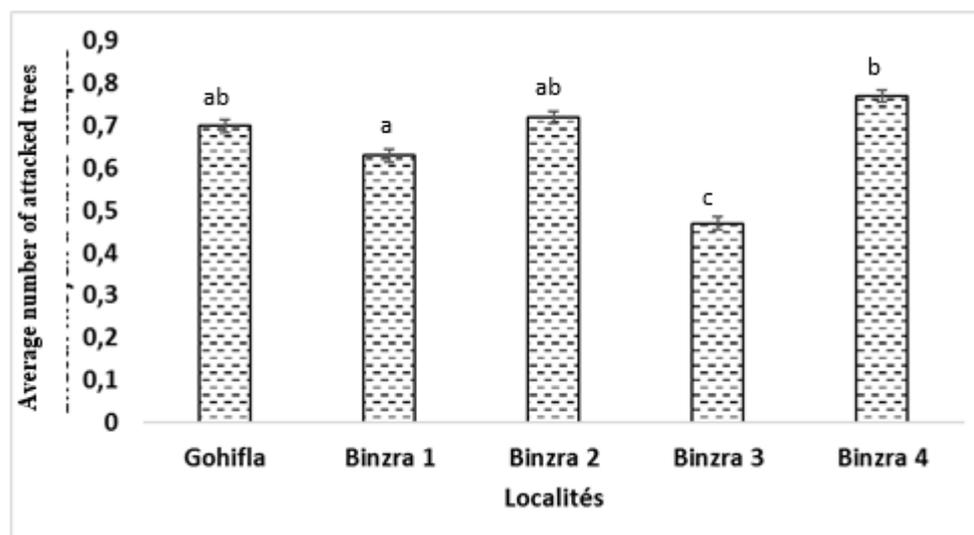


Fig 5: Average attacked trees by *D. trifasciata* on sites

ANOVA $\alpha=5\%$,

ddl = 4

F = 15.39

P = 0.000

Student Newman Keuls test: the averages affected by the same letter are statistically identical

3.1.2.2- Relative abundance of attacked branches in orchards

The average of attacked branches varies from 0.90 ± 0.09 to 2.82 ± 0.21 branches at the different sites (Fig 6). The average of branches most attacked is observed on Binzra 2 with 2.82 ± 0.2 branches, Binzra 4 and Gohifla with respectively 2.30 ± 0.14 branches and 2.24 ± 0.2 attacked branches, have a relatively equal number of attacked branches. In addition, Binzra 3 recorded the lowest value with 0.90 ± 0.09 attacked branch. The analysis of variance of the average of attacked branches between sites shows a highly significant difference ($p = 0.000$). The highest values of severed branches were observed to Gohifla, Binzra 2 and Binzra 4 with 1.71 ± 0.16 branches, 1.84 ± 0.15 branches and 1.81 ± 0.12 branches respectively. On the other hand, the weakest values were observed to Binzra 1 and Binzra 3 sites (Fig 6). Analysis of variance revealed a highly significant difference between the average of branches broken down by site ($p = 0.000$).

3.1.2.3- Circumference of the cut branches

The average circumferences of the cut branches vary from one site to another. At Gohifla, Binzra 1, Binzra 2 and Binzra 4, the observed average circumferences are greater than 15 cm. They are between 15.77 ± 5.24 and 16.66 ± 3.64 cm. The lowest average was observed at Binzra 3 with 13.29 ± 5.08 cm (Fig 7). The analysis of variance revealed a significant difference ($p = 0.04$) between the circumferences of the cut branches between sites.

3.1.2.4- Attacks Intensity

The attacks intensity was evaluated according to the types of damage caused by the insect on the trees in the sites. Of the 240 trees observed by planting, Gohifla, Binzra 1, Binzra 2 and Binzra 4 have the highest number of trees with D_4 damage with 166, 151, 172 and 185 affected trees respectively. Damage type D_2 is abundant in Gohifla (58 trees), Binzra 2 (92 trees) and Binzra 4 (63 trees). Damage type D_1 , although observed, are generally low on all sites. Those of the type D_3 are strongly marked in Gohifla, Binzra 1 and Binzra 4. As for the



type of damage D_0 , it is more observed in Binzra 1 where the number of healthy trees (123 trees) is the highest (Fig 8).

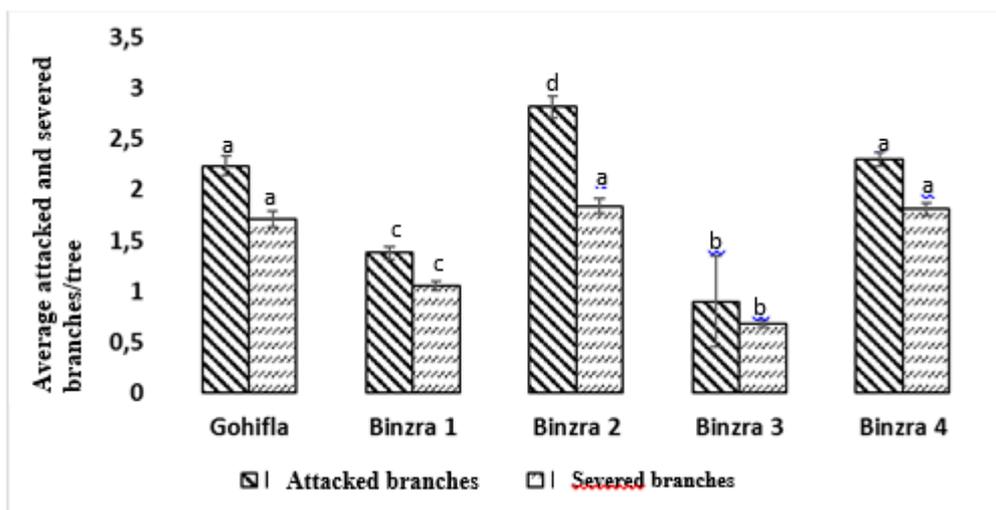


Fig 6: Average attacked and severed branches by *D. trifasciata* per sites

Attacked branches: ANOVA $\alpha=5\%$, $ddl = 4$ $F = 24,093$ $p = 0,000$

Severed branches: ANOVA $\alpha=5\%$, $ddl = 4$ $F = 18,049$ $p = 0,000$

Student Newman Keuls test: the averages affected by the same letter are statistically identical

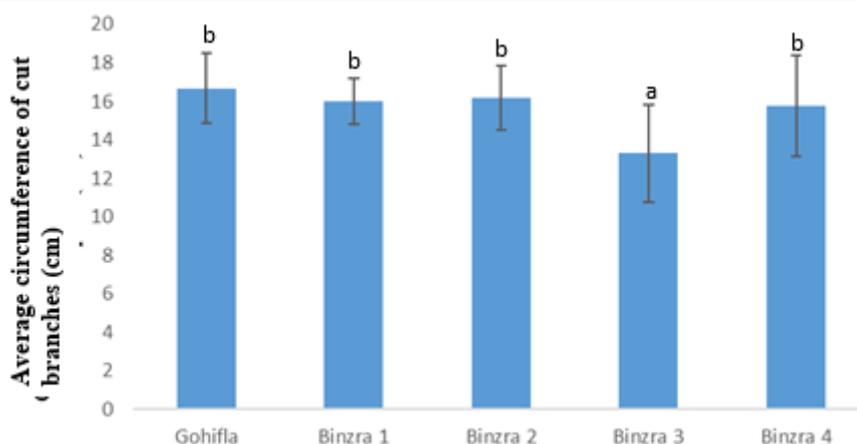


Fig 7: Average circumference of severed branches

ANOVA $\alpha = 5 \%$ $ddl = 4$ $F = 2,567$ $P = 0,040$

Student Newman Keuls test: the averages affected by the same letter are statistically identical

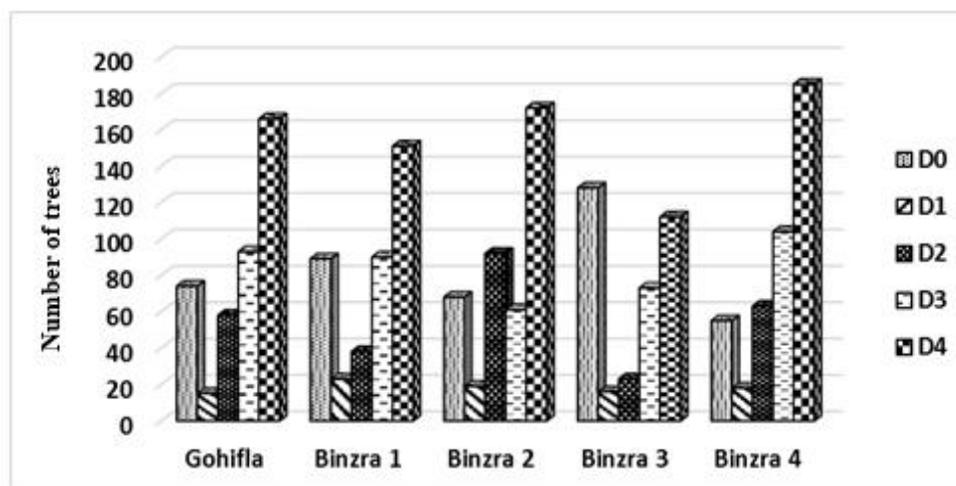


Fig 8: Number of trees according to the types of damage caused by *D. trifasciata*

D₀: Healthy trees; D₁: Attack but no severed branches; D₂: Number of attacked branches greater than number of severed branches; D₃: Number of attacked branches equal to number of branches cut, D₄: All trees are affected.

3.1.3- Fluctuation of *D. trifasciata* population

In general, the *D. trifasciata* population is practically sawtooth at the different sampling sites. Peaks of growth are observed between the 2nd and 3rd week. From the 4th week, the population level's declines at all sites and disappear plots at the 6th week (Fig 9).

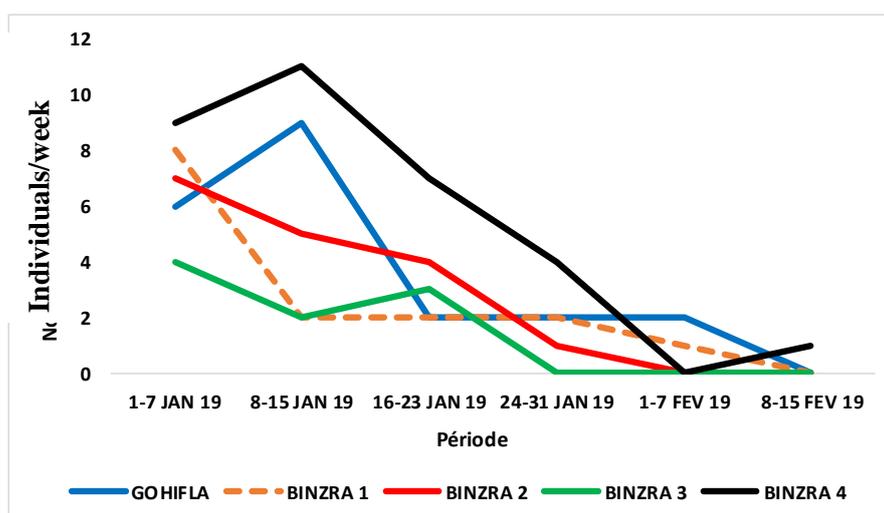


Fig 9: Population fluctuation of *D. trifasciata* in the different sites

3.2- DISCUSSION

The results of this study showed that *D. trifasciata* is a potential pest of the trunks and branches of cashew in Côte d'Ivoire. The results of this study are similar to those of N'Dépo *et al.* (2017); Siéla *et al.* (2017); Kra *et al.* (2017) who in their various works, have described this Cerambycidae and the trunk driller *Apate*



Tenebrans as potential pests of the cashew orchard in Côte d'Ivoire. An earlier report made by **Fabre & Brunck (1970)** on the incidence of *D. trifasciata* in the Center of the country revealed a colonization of this pest of cashew plots in the area of Bouaké. The appearance of this insect usually occurs at the beginning and end of the rainy seasons. This has also been confirmed by **Kra et al. (2017)** who speculate that this Cerambycidae disappeared during the dry season. According to these same authors, this insect has two appearances, the most important from September to December and the second least important from April to May in the area of Iffou in Central Côte d'Ivoire. The different population observed in the five plantations visited remains relatively low compared to those observed by **N'Dépo et al. (2017)** in the areas of Bounkani, Indénié-Djuablin and Gontougo (relative abundance: 03.5 ± 01.46 individuals). This difference is explained by the fact that the period from January to February corresponds to the dry season of the said locality, during which time these Cerambycidae disappeared from the plots (**Akessa et al., 2018**). **Niassy et al. (2011)** report that in Senegal, 10 adults of *D. trifasciata* can be observed on the baobab. According to **Asogwa et al. (2011)** Maximum infestations can reach 117 to 130 adults per plot from September to December in Nigeria. One of the most important periods of outbreak of this Cerambycidae in orchards, would be that which coincides with the period of inflorescence of the cashew tree according to the producers. The same observation was made by **Brunck and Fabre (1970)** who noticed massive appearances of the Coleoptere at the end of the short rainy season, a period coinciding with the flowering of the cashew trees. It is during this phenological stage of the cashew trees that the pest damages the maximum of branches and stems by annealing (**Tchibozo and Braet, 2004**). This good observation is due to a high rate of kairomones released by cashew trees during this phenological stage. The damage caused by this Beetle has also been reported in most cashew orchards in Zuénoula locality and elsewhere in Africa. This was the case in Nigeria where **Asogwa et al. (2011)** observed in 22 states out of 25, the symptoms attack of this Beetle in cashew orchards. The evaluation of the damage caused by the pest on each of the visited sites, reveals the different types of attack of this Cerambycidae in plantations. Indeed, it was found that the insect caused more damage to the plantation areas where the density is not respected. One of the reasons would be the high density of trees in this part of the plot, which would facilitate the movement of the insect from one tree to the other. This same observation was made by **Boya Bi (2017)** and **Siéla et al. (2017)**. This formidable pest is able to attack an average of 3 branches per tree and cut more than half or all. This finding was observed in Binzra 2 plantations with the highest average of attacked branches (2.82 ± 0.21 branches). In addition, we note the attack of 18 branches including 16 cut in plantation. Older trees are prone to attack. Thus, the largest damage has been reported in 25-year-old Gohifla plantations where the pest population is abundant. This same observation was made for the Binzra 1 and Binzra 3 sites, aged 15 years and more. **Fabre & Brunck (1970)** observed significant insect damage in cashew orchards four years and older. Fallen branches (types D_2 , D_3 and D_4) correspond to attacks for reproductive needs of the pest. This would explain the devastating (loss of many stems and branches) in some orchards. It should be noted that poorly maintained orchards and orchards with high tree densities would be breeding grounds for this Cerambycidae over time.

CONCLUSION

Damage assessment and population dynamics of *D. trifasciata* in cashew orchard showed that Cerambycidae is the main pest of cashew nuts in Côte d'Ivoire. The damage is materialized by the annelation followed by breakage of branches and stems of cashew and scarification. The attack rate was estimated at more than 50% in 4 of the 5 plantations studied. This attack rate is between 46.67 and 77.08%. The average size of affected branches fluctuates between 0.09 to 2.82 branches with an average circumference of cut



branches varying between 15.77 and 16.66 cm. Damage types D₄ are the most worrying at the Gohifla, Binzra 1, Binzra 2 and Binzra 4 sites.

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