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Impact of insect pests of female oil palm inflorescences on the quality of palm bunches and palm oil

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Abstract
Oil palm is a major cash crop for many countries. In fact, Côte d'Ivoire is the second largest African producer after Nigeria and the first African exporter. Despite this performance, the cultivation of this plant is limited by a variety of pests that strongly affect its production. These include leafminer *Coelaenomenodera lameensis*, defoliating caterpillars (*Latoia* spp), pests of the stipe of young palms (*Oryctes monoceros*), etc. and pests of female oil plam inflorescences. The latter destroys female inflorescences, which leads to malformation of many fruits, negatively impacting on the production of bunches. The objective of this work was to study the impact of female inflorescence pests on the quality of bunches and palm oil. The study was conducted at the CNRA research station in La Mé. The mosquito net placed on isolated female inflorescences allowed the capture and the identification of three main insect pests of female inflorescences of oil palm. These are the Curculionidae beetles *Prosoestus minor* and *Prosoestus sculptilis* and the Pyralidae lepidopteran *Elaeidiphylos adustalis*. These insects cause significant damage in palm groves, ranging from 60% to 70.98% of seeds damaged. Indeed, the large number of fruits damaged by these insects does not affect the quality of the oil produced because the acidity and fluidity of the oil remain within the quality standards. However, further biochemical studies are needed to elucidate real impact of these insects on the quality of the palm oil such such as fatty acid composition, β-carotene and vitamin E.

Keywords: Oil palm, female inflorescence, female inflorescences pests, incidence, bunch

1. Introduction
The cultivation of the oil palm *Elaeis guineensis* JACQUIN (1763) has been expanding rapidly over the past twenty years. This plant produces palm oil and palm kernel oil, respectively extracted from the pulp and the kernel of the fruit [1, 2]. With a production of 60 million tonnes of oil per year, including 54 million tonnes of palm oil and 6 million tonnes of palm kernel oil, oil palm is the world's leading oil crop and a strategic crop for many tropical countries [3]. In Côte d'Ivoire, oil palm covers an area of approximately 228,000 hectares, with 140,000 hectares of village plantations and 88,000 hectares of industrial plantations [4]. This allows the oil palm sector to occupy the 4th place in the Ivorian economy [5]. With 400,000 tonnes of crude palm oil produced per year, Côte d'Ivoire is the 5th largest producer in the world after Malaysia, Indonesia, Nigeria and Colombia, the 2nd largest African producer behind Nigeria and the 1st largest African exporter [20]. Thus, palm oil production represents 3.13% of the Ivorian Gross Domestic Product (GDP). These economic indicators highlight the importance of the oil palm value chain, which encompasses a long list of trades and businesses ranging from the cultivation of seedlings to the processing of crude oil and the manufacture of finished products. Oil palm therefore contributes to poverty reduction and ensures food security for the Ivorian population. The Ivorian market consumes 45% of national palm oil production, and the remaining 55% is destined for export, mainly to the West African Economic and Monetary Union (WAEMU) and Economic Community of West African States (ECOWAS) zones, which still have a large deficit. This palm oil deficit, which is estimated at around 500,000 tonnes in the WAEMU region and slightly more than 1,800,000 tonnes in (ECOWAS), could be due to a number of factors such as soil depletion, the effect of chemical applications on pollinators [7], the impact of insect pests [8, 9]. It is therefore in this context that this study was initiated with the general objective of investigating the impact of pests of female oil palm inflorescences on bunches quality. Specifically, it was intended to

- Inventory insect pests of female oil palm inflorescences;
- Evaluate the importance of the damage of female inflorescence pests on palm seed formation;
- Study the impact of inflorescence pests on the quality of oil palm.

2. Materials and Methods

2.1 Study site

The study was conducted at the National Agricultural Research Centre of La Mé (Latitude: 5° 26' N and Longitude: 3° 50' W). This station is located 30 km from the capital Abidjan, in the south-east of Côte d'Ivoire, in the lagoon region. The climate at this station is sub-equatorial, hot and humid, characterised by two rainy seasons and two dry seasons. The first dry season runs from December to April and the second dry season from August to September. The first rainy season occurs from May to July, and the second from October to November. The average annual rainfall is between 1,400 and 2,400 mm. This area benefits from a fairly high relative humidity (80 to 90%) and a more or less constant temperature (28 to 29°C) [10].

2.2 Experimental design

The experimental design used is a completely randomised design. The trials were carried out on Tenera hybrid palms trees of the C1001F category issued from Deli x La Mé breeding crosses. With four plots (E70, F50, I73 and A62) with 20 lines of 10 trees each and aged between 7 and 10 years were selected.

2.3 Monitoring the density of insect pests of female oil palm inflorescences

2.3.1 Collection and identification of insect pests of female inflorescences

In each of the 4 plots, ten (10) female inflorescences at the beginning of anthesis were randomly selected. These inflorescences were isolated by removing their spathes and troublesome palms. They were then enclosed with the mosquito net (Fig. 1). Daily monitoring was carried out and all insects on the mosquito net were collected at each flowering stage (starting, mid and ending stage) using a mouth aspirator. The collected insects were placed in boxes and identified in the laboratory with a binocular magnifying glass using the oil palm inflorescence insect collection available at this station.

2.3.2 Assessment of the abundance of insect pests on female inflorescences

The insect pests collected and identified on the inflorescences were then counted at each collection according to the flowering stage. This made it possible to assess their abundance according to these different flowering stages. Abundance was thus determined following formula (1):

(1) Abundance = $\Sigma ni/N$, ni: Number of individuals of species i, N : Total number of insect pests of female inflorescences collected.

2.4 Assessment the extent of damage of female inflorescence pests on palm bunch formation

The extent of insect damage to the quality of the palm bunches was determined using the following methodology. Four batches of each species of female inflorescence pests composed by fifty (50), one hundred (100), two hundred (200) and three hundred (300) insects were formed. For each batch, three female inflorescences were taken at random from each of the four (4) trial plots. A total of 12 female inflorescences for each batch of female inflorescence pests were selected. A control batch was made in each case. These insects were placed on these female inflorescences at the beginning of flowering according to the number of individuals per batch and per species, i.e. 48 female inflorescences at the beginning of anthesis used for this activity. These were then monitored monthly until the bunches ripened. Once ripe, these bunches were harvested and weighed to determine the average bunches weight (ABW) per batch and per pest species. The spikelets were separated from the stalk with a hatchet. From each bunch, fifty (50) spikelets were randomly selected. From these spikelets, the fruits were counted in order to evaluate the percentage of damaged fruits per lot and per species following formula (2) and formula (3):

(2) ABW = Total weight of palm bunches / Total number of palm bunches

(3) % Damaged fruit = (Number of damaged fruits / Total number of fruits) x 100

2.5 Assessment of the impact of female inflorescence pests on bunches and palm oil quality

The impact of female inflorescence pests on bunch palm and palm oil quality was determined according to four physico-chemical parameters. These were the percentage of fruit on bunches and the oil content on bunches according to the method of Noh *et al*. [11]. Using a hatchet, the bunches were destemmed by separating the spikelets from the rachis. This operation was carried out in individual boxes or cages. Using stainless steel knives, the fruits were completely separated from the spikes, taking care not to damage the fruit. At the end of the operation, the fruit and the rachis with the spikelets were weighed in order to evaluate the percentage of fruit on the bunches (% F/B). After the fruit removal stage, a sample of thirty (30) ripe fruits was taken and put into plastic bags. The fruits were then weighed on an electronic scale and pulped with a knife on a 3 mm thick hardened steel plate, separating the pulp from the nuts in order to evaluate the percentage of pulp on fruit (% P/F). The pulp obtained after shattering was then finely ground to a homogeneous micella. The micella was taken to a near infrared spectrometer to determine the percentage of oil on fresh pulp (O/FP). The oil content of the bunch was then determined following formula (4):

$$(4)\ OCB = (F/B \times P/F \times O/FP) \div 10000$$

Determination of acidity and fluidity (iodine value) was carried out by BRUKER NIR spectrometry with OPUSLAB software, 2015 [12].

2.6 Data analysis

All the results obtained were entered into an Excel spreadsheet. The SAS (Statistical Analysis System version 9.4) software was then used for statistical processing. A one-factor analysis of variance (ANOVA) was carried out on all the results obtained in order to determine the existence of statistically significant differences between the values of the averages calculated. Statistically significant differences were highlighted by the LSD Ficher test at the α threshold of 5%.

3. Results

3.1 Insect pests of female inflorescences surveyed

The results of the inventory revealed the presence of three main pests of oil palm inflorescences. These are:

- **Prosoestus minor Faust (Coleoptera : Curculionidae)**

The body length is 2.5-3.5 mm. The adult is brown in colour with a dark thorax and hard tips. On the head there is a rough punctation. The rostrum is approximately equal to the thorax. The prothorax is slightly wider, gradually narrowing from the base to the apex. The elytra are broadly rounded at the apex. The forewings are strongly striated with large, closely spaced dots (Figure 2A).

- ***Prosoestus sculptilis* (Coleoptera : Curculionidae)**

The body length is 4.5 mm. The adult is black, hairless above. The head has a dense punctation. The rostrum is much longer. Unlike the previous one, the prothorax is a little shorter. The sides are parallel behind, narrowed in a curve towards the front, with large dense punctation mixed with small dots. The elytra are equal to the thorax at the base and parallel. The striae are marked by large dots and the interstriae are very finely coriaceous (Figure 2B).

- ***Elaeidiphylos adustalis* Hampson (Lepidoptera: Pyralidae)**

The last larval stage insects are about 1.5 cm long. They are black-brown in colour, with the head slightly lighter than the rest of the body. They produce a cocoon and remain in the pre-pupal stage for about a week before entering pupation (Figure 2C).

3.2. Average number of pests on female inflorescences according to flowering stage

- ***Prosoestus minor***

The counting of *P. minor* individuals showed that this insect is more numerous on the inflorescences when they are in full anthesis. Thus, the number of *P. minor* was 139.65 ± 39.53 individuals in full anthesis. An average number of *P. minor* was observed at the beginning of anthesis (35.03 ± 11.69 individuals). The number of *P. minor* was low at the end of anthesis, with an average of 10.13 ± 1.62 individuals. The analysis of variance showed significant differences ($p< 0.05$) between the number of *P. minor* individuals at the different flowering stages of the oil palm (Fig. 3).

- ***Prosoestus sculptilis***

P. sculptilis was most numerous on female inflorescences when they were in full anthesis, with an average of 4.67 ± 1.13 individuals. The number of *P. sculptilis* was low at the beginning of anthesis and at the end of anthesis, with respectively 1.25 ± 0.35 and 0.50 ± 0.16 individuals. Analysis of variance showed significant differences ($p< 0.05$) between the number of *P. sculptilis* individuals at the different flowering stages of the oil palm (Fig. 4).

- ***Elaeidiphylos adustalis***

The average number of *E. adustalis* was identical in the four Mé plots, during the different flowering stages. Thus, the respective average number of *P. sculptilis* was 0.30 ± 0.25 individuals at the beginning of anthesis, 0.125 ± 0.06 individuals at full anthesis and 0.07 ± 0.05 individuals at the end of anthesis. The analysis of variance showed no significant difference ($p> 0.05$) between the number of *E. adustalis* individuals at the different flowering stages of the oil palm (Fig. 5).

3.3 Abundance of insect pests of inflorescences

In general, the species *P. minor* was more abundant in the plots with an average of 1848 ± 717.62 individuals. *P. sculptilis* was moderately abundant with an average of 63.50 ± 17.08 individuals. A low abundance of *E. adustalis* was observed in la Mé plots with an average of 5 ± 2.79 individuals (Table 1).

3.4 Impact of insect pests of female inflorescences on bunch formation

3.4.1 Description of damage caused by insect pests on female inflorescences

The presence of insect pests on the bunches results in the formation of many parthenocarpic fruits indicating a low fruit set rate (Fig. 6A). Some knotted fruits are clearly visible on the bunches (Fig. 6B). However, a long palm stalk is observed (Fig. 6C). Due to the malformation of many fruits (seeds), the spines appear very long (Fig. 6D).

3.4.2 Damage of *Prosoestus minor* on female inflorescences

The results of the evaluation of the infestation rate of la Mé study plots by *Prosoestus minor* revealed enormous damage caused by this insect. Indeed, the damage caused by this pest was higher in the different insect batches than in the control. Thus, the percentage of fruits damaged by this insect varied between 65.65 ± 5.62% and 69.62 ± 8.06% for the different batches of *P. minor*. These values are quite close. However, the percentage of damaged fruits was low in the control (23.05 ± 3.55%). The analysis showed significant differences ($p = 0.0001 < 0.05$) between the percentage of damaged fruit in the different lots of *P. minor* and the control (Table 2). The mean bunches weight varied from 10.99 ± 0.89 kg for the control to 7.64 ± 1.25 kg for the 300-member lot. The average bunch weight was higher in the control than in the different batches of *P. minor*. These values are statistically different p = 0.0168 < 0.05) (Table 2).

3.4.3 Damage of *Prosoestus sculptilis* on female inflorescences

The rate of fruit damage by *P. sculptilis* was high in the bunches with the different batches of *P. sculptilis* individuals, whereas in the control it was low. The percentage of damaged fruits in the different pest batches ranged from 62.77 ± 4.54% to 71.06 ± 4.50%. The percentage of damaged fruit in the control was 24.89 ± 4.40%. The analysis of variance showed significant differences ($p = 0.0001 < 0.05$) between the percentage of damaged fruit in the different batches of *P. suclptilis* individuals (Table 3).

The average weight of the bunches was high in the Control (12.75 ± 1.36 kg) compared to the batches of 50, 100, 200 and 300 *P. sculptilis* individuals with an average weight of 8.88 ± 0.85 kg, 7.75 ± 1.08 kg, 7.21 ± 0.45 kg and 7.81 ± 1.29 kg respectively (Table 3).

3.5 Impact of insect pests of female inflorescences on the physicochemical parameters of bunches

3.5.1 Impact of insect pests of female inflorescences on physical parameters of bunches

- **Percentage of fruit on bunch (%)**

The impact of *P. minor* on the percentage of fruit on the bunches varied significantly ($p = 0.04 < 0.05$) between the insect batches and the control (Table 4). It was less in the control and the batch of 50 individuals with a percentage of fruit on bunches of 54.19 ± 5.42% and 53.94 ± 1.70% of fruit not infested by this insect respectively. However, the batches of 100 and 200 individuals recorded average percentages of

45.56 ± 4.24% and 46.93 ± 7.06% of fruit not infested, respectively. The batch of 300 individuals recorded a low percentage of non-infested fruits on the diet which is 43.36 ± 3.16%.

With *P. sculptilis*, the percentage of fruits on bunches was high in the control with an average of 53.94 ± 1.69% of fruits not infested compared to the bunches with the different batches of the pest. The percentage of fruit on bunches in the different batches was average with batches of 100 and 200 individuals. The respective percentage of fruit on bunches was 41.54 ± 4.98% and 44.38 ± 4.18%. The lowest percentage of fruit on the diet was observed with the batch of 300 individuals (37.32 ± 11.57% of non-degraded fruit). These means are statistically different ($p = 0.039 < 0.05$) (Table 4).

- **Oil rate of bunch**

The impact of female inflorescence pests on the oil content of the bunch (OCB) is presented in Table 4. With respect to the different batches of insects, the OCB varied statistically ($p = 0.009 < 0.05$). The results show that for the pest *P. minor*, the OCB is high in the control and the batch of 50 individuals with a OCB of 22.83 ± 2.03% and 22.77 ± 4.93% respectively. However, in the batches of 100, 200 and 300 *P. minor* individuals, the OCB was low with values of 19.48 ± 2.43%, 19.70 ± 1.75% and 19.05 ± 2.21% respectively. The analysis of variance revealed significant differences ($p = 0.01 < 0.05$) between these different batches of insects and the control with regard to the oil content on the bunch (Table 4).

For *P. sculptilis*, the high OCB was determined in the control (22.27 ± 2.20%). The average OCB values were recorded with batches of 50 and 200 individuals with values of 19.58 ± 2.75% and 19.48 ± 2.43% respectively. However, low OCB values were observed with batches of 100 and 300 individuals with percentages of 18.87 ± 6.88% and 17.69 ± 2.54% (Table 4).

3.5.2 Impact of of insect pests of female inflorescences on the quality of the palm oil

- **Acidity**

Statistically significant differences at the 5% risk were revealed between the pest batches with respect to oil acidity (Table 5). The acidity of the extracted oil was high with the 200 and 300 *P. minor* batches at 5.72 ± 3.07% and 4.59 ± 1.33% respectively. However, the acidity was low in the control and the batches of 50 individuals with values of 1.03 ± 0.74% and 2.54 ± 0.95% respectively. The batch of 100 individuals also recorded an average percentage of 3.35 ± 1.11%.

Concerning *P. sculptilis*, a low acidity was observed in the control and the batch of 50 individuals with percentages of 1.81 ± 0.61% and 1.36 ± 0.06% respectively. The acidity observed with the batches of 200 and 300 individuals was high with values of 4.14 ± 1.61% and 5.07 ± 3.35% respectively. Significant differences ($p = 0.006 < 0.05$) were also observed between the batches (Table 5).

- **Oil fluidity or Iodine value**

Table 5 presents the impact of pests on the oil fluidity of the bunches. Statistical analyses indicated a clear variability between the means of the said parameter ($P < 0.05$) observable at the level of the insect batches. Thus, with *P. minor*, the iodine index was higher in the control (59.12 ± 0.39 g I_2/100g). It was average with batches of 50, 100 and 200 individuals (57.59 ± 1.16 g - 58.45 ± 0.75 g I_2/100g). The lowest iodine value was observed with the batch of 300 individuals (56.27 ± 0.03 g I_2/100g).

Also with *P. sculptilis*, the lowest iodine value was found with the batch of 300 individuals (56.27 ± 0.03 g I_2/100g). In contrast, it was high in the control (59.12 ± 0.39 g I_2/100g). The average indices were for with the batches of 50, 100 and 200 individuals of *P. sculptilis* for values of 58.45 ± 0.75 g I_2/100g, 58.33 ± 0.53 g I_2/100g and 57.59 ± 1.16 g I_2/100g respectively (Table 5).

4. Discussion

The results of the inventory revealed the presence of three main pests of female oil palm inflorescences. These are : *Prosoestus minor* Mshl (Coleoptera: Curculionidae), *Prosoestus sculptilis* Faust (Coleoptera: Curculionidae) and *Elaeidiphylos adustalis* Hampson (Lepidoptera: Pyralidae). Philippe [13] had reported the presence of these insect pests and their impact on female oil palm inflorescences in West Africa. The results obtained show that *P. minor* and *P. sculptilis* are more numerous on female inflorescences at full anthesis than at the beginning and end of anthesis. This high presence of pests could be explained by the fact that at this stage of flowering, the aniseed odour given off by the flowers is very strong, which would have attracted many pollinating insects and pests in search of food. According to Pouvreau [14], beetles also visit plants whose flowers are grouped in compact inflorescences, giving off a strong odour, as the nectar is easily accessible. Oil palms with this type of inflorescence are therefore attracted by these insect pests.

In general, *P. minor* was more abundant than *P. sculptilis* and *E. adustalis* in the plots. As *P. minor* is known in Côte d'Ivoire palm groves as the main pest of female inflorescences, this species would have a very high capacity to adapt to the oil palm environment, thus leading to its rapid multiplication in the plots. Indeed, according to Brodeur *et al.* [15] it is unlikely that species of any trophic level will acclimatise or adapt in the same way to anticipated changes.

Damage caused by *P. minor* and *P. sculptilis* is very high in the trials, regardless of species or batch of individuals compared to the control. The same is true for the average bunch weight, where the control was higher. Philipe [13] and Kouakou *et al.* [16] had indicated that *Prosoestus* spp lay their eggs on female flowers where the larvae feed and cause damage. In fact, the larvae destroy the stigmas or dig a gallery in the gynoecium of the female flower as they develop. This explains the high percentage of damaged fruits. In fact, Mariau [17] stated that these pests have an important influence on the development of future bunches, which can lead to a decrease in the rate of fruit set and consequently to a 50% decrease in oil palm production; this could be the reason for the low weight obtained as well as the low rate of oil on bunches recorded with batches of 100, 200, 300 individuals of these two pest species. It is then very easy to distinguish a very weakly or moderately attacked bunch from a heavily to very heavily infested bunch [17].

The impact of these pests on the quality of the oil produced was also carried out in this study. The acidity (free fatty acid content) of the oil from the diets degraded by the batch of 200 individuals of *P. minor* was high (5.72 ± 3.07%) above the recommended standard value of 5%. The same is true for *P. sculptilis*, where the acidity of the batch of 300 individuals was 5.07 ± 3.35. The high acidity of the palm oil leads to a poor quality of the oil. These insects are thought to have enzymes in their saliva capable of hydrolysing the triglycerides present in palm oil when they feed on oil palm inflorescences. Kouamé *et al.* [18] reported that mirids inject toxic saliva into the tissues of the cocoa tree when bitten, resulting in cell destruction over a large or small area. *Prosoestus* spp. are said to have such saliva capable of degrading the quality of the oil, thus increasing its acidity.

In this study, the fluidity of the oil produced (iodine value) varied from 56.27 g I2/100g to 58.45 g I2/100g for *P. minor* and from 56.27 g I2/100g to 58.41 g I2/100g for *P. sculptilis*. In comparison, these values are slightly higher than the palm oil of the improved plant material popularised in Côte d'Ivoire showing an average iodine value between 50 and 55 [19]. This means that the activity of these insects did not have a negative impact on the fluidity of the palm oil produced. In addition, the oil is fluid and therefore good for consumption.

Table 1: Abundance of inflorescence pests in the plots

Pests of female inflorescences	Average abundance
P. minor	1848,00 ± 717,62 A
P. sculptilis	63,50 ± 17,08 B
E. adustalis	5,00 ± 2,79 Cc

Means with the same letter in the same column are not significantly different at the 5% level.

Table 2: Effect of *P. minor* on bunch

P. minor	50 individuals	100 individuals	200 individuals	300 individuals	Control
Percentage of damaged fruit (%)	67,19 ± 6,38 a	68,71 ± 5,61 a	65,65 ± 5,62 a	69,62 ± 8,06 a	23,05 ± 3,55 b
Average weight of bunches (kg)	7,81 ± 1,22 bc	8,69 ± 0,90 b	9,16 ± 0,58 b	7,64 ± 1,25 c	10,99 ± 0,89 a

Means with the same letter on the same line are not significantly different at the 5% level.

Table 3: Effect of *P. sculptilis* on bunch

P. sculptilis	50 individuals	100 individuals	200 individuals	300 individuals	Control
Percentage of damaged fruit (%)	62,77 ± 4,54 a	64,34 ± 5,82 a	71,06 ± 4,50 a	70,98 ± 4,61 a	24,89 ± 4,40 b
Average weight of bunches (kg)	8,88 ± 0,85 ab	7,75 ± 1,08 c	7,21 ± 0,45 c	7,81 ± 1,29 c	12,75 ± 1,36 a

Means with the same letter on the same line are not significantly different at the 5% level.

Table 4: Impact of female inflorescence pests on bunch quality

Parameters	Species	Number of individuals per lot				
		50	100	200	300	Control
Percentage of fruit on bunch (%)	*P. minor*	53,94 ± 1,70 a	45,56 ± 4,24 b	46,93 ± 7,06 b	43,36 ± 3,16 c	54,19 ± 5,42 a
	P. sculptilis	44,34 ± 14,51 b	41,54 ± 4,98 b	44,38 ± 4,18 b	37,32 ± 11,57 c	53,94 ± 1,69 a
Oil content on bunch (%)	*P. minor*	22,77 ± 4,93 a	19,48 ± 2,43 b	19,70 ± 1,75 b	19,05 ± 2,21 b	22,83 ± 2,03 a
	P. sculptilis	19,58 ± 2,75 ab	18,87 ± 6,88 b	19,48 ± 2,43 ab	17,69 ± 2,54 b	22,27 ± 2,20 a

Means with the same letter on the same line are not significantly different at the 5% level.

Table 5: Impact of pests on palm oil quality

Parameters	Species	Number of individuals per lot				
		50	100	200	300	Control
Acidity (%)	*P. minor*	1,03 ± 0,74 c	3,35 ± 1,11 ab	5,72 ± 3,07 a	4,59 ± 1,33 a	2,54 ± 0,95 bc
	P. sculptilis	1,36 ± 0,06 c	2,54 ± 0,95 bc	4,14 ± 1,61 ab	5,07 ± 3,35 a	1,81 ± 0,61 c
Fluidity (g I_2/100g)	*P. minor*	58,45 ± 0,75 ab	58,33 ± 0,58 ab	57,59 ± 1,16 ab	56,27 ± 0,03 b	59,12 ± 0,39 a
	P. sculptilis	58,41 ± 0,53 a	57,93 ± 2,86 b	56,27 ± 0,03 b	57,80 ± 0,41 b	59,16 ± 0,42 a

Means with the same letter on the same line are not significantly different at the 5% level.

Fig 1: Trapping insect pests on female inflorescences; A. Isolation of a female inlorescence, B. Installation of the net, C. Capture of the insects.

Fig 2: Main insect pests of female oil palm inflorescences; A: Adult of *Prosoestus minor* (Coleoptera: Curculionidae), B: Adult of *Prosoestus sculptilis* (Coleoptera: Curculionidae), C: Caterpillar of *Elaeidiphylos adustalis* (Lepidoptera: Pyralidae).

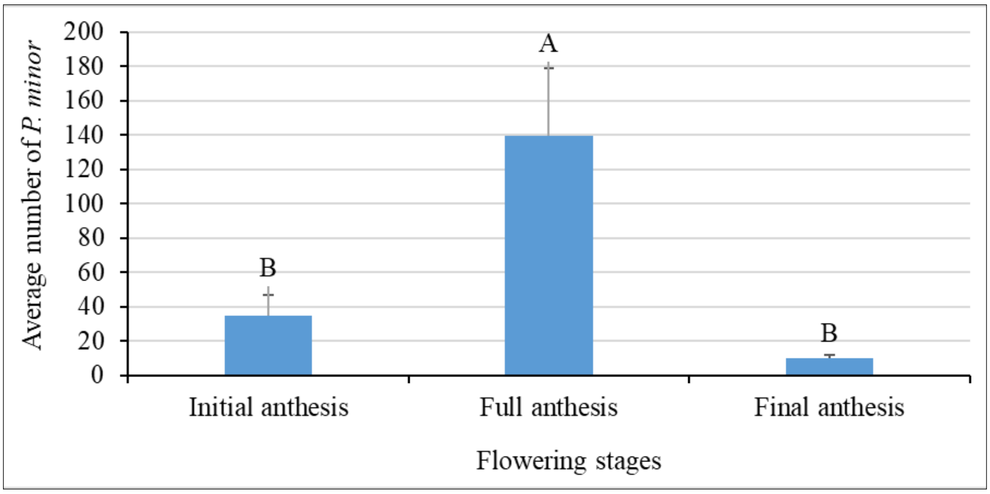

Fig 3: Variation of the average number of P. minor according to the flowering stage of the oil palm; Bars with the same letters are not significantly different (LSD, α = 0.05; p = 0.0004).

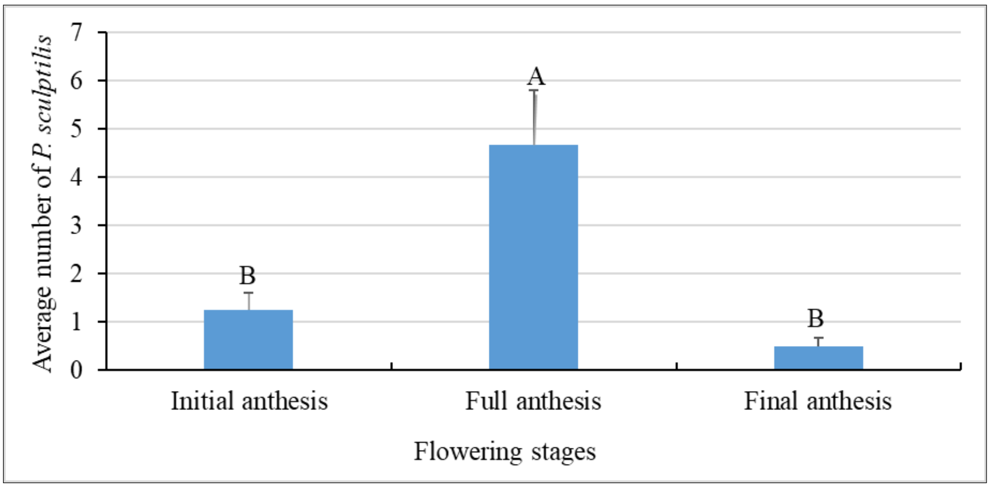

Fig 4: Evolution of the average number of *P. sculptilis* according to the flowering stage of the oil palm; Bars with the same letters are not significantly different (LSD, $\alpha = 0.05$; $p = 0.0001$).

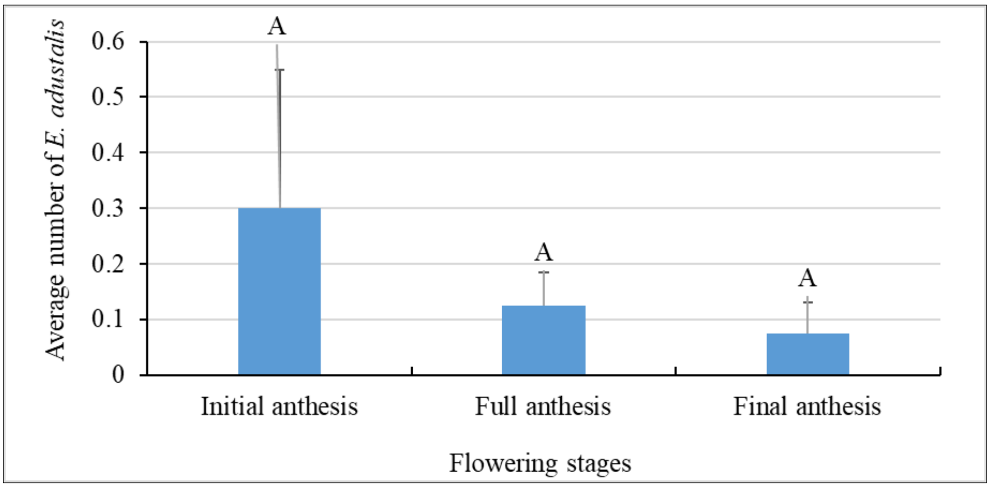

Fig 5: Evolution of the average number of Elaeidiphylos adustalis according to the flowering stage of the oil palm ; Bars with the same letters are not significantly different (LSD, $\alpha = 0.05$; $p = 0.0001$).

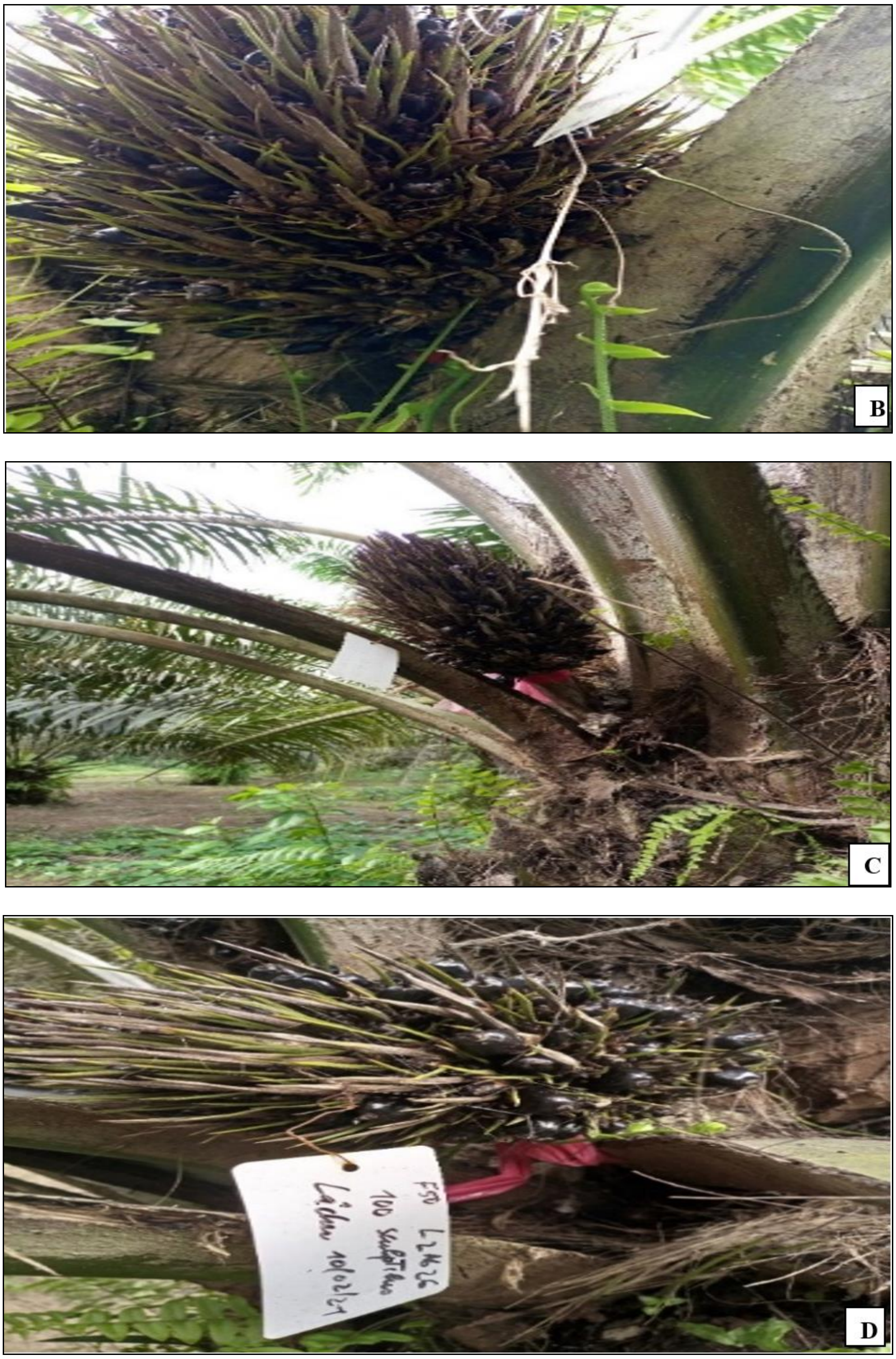

Fig 6: Damage caused by insect pests of female oil palm inflorescences, A : several parthenocarpic fruits on bunch, B : some knotted fruits on bunch, C : a long palm stalk, D : *ery long spines*

5. Conclusion

Three main pests of female oil palm inflorescences were identified in the palm groves of La Mé. These are *Prosoestus minor* Faust (Coleoptera: Curculionidae), *Prosoestus sculptilis* (Coleoptera: Curculionidae) and *Elaeidiphylos adustalis* Hampson (Lepidoptera: Pyralidae). These insects cause enormous damage to the bunches, showing a high number of damaged fruits which is reflected in the average weight of the bunches, the percentage of detached fruits and the oil content of the bunches. However, *Prosoestus minor* is more abundant than the others. The presence of these two pests resulted in an increase in oil acidity but did not affect the fluidity of the palm oil produced from the bunches. However, further biochemical studies are needed to elucidate real impact of these insects on the quality of the palm oil, such such as fatty acid composition, β-carotene and vitamin E.

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7. References

1. Jacquemard JC. Le palmier à huile. Le technicien de l'agriculture tropicale. Ed. Maisonneuve et Larose, Paris, 1995, 207.
2. ACMA. Production de l'huile de palme et de l'huile de palmiste. 2019; Fiche technique, Cotonou, Bénin. www.ifdc.org/acma-BENIN/.
3. Genetet A. Enjeux sanitaires et environnementaux de l'huile de palme. Les Notes Scientifiques de l'Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques (OPECST) Note n°7. 2018 Nov, 8.
4. Carrère R. Le palmier à huile en Afrique: le passé, le présent et le futur. Mouvement Mondial pour les Forêts Tropicales. Collection du WRM sur les plantations. 2010 Déc; actualisé en. 2013;15:69.
5. Anonyme. Le palmier à huile dans l'économie ivoirienne. http: //www.palmafrique.com/l hui l e-de-pal medans-leconomie-ivoirienne/#(visité le 15/09/2021) à 12h05mn, 2015.
6. Monde Aké Absalome, Cisse-Camara Massara, Bouberi-Niava Benitta, Koffi Konan Gervais, Ake Aké Alexandre, Yapo Aké Bénédicte, *et al*. Effects of palm oil consumption on Lipid and Lipoprotein profiles in a group of hypertensive patients at the Abidjan Heart Institute. Int J Adv. Biochem. Res. 2021;5(2):13-17. DOI: 10.33545/26174693.2021.v5.i2a.68
7. N'Guessan AH, Konan KJN, Kouassi AC, Allou K, Diabaté S. Comparative study of the effect of three chemical insecticides on oil palm pollinating insects. International Journal of Entomology Research. 2020;5(4):158-161.
8. Jacquemard JC. Le palmier à huile en plantation villageoise. Ed. Quae; CTA, 2013, 142.
9. N'Guessan AH, Kouassi NA, Konan KJN, Gogoue DO, Diabaté S, Niamketchi GL, *et al*. Effet de l'engrais organique biojadi sur les populations d'insectes visitant le palmier à huile. Agronomie Africaine. 2020;32(1):113-119.
10. Brou YT. Variabilité climatique, déforestation et dynamique agrodémographique en Côte d'Ivoire. Sécheresse. 2010;21(1e):1-6. Doi: 10.1684/sec.2010.0277.
11. Noh A, Rafii MY, Mohd Din A, Kushairi A, Norziha A. Variability and performance evaluation of introgressed Nigerian dura x Deli dura oil palm progenies. Genetics and Molecular Research. 2014;13(2):2426-37. Doi: 10.4238/2014.April.3.15.
12. Azeman NH, Yusof NA, Othman AI. Detection of free fatty acid in crude palm oil. Asian Journal of Chemistry. 2015;27:1569-1573. Doi: https://doi.org/10.14233/ajchem.2015.17810.
13. Philippe R. Etude de l'incidence des ravageurs sur les inflorescences femelles du palmierà huile en Afrique de l'Ouest. Oléagineux. 1993;48(10):389-403.
14. Pouvreau A. Les Coléoptères et les fleurs. Insectes. 1996;3(102):25-28.
15. Brodeur J, Boivin G, Bourgeois G, Cloutier C, Doyon J, Grenier P, *et al*. Impact des changements climatiques sur le synchronisme entre les ravageurs et leurs ennemis naturels : conséquences sur la lutte biologique en milieu agricole au Québec. Fonds vert, Québec, 2013, 99.
16. Kouakou M, Hala KA, Hala N, Dagnogo M. Efficacité de la pollinisation entomophile du palmier a huile dans les plantations du Sud-Ouest Et Du Sud-Est de la Côte d'Ivoire. European Scientific Journal. 2018;14(12):392-406. Doi: https://doi.org/10.19044/esj.2018.v14n12p392.
17. Mariau D. La faune du palmier à huile et du cocotier : Les lépidoptères et les hémiptères ainsi que leurs ennemis naturels. Montpellier : CIRAD, 2000, 97.
18. Kouamé N, N'Dri FK, N'guessan HA, N'guessan PW, N'guessan YT. Variations saisonnières des populations de mirides du cacaoyer dans la région du Haut-Sassandra en Côte d'Ivoire. Journal of Animal & Plant Sciences. 2015;25(1):3787-3798.
19. Koutou A, Cochard B, Durand-Gasselin T. Fluidité de l'huile produite par des arbres du second cycle de sélection récurrente réciproque chez le palmier à huile *(Elaeis guineensis* JACQ*)*. Agronomie Africaine. 2014;26(3):275-280.
20. Palmafrique. Le palmier à huile dans l'économie Ivoirienne. 2018. http://www.palmafrique.com/lhuile-de-palme-dans-leconomie-ivoirienne/. Visité le 06 Juin 2021.sss