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The effect of three plants aqueous extracts on feed intake and reproduction parameters of *Coelaenomenodera lameensis* Berti and Mariau (Coleoptera: Chrysomelidae) the pest of oil palm (*Elaeis guineensis* Jacq.)

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Key words: Aqueous extract of plants, *Coelaenomenodera lameensis*, *Elaeis guineensis*, feed intake, reproduction parameters

1 SUMMARY

Coelaenomenodera lameensis **is an insect and the major pest of the oil palm. Several methods have been employed in the fight against this pest like spraying insecticide on the palm leaflets, systemic insecticide injection in the trunk and biological control using ants of genus Oecophylla. Investigations were carried out at the agro-industrial unit of Toumanguié located in south-eastern Côte d'Ivoire. Aqueous extracts of *Ricinus communis* (**castor oil plant**) seed capsule, *Azadirachta indica* (**neem tree**) seed and *Zingiber officinale* (**ginger**) rhizome were applied in various concentrations on *C. lameensis.* Leaflets covered with sleeves of muslin were used as substrate for laying and feed intakeby *C. lameensis.* Two cases were considered. In the first case, the adults were placed on treated leaflets; in the second, the unit (insects and leaflets) were treated. Significant reduction rates of studied parameters, compared to controls, were obtained in second case with *R. communis* (0.8 g/ml) and *A. indica* (1.66.10 $^{-3}$ g/ml). Those were respectively 63 and 60% for the length of furrows, 76.31 and 77.78% for the number of laid eggs, 40.32 and 28.24% for the fertility of eggs, 15.24 and 8.33% for the emergence of adults.The aqueous extract of *A. indica* and *R. communis* could be used for integrated pest management against *C. lameensis* by reducing numbers of its eggs and adults.**

2 INTRODUCTION

Côte d'Ivoire is the eighth largest world producer of palm oil and the main African exporter (Boutin, 2007). The annual production of palm oil was estimated at more than 320,000 tons in 2007 (Boutin, 2007). The country contributes 60% of exports of the Economic Community of West African States (ECOWAS). Palm oil accounts for about 50 billion XOF (USD 100 million) of the gross domestic product of Côte d'Ivoire (Anonymous, 2008). The production of palm oil however, is insufficient with a deficit of 150,000 tons in the West African Monetary Union and 500,000 tons for the ECOWAS.

Unfortunately, the palm oil tree is susceptible to diseases, (viral infections, fungal infections, mineral deficiencies); and pests (rodents and insects) (Jacquemard, 1995). The insect that causes the greatest damage is *Coelaenomenodera lameensis* (Mariau, 2001; Koua, 2008). Leaf miner larvae feed on the parenchyma; they excavate galleries visible on the upper surface of the leaflets. Strong defoliation can lead to a yield decrease ranging from 30 to 50%, during 2 to 3 consecutive years, wrecking production (Mariau 2001; Appiah and Yawson, 2003). Many control methods are used to reduce populations of this pest: biological control, selection of resistant varieties and chemical control by means of terrestrial, air or systemic application (Mariau *et al.*, 1979; Philippe 1990; Yawson *et al.*, 2009; Coffi *et al.*, 2009; Niamouké *et al.*, 2011). Only chemical control can now maintain populations of this insect to a tolerable economic threshold by systematic injection of insecticides into the trunks of the palm trees (Mariau, 2001). A heavy and consistent use of pesticide pollutes the environment and can be harmful to human health. Problems generated by pesticides have stimulated the development of less polluting methods of pest control such as biological control using plant extracts (Philogène *et al.*, 2002). Tests on the use of plant based insecticides for pest control demonstrated good performance on many pest insects (Agarwal *et al.*, 2001; Riba *et al.*, 2003; Séri-Kouassi *et al.*, 2004; Adabie-Gomez *et al.*, 2006; Mollah and Islam, 2007). This study evaluates the efficiency of the aqueous extracts of three plants (*Ricinus communis, Zingiber officinale* and *Azadirachta indica*) on feed intake and some reproduction parameters of *C. lameensis*.

3 MATERIALS AND METHODS

3.1 Study area: The tests were carried out at the Toumanguié agro-industrial units (latitude: 050 15' N, and longitude: 030 56' W, at an altitude: 7 m above sea level) located 90 km from Abidjan, the economic capital of Côte d'Ivoire. This region has a wet, tropical climate with an annual temperature ranging from 24 to 28°C, a relative humidity between 79 and 90% and a 12:12 (L: D). Average annual rainfall varies between 1400 and 1800 mm. The area has two annual rainy seasons (from April to mid-July and September to November) and two dry seasons (from mid-July to August and December to March). The tests were conducted on 25 ha of land. The study took place from January 2010 to July 2010. It focused on palms tree of the "*Tenera*" variety that were 12 years old and had an average height of 5 m.

3.2 Preparation of aqueous extracts of plants:

3.2.1 Two groups of extracts were made: The first group was various concentrations of Suneem extract 1%, a commercial preparation. Suneem 1% is obtained from the seeds of *Azadirachta indica* A. Juss. The dilution of Suneem 1% (10 ml) in distilled water (1500 ml; 1000 ml; 500 ml; 100 ml and 50 ml) gave 5 concentrations of azadirachtin: $6.62.10^{-5}$ g/ml; $9.90.10^{-5}$ g/ml; $1.96.10^{-4}$ g/ml; $9.09.10^{-4}$ g/ml and $1.66.10^{-3}$ g/ml.

3.2.2 The second group was two extracts from components of two other plants; seed capsule of *R. communis* and rhizome of *Z. officinale.* These plant components were dried in an oven at 30°C for 48 to 96 hours and then crushed by a blender. For each plant, 100 g of powder obtained from the specified organ were mixed with 1 liter of distilled water, by magnetic agitation, for 48 hours. The mixture was filtered on Bûchner using paper Whatman (3 MM) and then evaporated with reduced pressure, at 50°C, by a rotary evaporator Buchi (Koua, 1998). Each dry residue was used to prepare one concentration of aqueous extract: 0.1g/ml; 0.2g/ml; 0.4g/ml; 0.6 g/ml and 0.8g/ml. The aqueous extracts were then applied to adult *C. lameensis* using a hand pulverizer that emitted a jet of 0.25ml per second. The device wet a leaf area (650 cm²) at a distance of 30 cm from the leaflet.

3.3 Effects of aqueous extracts on feed intake of *C. lameensis* adults: For each aqueous extract, two tests were performed on adult male and female *C. lameensis* aged 20 days.

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3.3.1 Test 1: Four lots, each containing 30 adults of *C. lameensis* were made: lot1a (male test) lot1b (control male) lot2a (female test) and lot2b (control females). Palm leaflets selected for the experiment were cut at their end to reduce their length to 20 cm from the spine to allow the muslin cloth sleeves completely cover the leaflets. A sleeve protected 6 leaflets i.e. 3 on both sides from the rachis of the palm. For each batch of insects, 30 sleeves were placed on trees at the distal ends of the palm. Each extract was sprayed once on the leaflets protected by a sleeve. A male or female insect was introduced into a corresponding sleeve immediately after spraying.

3.3.2 Test 2: Four lots of 80 adults were also made : lot3a (male test) lot3b (control male) lot4a (female test) and lot4b (control female). For each batch, 3 repetitions were made. An adult male or female was introduced into the corresponding sleeve. Twenty-four hours later, each extract was sprayed once on the insect and six leaflets protected by a sleeve, the period of 24 hours which allowed insects to adapt to the leaflets that are the source of feed. The lethal concentration (LC_{50}) caused death in 24 hours in 50% of the treated insect population. It was given for each extract of plant by Finney's method (1971). For both tests, the duration of stay of insects in the sleeves was 5 days. The average length of furrows (Ls) dug by the adults for feed was measured and expressed in centimetres. The average rate of reduction of the length of the furrows (Tr) by treatment insects was calculated relative to control.

$$Ls = \frac{\sum piri}{\sum ri}$$

pi: length of the furrows in the leaflets ; ri= number of adults

$$Tr = \frac{\sum xini}{\sum ni}$$

$$xi = \left(\frac{Nt - Ne}{Nt}\right) \times 100$$

Tr: The average rate of reduction; xi: The rate of reduction; ni: number of adults;
Nt: length of the furrows dug by the control insect;
Ne: length of the furrows dug by the insect after treatment

3.4 Effects of aqueous extracts on some reproduction parameters of *C. lameensis* adults: For each aqueous extract, two tests were performed on pairs of *C. lameensis* aged 20 days.

3.4.1 Test 1: Three batches, each comprising 30 pairs were formed: lot5a (couple test), lot5b (couple test) and lot5c (control couple). Thirty sleeves, corresponding to each batch of insects, were placed on the distal ends of the shafts as previously explained. Each extract was sprayed once on the leaflets protected by a sleeve. Couples lots 5a and 5b were introduced into the corresponding sleeves immediately after spraying. Eggs laid each day from 1st to 5th, visible on the upper sides were counted using a hand held magnifying glass.

3.4.2 Test 2: Three batches of 80 couples were also made lot6a (couple test), lot6b (couple test) and lot6c (control couple). Each couple was introduced into the corresponding sleeve. Twenty-four hours later, each extract was sprayed once on the couple and six leaflets protected by a sleeve, the period of 24 hours which allowed insects to accommodate the leaflets which are the source of feed and spawning substrate. The eggs laid daily, from 1st to the 5th day, visible on the upper sides were counted using a hand held magnifying glass. For each batches, 3 repetitions were made. For both tests, the length of stay of insects in the sleeves was 5 days. For lots 5a and 6a, the eggs laid were followed until adult emergence. The average rate of emergence of adults (Te) was calculated. Leaflets lots 5b and 6b were cut to determine the average fertility rate (*Tf*) of eggs.

$$Tf = \frac{\sum xini}{\sum ni}$$

$$xi = \frac{Number\ of\ hatched\ eggs}{Total\ number\ of\ laid\ eggs} \times 100$$

Tf: Average fertility of eggs; xi: fertility rate of eggs ; ni: number of sleeves

$$Te = \frac{\sum eifi}{\sum fi}$$

fi: Number of female parent

$$ei = \frac{Number\ of\ adult}{Number\ of\ egg\ laid} \times 100$$

4 RESULTS

The highest mortalities, the smallest lengths of furrows and the smallest values of reproduction parameters were obtained with the concentration of 1. 66.10 $^{-3}$ g/ml of *A. indica* seed and with those of 0.6 and 0.8 g/ml of *Z. officinale* rhizome and *R. communis* seed capsule.

4.1 Effects of aqueous extracts on feed intake of *C. Lameensis:* To feed, the adult of *C. lameensis* dig furrows in the leaflets. As the insect progresses, it consumes the portion of the limb that it scrapes. Thus, the amount of feed taken can be likened to the length of the furrows. It can be considered then that the reduction rate of the length of the furrows corresponds to the reduction rate of feed intake. The experiments relating to the feed intake were made with the survivors of the treated batches and the results were compared to control.**4.1.1 Adults introduced in sleeves after spraying extracts on the leaflets:** Out of a number of 30 adult males and females in contact with the aqueous extracts, no mortality was recorded during 5 days. The start digging furrows was noted on the second day (2.14 ± 1 day). The lengths of the furrows made by control males and females on the leaflets in sleeves were respectively 20.23 ± 1.51 and 23.96 ± 1.82 cm, during the 5 days (Table 1).

Table 1: Effects of aqueous extracts on feed intake of *C. lameensis* adults introduced in sleeves after spraying extracts on the leaflets

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Aqueous extract of plant	Concentration (g /ml)	Length average of the furrows (cm)		Reduction rate length of the furrows (%)	
		Male	Female	Male	Female
Zingiber officinale rhizome	0.1	18.94 ± 0.37 e	21.32 ± 0.74 b	6.37 ± 1.21 v	11.14 ± 1.56 t
	0.2	18.17 ± 0.67 e	20.15 ± 0.42 c	10.12 ± 3.15 u	15.80 ± 1.43 k
	0.4	17.69 ± 0.92 f	19.08 ± 0.41 d	12.45 ± 1.32 s	20.36 ± 2.89 m
	0.6	16.56 ± 0.89 g	18.11 ± 1.43 e	18.01 ± 2.43 o	24.43 ± 1.32 j
	0.8	15.88 ± 0.91 h	17.95 ± 1.12 ef	21.40 ± 1.75 l	25.18 ± 2.32 i
Ricinus communis seed capsule	0.1	17.21 ± 0.24 f	19.24 ± 0.88 d	14.82 ± 1.65 r	19.59 ± 1.10 n
	0.2	15.10 ± 0.81 hi	17.24 ± 1.15 f	25.25 ± 2.11 i	28.14 ± 1.88 g
	0.4	14.23 ± 0.75 i	16.29 ± 0.92 g	29.43 ± 1.95 f	32.11 ± 2.52 d
	0.6	12.14 ± 1.07 j	14.72 ± 0.96 i	40.04 ± 1,15 b	38.51 ± 1.16 c
	0.8	11.95 ± 0.97 j	13.98 ± 1.21 ij	40.72 ± 1.86 a	41.45 ± 2.68 a
Azadirachta indica seed	$6.62.10^{-5}$	18.15 ± 0.92 e	19.94 ± 1.17 d	10.18 ± 2.14 u	16.67 ± 1.78 p
	$9.90.10^{-5}$	17.33 ± 0.94 f	18.51 ± 0.89 e	14.23 ± 1.27 r	22.64 ± 2.90 k
	$1.96.10^{-4}$	16.26 ± 0.73 g	17.44 ± 1.05 f	19.52 ± 2.45 n	27.11 ± 1.43 h
	$9.09.10^{-4}$	15.64 ± 1.34 h	16.22 ± 0.82 g	22.48 ± 1.83 k	32.30 ± 1.24 e
	$1.66.10^{-3}$	14.28 ± 1.57 i	15.91 ± 0.73 h	29.60 ± 3.54 f	33.44 ± 2.84 d
Control		20.23 ± 1.51 c	23.96 ± 1.82 a	-	-

Test de Newman-Keuls au seuil de 5% ;
Length average of the furrows: F= 2450.26; ddl=31; p < 0,001.
Reduction rate length of the furrows: F= 2759.78; ddl=29; p < 0,001.
In every parameter, the averages followed by the different letters are significantly different.

Males dug furrows length ranging from 11.95 ± 0.97 cm (*R. communis* seed capsule) to 15.88 ± 0.91 cm (*Z. officinale* rhizome); the reduction rate of the length of furrows compared to the control ranged from 21.40 ± 1.75 and 40.72 ± 1.86 % (Table1). The length of the furrows by females in leaflets ranged from 13.98 ± 1.21 cm (*R. communis* seed capsule) to 17.95 ± 1.12 cm (*Z. officinale* rhizome), the reduction rate length of the furrows compared to the control ranged from 25.18 ± 2.32 and 41.45 ± 2.68 % (Table 1). Statistical analysis showed significant differences between the lengths of furrows made by insects after spraying (F = 2450.26, DF = 31, p <0.001) and the rate of reduction of the lengths of furrows (F = 2759.78, df = 29, p <0.001).

4.1.2 Adults introduced in sleeve**s before spraying extracts on the leaflets:** Out of a number of 80 males and 80 females adults introduced into the sleeves at the beginning of experiment, 48 ± 1, 46 ± 1 and 50 ± 2 died among the males and 48.66 ± 0.58, 43.33 ± 0.58 and 49.66 ± 0.58 among the females in presence respectively of the aqueous extracts of *A. indica* seed (1. 66.10^{-3} g/ml), Z. *officinale* rhizome (0.8 g/ml) and *R. communis* seed capsule (0.8 g/ml) (Figure 1, 2 and 3). For the adults aged 20 days, the lethal concentrations (LC_{50}) of azadirachtin were $9.16.10^{-4}$ g/ml (male) and $1.02.10^{-3}$ g/ml (female). For the other extracts, the lowest values were obtained with *R. communis* seed capsule (male: 0.41 g/ml; female: 0.48 g/ml), and the highest with *Z. officinale* rhizome (male: 0.57 g/ml; female: 0.65 g/ml). The observations related to the activity of the other survivor insects. Lengths of furrows by control male and female, during 5 days on the leaflets in the sleeves, were respectively 20.37 ± 1.36 and 23.76 ± 1.54 cm (Table 2). Males dug furrows ranging from 7.37 ± 0.79 cm (*R. communis* seed capsule) 8.64 ± 0.81 cm (*Z. officinale* rhizome), the rate of reduction of the length of the furrows compared to the control ranged from 57.38 ± 1.12 and 63.46 ± 1.93 % . The lengths of furrows by females in leaflets ranged from 8.59 ± 0.47 cm (*R. communis* seed capsule) to 9.62 ± 0.97 cm (*Z. officinale* rhizome), the reduction rate of the length of the furrows compared to the control ranged from 59.48 ± 1.35 and 63.38 ± 1.62% (Table 2). Statistical analysis revealed a significant difference between the lengths of furrows made by insects after spraying (F = 2566.24, df = 31, p <0.001) and the rate of reduction of the lengths of furrows (F = 2330.51, df = 29, p <0.001).

Table 2: Effects of aqueous extracts on feed intake of *C. lameensis* adults introduced in sleeves before spraying extracts on the leaflets

Aqueous extract of plant	Concentration (g /ml)	Length average of the furrows (cm)		Reduction rate length of the furrows (%)	
		Male	Female	Male	Female
Zingiber officinale rhizome	0.1	13.80 ± 0.84 d	14.29 ± 0.71 c	32.35 ± 1.46 w	39.75 ± 1.55 t
	0.2	12.97 ± 0.92 e	13.75 ± 0.27 d	36.42 ± 2.27 u	42.32 ± 1.86 q
	0.4	10.14 ± 0.77 g	11.31 ± 0.41 f	50.44 ± 1.92 l	52.29 ± 2.12 k
	0.6	8.99 ± 0.51 i	9.78 ± 0.82 h	55.85 ± 1.62 h	58.84 ± 1.05 e
	0.8	8.64 ± 0.81 i	9.62 ± 0.97 h	57.38 ± 1.12 f	59.48 ± 1.35 d
Ricinus communis seed capsule	0.1	11.91 ± 0.74 f	12.23 ± 0.53 e	41.64 ± 1.29 r	48.35 ± 1.46 o
	0.2	10.12 ± 0.88 g	11.16 ± 0.42 f	50.21 ± 1.25 l	53.12 ± 1.75 j
	0.4	9.34 ± 0.57 h	10.22 ± 0.88 g	54.26 ± 1.38 i	56.68 ± 1.92 g
	0.6	7.56 ± 0.47 i	8.85 ± 0.64 i	62.87 ± 1.24 b	62.77 ± 1.39 b
	0.8	7.37 ± 0.79 i	8.59 ± 0.47 i	63.46 ± 1.93 a	63.38 ± 1.62 a
Azadirachta indica seed	$6.62.10^{-5}$	13.11 ± 0.24 de	14.10 ± 0.85 c	35.54 ± 2.15 v	40.45 ± 1.27 s
	$9.90.10^{-5}$	12.97 ± 0.75 e	13.19 ± 0.72 de	36.62 ± 1.65 u	44.38 ± 1.46 p
	$1.96.10^{-4}$	11.27 ± 0.82 f	12.17 ± 0.49 e	44.47 ± 1.75 p	48.77 ± 1.12 o
	$9.09.10^{-4}$	9.12 ± 0.94 h	10.21 ± 0.39 g	55.31 ± 1.62 h	57.12 ± 2.18 f
	$1.66.10^{-3}$	8.34 ± 0.60 i	9.56 ± 0.43 h	60.77 ± 2.72 c	59.71 ± 1.13 d
Control		20.37 ±1.36 b	23.76 ± 1.54 a	-	-

Test de Newman-Keuls au seuil de 5%
Length average of the furrows: F= 2566.24; ddl=31; p < 0,001
Reduction rate length of the furrows: F= 2330.51; ddl=29; p < 0,001
In every parameter, the averages followed by the different letters are significantly different.

4.2 Effects of the aqueous extracts on some reproduction parameters of *C. lameensis*

4.2.1 Couples introduced after spraying extracts on the leaflets: Out of 30 couples of *C. lameensis* in contact with the aqueous extracts, no mortality was recorded during the 5 days. The first laying was observed between the second and third day with an average of 2.33 ± 0.74 days. The number of eggs laid by control females on leaflets in the sleeves was 24.13 ± 0.78 (Table 3).

Table 3: Effects of the aqueous extracts on the laying of C. *lameensis* couples introduced after and before spraying extracts on the leaflets

Aqueous	Concentration (g	Average number of eggs laid by the females

extract of plant	/ml)	Couples introduced after spraying extracts	Couples introduced before spraying extracts
Zingiber officinale rhizome	0.1	18.14 ± 0.83 b	16.29 ± 0.62 b
	0.2	17.92 ± 0.75 bc	15.22 ± 0.83 c
	0.4	16.13 ± 0.62 c	14.95 ± 0.69 d
	0.6	14.36 ± 0.72 d	13.36 ± 0.72 e
	0.8	14.12 ± 0.84 d	13.12 ± 0.65 e
Ricinus communis seed capsule	0.1	12.97 ± 0.37 e	8.97 ± 0.45 f
	0.2	12.23 ± 0.83 e	8.29 ± 0.37 fg
	0.4	10.92 ± 0.76 f	7.12 ± 0.86 g
	0.6	9.27 ± 0.74 h	5.57 ± 0.68 i
	0.8	9.10 ± 0.89 h	5.13 ± 0.84 i
Azadirachta indica seed	$6.62.10^{-5}$	12.77 ± 0.41 e	9.12 ± 0.77 f
	$9.90.10^{-5}$	11.26 ± 0.62 f	8.41 ± 0.67 fg
	$1.96.10^{-4}$	10.13 ± 0.47 g	7.29 ± 0.71 g
	$9.09.10^{-4}$	8.32 ± 0.81 i	6.31 ± 0.89 h
	$1.66.10^{-3}$	7.23 ± 0.77 j	5.10 ± 0.73 i
Control		24.13 ± 0.78 a	23.43 ± 0.68 a

Test de Newman-Keuls au seuil de 5% ;
Couples introduced after spraying extracts: F= 3122.50; ddl=15; p < 0,001
Couples introduced before spraying extracts: F= 2405.67; ddl=15; p < 0,001
In every treatment, the averages followed by the different letters are significantly different.

The number of eggs ranged from 7.23 ± 0.77 (*A. indica* seed) to 14.12 ± 0.84 (*Z. officinale* rhizome) (Table 3). The rate of reduction in the number of eggs compared to controls was 70.10 ± 3.14% (*A. indica* seed), 61.62 ± 2.55% (*R. communis* capsule) and 40.52 ± 1.49% (*Z. officinale* rhizome). Statistical analysis showed significant differences between the numbers of eggs laid by females on leaflets treated with the extracts (F = 3122.50, df = 15, p <0.001). Fertility rates were 85.13 ± 0.78, 36.12 ± 1.23, 53.27 ± 1.78 and 74.33 ± 2.77% respectively for the control, *A. indica* seed, *R. communis* seed capsule and *Z. officinale* rhizome. Statistical analysis indicated significant differences between the fertility of the eggs laid on the leaflets treated with the extracts (F = 2301.31, df = 15, p <0.001). Rates of adult emergence were 16.18 ± 1.25, 28.80 ± 2.29, 49.44 ± 1.80 and 66.84 ± 1.94% for eggs laid by females emerged from respectively leaflets treated with *A. indica* seed, *R. communis* capsule, *Z. officinale* rhizome and control leaflets.

4.2.2 Couples introduced before spraying extracts on the leaflets: Pairs of C *.lameensis* were introduced one day before spraying extracts. Out of 80 pairs introduced into the sleeves at the beginning of the experiment, 48.66 ± 0.58, 44 ± 1 and 48 ± 2 respectively, died in the presence of aqueous extracts of *A. indica* seed, *Z. officinale* rhizome and *R. communis* seed capsule. Comments focused on the activity of survivors insects. The first laying was observed between the 3rd and 4th day with an average of 3.33 ± 0.71 days. The number of eggs laid by control females was 23.43 ± 0.68 (Table 3). Those laid by females after spraying aqueous extracts ranged from 5.10 ± 0.73 eggs (*A. indica* seed) to 13.12 ± 0.65 eggs (*Z. officinale* rhizome) (Table 3). The reduction rates of the number of eggs compared to controls were 77.78 ± 2.21% (*A. indica* seed), 76.31 ± 3.11% (*R. communis* seed capsule) and 43.05 ± 1.95% (*Z. officinale* rhizome). Statistical analysis revealed significant differences between the numbers of eggs laid by females (F = 2405.67, df = 15, p <0.001). Fertility rates were 84.12 ± 0.48, 28.24 ± 1.35, 40.32 ± 1.34 and 63.42 ± 1.23% for the control, *A. indica* seed, *R. communis* seed capsule and *Z. officinale* rhizome. Statistical

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analysis showed significant differences between the fertility of the eggs laid on the leaflets treated with the extracts (F = 3421.57, df = 15, p <0.001). Rates of adult emergence were 8.33 ± 2.27, 15.24 ± 2.51, 42.37 ± 1.74 and 65.38 ± 1.15% for eggs laid by females emerged respectively from treated leaflets with *A. indica* seed, *R. communis* seed capsule, *Z. officinale* rhizome and control leaflets.

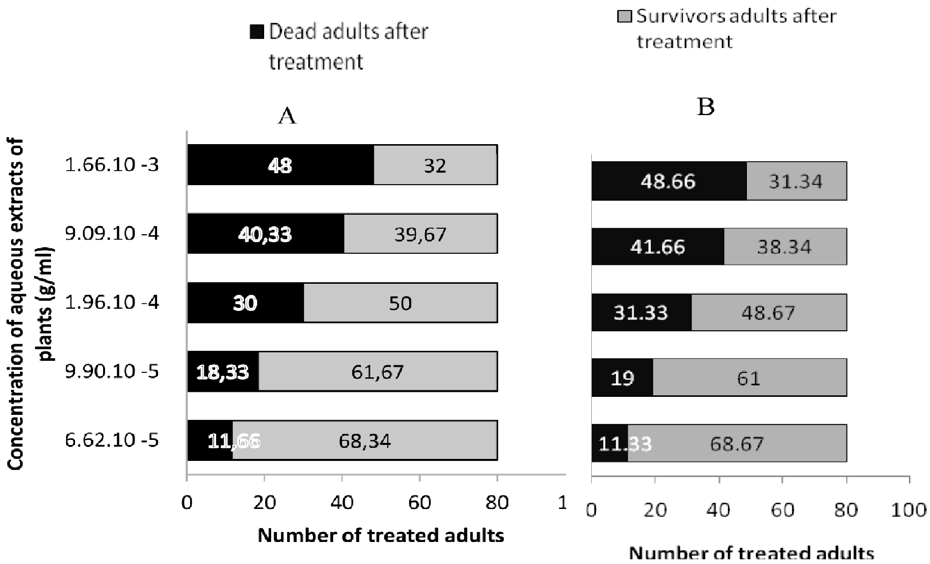

Figure 1: Mortality of adult males (A) and females (B) of *C. lameensis* at 24 hours after spraying the aqueous extract of *A. indica* seed

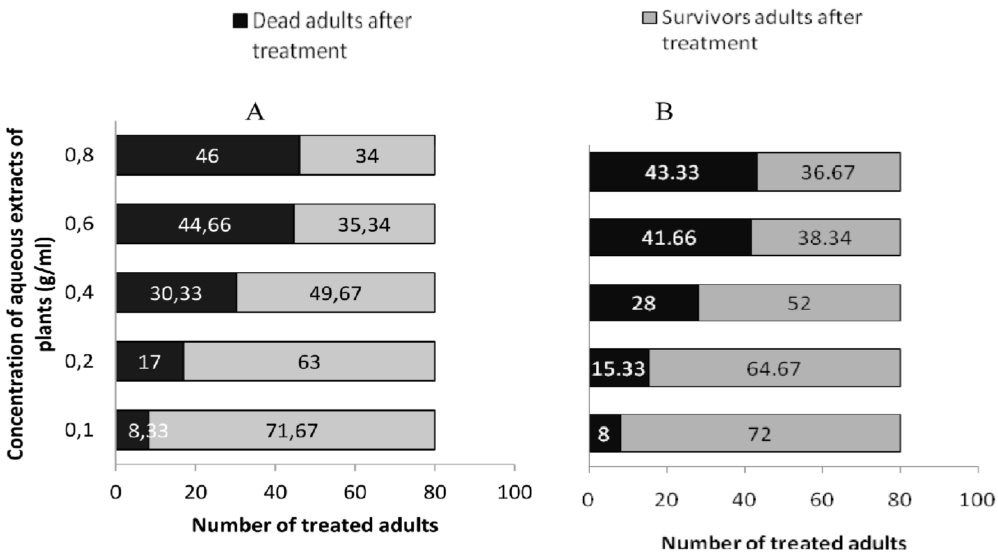

Figure 2: Mortality of adult males (A) and females (B) of *C. lameensis* at 24 hours after spraying the aqueous extract of *Z. officinale* rhizome

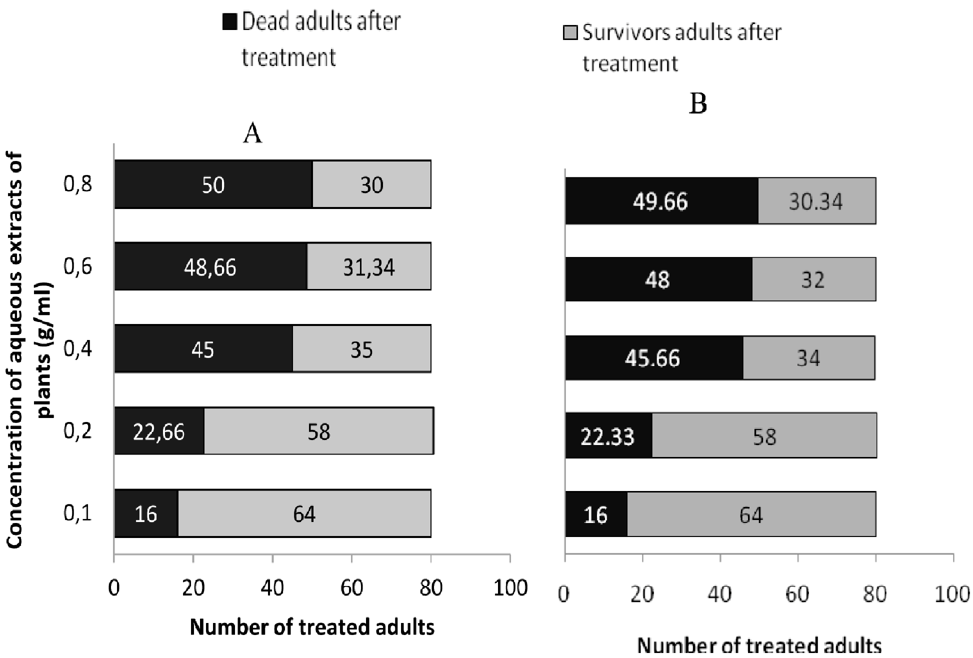

Figure 3: Mortality of adult males (A) and females (B) of *C. lameensis* at 24 hours after spraying the aqueous extract of *R. communis* seed capsule

5 DISCUSSION

Concerning the effect of plant extracts on feed intake of *C. lameensis*, two cases were considered. In the first case, the adults were placed on treated leaflets and the highest reduction rate of the length of furrows rates were 40.72% for males and 41.45% for females. In the second case, the unit (insects and leaflets) was treated, the highest reduction rate of the length of the furrows were 63% for males as well as females. In the first case insects were confronted with the antifeedant aqueous extract of *R. communis* seed capsule. In the second case the insects were subjected to two tests. First, insects had to mobilize energy to overcome the shock of the topical effect of the aqueous extract, and then they got down to solving the problem related to the antifeedant caused by the spray (Séri-Kouassi *et al.* 2004). The antifeedant extract of *R. communis* capsule is related to the chemical characteristics of one of its main components: ricin. According to Darby *et al.* (2001), this substance is an alkaloid, which gives a bitter taste in the insect. This causes a rejection of feed by the insect. The antifeedant induced by azadirachtin is linked to the determination of this molecule on the taste receptors in the taste buds of the insect, causing the rejection of any one feed (Asogwa *et al.*, 2010). This noxious effect of azadirachtin has been demonstrated by several studies on many pests including the southern green stink bug *Nezara viridula* L. (Hemiptera: Pentatomidae) (Riba *et al.*, 2003), the cabbage moth *Mamestra brassicae* L. (Lepidoptera: Noctuidae) (Seljâsen and Meadow, 2006) and the cocoa capsid *Sahlbergella singularis* Haglund (Homoptera: Miridae) (Asogwa *et al.*, 2010). Feeding deterrent effects were observed on other insects with plant extracts including those of the genus *Allium* that perturb the feed intake of *Epilachna varivestis* Mulsant (Coleoptera: Coccinellidae) (Thibout et Auger, 1997). Extracts of garlic (*Allium sativum* L.) and onion (*Allium cepa* L.) also perturb the maintaining of the aphid *Myzus pericae* Sulzer (Hemiptera: Aphididae) on its host plant and preventing insect feeding, resulting in its death (Hori, 1996). The contact of the insect with the aqueous extracts could cause inhibition of feed intake by the penetration of active insecticides substances through the cuticle and the stigma of the insect. This argument was raised by Tahiri *et al.* (2010) studying the toxicity and the mode of action of *Carica papaya* L. extracts (Caricaceae) on *Macrotermes bellicosus* Smeathman (Isoptera: Macrotermitidae). The digging of the furrows for nutrition had begun on the 2nd day of releasing the insects on treated leaflets reflecting the repellent effect of plant extracts. A similar observation was made by Trematerra and Lanzotti (1999) reported that the repellent effect of plants of the genus *Allium* on three species of beetles (*Oryzaephilus surinamensis L.*, *Sitophilus oryzae* L. and *Tribolium castaneum* Herbst) of stored feed. Thus, Tounou *et al.* (2011) showed a repellent effect of the seed extract *R. communis* on a cabbage pests *Plutella xylostella L.* (Lepidoptera: Plutellidae). The effectiveness of *A. indica* seed and *R. communis* seed capsule was confirmed by the lowest LC_{50}. The insecticidal effect of *R. communis,* was also demonstrated by Adabie-Gomez *et al.*, (2006) in a study that reported that the powder of the leaves of *R. communis*, with concentration of 0.2 g/ml, added with the corn grain involved an inhibition of the emergence of adult insects at rates of 96.08% (*Callosobruchus maculatus* F.) and 60% (*Sitophilus zeamais* Motschulsky). As regards the effects of aqueous extracts of plant on insect reproduction, those of *Z. officinale rhizome*, *R. communis* capsule and *A. indica* seed resulted in a significant reduction in the average number of eggs laid by females of *C. lameeensis* with respective rates of 40.52, 61.62 and 70.10% when females were dropped on treated leaflets. The reduction rate of in the average number of eggs laid was 43.05, 76.31 and 77.78% respectively for *Z. officinale* rhizome, *R. communis* capsule and *A. indica* seed when the extracts were sprayed on the unit (insect and leaflet). This decrease in the average number of eggs compared to the control could be linked to the action of the active component of the aqueous extracts. Similar results were obtained by Bruce *et al.* (2004), who reported that the application of *A. indica* oil causes a reduction ratio of the number of eggs laid by females of *Eldana saccharina* Walker (Lepidoptera: Pyralidae) and *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae) respectively 49 and 88% compared to control females. Séri-Kouassi *et al.* (2004) and Aboua *et al.* (2010) reported a decrease in the number of eggs laid by females of *C. maculatus* treated with essential oils of plants (*Ageratum conyzoides*, *Citrus aurantifolia* and *Melaleuca quinquenervia*). According to Tounou *et al.* (2011), *Plutella xylostella* females laid fewer eggs on cabbage treated with castor oil as cabbage control. The first eggs have been laid by females on treated leaflets between the second and third day after treatment. This behaviour reflects the inhibitory effect of aqueous extracts on the female oviposition. This hypothesis is similar to that of Agboka *et al.* (2009) that reported that inhibition of oviposition of *Mussidia nigrivenella* Ragonot (Lepidoptera: Pyralidae) by extracts of *A. indica*, *Jatropha curcas* and *Hyptis suaveolens* at respective concentrations of 5, 5 and 20%. The inhibition of oviposition by aqueous extracts is linked to the control of ovarian vitellogenetic activity by juvenile hormone. In fact, its secretion by the corpora allata is subject to dual control by excitatory of allatotrop neurohormone and inhibitor allatostatic neurohormone (Cassier *et al.*, 1997). The treatment of the unit (insect and leaflet) would cause a blockage followed by a slow recovery of the eggs laying by reducing the secretion of the oviposition stimulation: hormone after activation of the corpora allata (Cassier *et al.*, 1997). This argument is consolidated by that of Schmidt *et al.* (1991). For these authors, the vapours of *Acorus calamus* oil cause ovarian changes similar to those caused by chemosterilisants or the compounds based on juvenile hormone. This explains a blockage in the issuance of eggs per female *C. maculatus*. This hypothesis was also issued by Huignard *et al.* (2002). According to these authors, a sub-lethal concentration of *Cymbopogon schoenanthus* oil (0.5 µl/L) leads to a reduction in the number of eggs in treated females of *Dinarmus basalis* Rondani.

6 CONCLUSION

The analysis of the impact of aqueous extracts on feed intake showed that *A. indica* seed and *R. Communis* seed capsule induced the highest reduction rate of length of the furrows. Those varied 33.44 and 41.45% when the leaflet alone was treated and, 60.77 to 63.46% when the unit (insects and leaflets) was treated. The aqueous extracts of *Z. officinale* rhizome, *R. communis* seed capsule and *A. indica* seed involved a significant reduction of the average number of eggs laid by the females of *C. lameensis,* with respective rates of 40.52, 61.62 and 70.10% when the females were released on treated leaflets. The aqueous extracts significantly influenced the laying of the females of *C. lameensis*. Reduction rates of the number of laid eggs, slightly higher (43.05 to 77.78%), were obtained when the unit (insect and leaflet) was treated. The lowest fertility rates of eggs (28.24 and 40.32 %) and those of emergence of adults (8.33 and 15.24%) were respectively obtained with extract of *A. indica* seed and *R. communis* seed capsule. The aqueous extract of *A. indica* seed and *R. communis* seed capsule could be used to control *C. lameensis* by reducing respective numbers of its eggs and adults.

7 REFERENCES

Aboua LRN, Séri-Kouassi BP. and Koua KH: 2010. Insecticidal activity of essential oils from three aromatic plants on Callosobruchus maculatus F. in Côte d'Ivoire. European journal of scientific research 39 (2): 243-250.

Adabie-Gomez AD, Monford KG, Agyir-Yawson, Owusu-Biney and Osae M: 2006. Evaluation of four local plant species for insecticidal activity against Sitophilus zeamais Motsch. (Coleoptera: Curculionidae) and Callosobruchus maculatus (F) (Coleoptera: Bruchidae). Ghana Journal of Agricultural Science, 39 (2): 147-154.

Agarwal M, Walia S, Dhingra S. and Khambay BPS: 2001. Insect growth inhibition, antifeedant and antifungal activity of compounds isolated/derived from Zingiber officinale Roscoe (ginger) rhizomes. Wiley Chichester, 57 (3): 289-300.

Agboka K, Agbodzavu KM, Tamò M. and Vidal S: 2009. Effects of plant extracts and oil emulsions on the maize cob borer Mussidia nigrivenella (Lepidoptera: Pyralidae) in laboratory and field experiments. International Journal of Tropical Insect Science, 29:185-194.

Anonymous: 2008. La situation de la filière palmier en Côte d'Ivoire. www.FENACOPAHCI.org . Accessed 12 December 2008.

Appiah SO and Yawson GK: 2003. Phytosanitary surveillance/monitoring report in the Benso Oil Palm Plantation Ltd. Oil Palm Research Institute Technical Report, 1- 9.

Asogwa EU, Ndubuaku TCN, Ugwu JA. and Awe OO: 2010. Prospects of botanical pesticides from neem, Azadirachta indica for routine protection of cocoa farms against the brown cocoa mirid Sahlbergella singularis in Nigeria. Journal of Medicinal Plants Research, 4: 1-6.

Boutin D: 2007. Le palmier à huile. CIRAD, 29 p.

Bruce YA, Gounou S, Chabi-Olaye A, Smith H. and Schulthess F: 2004. The effect of neem (Azadirachta indica A. Juss) oil on oviposition, development and reproductive potentials of Sesamia calamistis Hampson (Lepidoptera: Noctuidae) and Eldana saccharina Walker (Lepidoptera: Pyralidae). Agricultural and Forest Entomology, 6: 1–10.

Cassier P, Lafont R, Descamps M, Porchet M. et Soyez D: 1997. Les insectes. In: La reproduction des invertébrés. Stratégies, modalités et régulation. Intérêt fondamental et appliqué. Ed. Masson, Paris, 193-268.

Coffi A, Atachi P. et Philippe R: 2009. Développement de Coelaenomenodera lameensis Berti et Mariau (Coleoptera : Chrysomelidae - Hispinae) sur diverses provenances de palmier à huile. Annales des Sciences Agronomiques, 12 (1): 1-14.

Darby SM, Miller ML, Len RO: 2001. Forensic determination of ricin and the alkaloid marker ricinine from castor bean extracts.

Journal of Forensic Sciences, 46: 1033-1042.

Hori M: 1996. Settling inhibition and insecticidal activity of garlic and onion against Myzus persicae (Sulzer) (Homoptera: aphadidae). Appl. Entomol. Zool., 31: 605-612.

Huignard J, Dugravot S, Ketoh KG, Thibout E. et Glitho AI: 2002. Utilisation de composés secondaires des végétaux pour la protection des graines d'une légumineuse, le niébé. Conséquences sur les insectes ravageurs et leurs parasitoïdes. In: Biopesticides d'origine végétale. Eds. TEC & DOC, Paris, 133-149.

Jacquemard JC: 1995. Le palmier à huile. Le technicien de l'agriculture tropicale. CIRAD. Maisonneuve et Larouse. CTA, 205 p.

Koua KH: 2008. Répartition spatio-temporelle des populations et physiologie de la digestion de *Coelaenomenodera lameensis* Berti et Mariau (Coleoptera: chrysomelidae), ravageur du palmier à huile. Thèse de Doctorat d'Etat ès-Sciences. Université de Cocody (Côte d'Ivoire), 152 p.

Koua KH, Han SH. et D'Almeida AM: 1998. Histopathologie d'Anopheles gambiae s.l Giles, 1902 (Diptera: Culicidae) soumis à l'activité larvicide de l'extrait aqueux de Persea americana Miller, 1768 (Lauraceae). Entomologie médicale. Bull. Soc. Path. Ex.91 (3): 252–256.

Mariau D: 2001. Gestion des populations de *Coelaenomenodera lameensis* Berti et Mariau (Coleoptera: Chrysomelidae) en vue de la mise au point d'une stratégie de lutte raisonnée. Thèse de Doctorat de l'ENSA de Montpellier (France), 198 p.

Mariau D, Philippe R. et Morin JP: 1979. Méthode de lutte contre Coelanomenodera (Coleoptera: chrysomelidae) par injection d'insecticides dans le stipe du palmier à huile. Oléagineux, 34: 51-58.

Mollah JU. and Islam W: 2007. Toxicity of Thevetia peruviana (Pers) Schum. Extract to adults of Callosobruchus maculatus F. (Coleoptera: Bruchidae). J. Agric. Rural Dev., 5 (1&2): 105-109.

Niamouké ES, Koua KH, Séri-kouassi BP, Aboua NRL, Danho M. et Adja N: 2011. Evaluation de l'efficacité du thiaméthoxame sur Coelaenomenodera lameensis (Coleoptera: Chrysomelidae) ravageur du palmier à huile (*Elaeis guineensis*) en Côte d'Ivoire. Annales des Sciences Agronomiques, 15 (1): 1-19.

Philippe R: 1990. Étude de l'action de l'Evisect S sur *Coelaenomenodera minuta* (Coleoptera - Chrysomelidae - Hispinae). Oléagineux, 45 (4): 143-163.

Philogène BJR, Regnault-Roger C. et Vincent C: 2002. Produits phytosanitaires insecticides d'origine végétale: promesses d'hier et d'aujourd'hui. In: Biopesticides d'origine végétale. Eds. Tech & Doc, Paris, 1-17.

Riba M, Martí J. and Sans A: 2003. Influence of azadirachtin on development and reproduction of Nezara viridula (Heteroptera: Pentatomidae). J. Appl. Entomol., 127: 37-41.

Schmidt GH, Risha EM. and El-Nahal AKM: 1991. Reduction of progeny of some stored-product Coleoptera by vapors of Acorus calamus. J. Stored Prod. Res., 27 (2): 121-127.

Seljâsen R. and Meadow R: 2006. Effects of neem on oviposition and egg and larval development of Mamestra brassicae L.: dose response, residual activity, repellent effect and systemic activity in cabbage plants. Crop Prot., 25(4):338-345.

Séri-kouassi BP, Kanko C, Aboua LRN, Bekon KA, Glitho A, Koukoua G. et N'Guessan YT: 2004. Action des huiles essentielles de deux plantes aromatiques de Côte-d'Ivoire sur Callosobruchus maculatus F du niébé. Elsevier,CR Chimie, 7 (10-11) : 1043-1046.

Tahiri A, Assi M. et Amissa A: 2010. Toxicité et mode d'action des extraits de Carica papaya L. (Caricaceae) sur Macrotermes bellicosus Rambur (Isoptera: Macrotermitinae). Cah. Agric., 19: 267-272.

Thibout E. et Auger J: 1997. Composés soufrés des Allium et lutte contre les insectes. Acta Bot. Gallica, 144: 419-426.

Tounou AK, Mawussi G, Amadou S, Agboka K, Gumedzoe YMD. and Sanda K: 2011. Bioinsecticidal effects of plant extracts and oil emulsions of Ricinus communis L. (Malpighiales: Euphorbiaceae) on the diamondback, Plutella xylostella L. (Lepidoptera: Plutellidae) under laboratory and semi-field conditions. Journal of Applied Biosciences, 43 (2): 899 -914.

Tremattera P. and Lanzotti V: 1999. The activity of some compounds extracts by Allium on stored-product insects Oryzaephilus surinamensis (L.), Stophilis oryzae (L.) and Tribolium castaneum (Herbst). J. Pest. Science. 72: 122-125.

Yawson GK, Shin ichi Tebayashi, Chul-Sa Kim, Davis HE and Owusu EO: 2009. Parasitoids of the oil palm leaf miner Coelaenomenodera lameensis Berti and Mariau (Coleoptera: Chrysomelidae) and prospects for biological control. African Journal of Science and Technology, 10 (1): 24-31.