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BIOLOGY OF PROSOESTUS SCULPTILIS AND PROSOESTUS MINOR (Coleoptera, Curculionidae), PESTS OF FEMALE INFLORESCENCES OF THE OIL PALM IN CÔTE D'IVOIRE

Hala K. A. [1,2*], Aby N. [1], Hala N. [1], Akpesse A. M.[2], Koua K. H. [2*]

[1]Centre National de Recherche Agronomique (CNRA).Station de La Mé. 13 BP 989Abidjan 13, Côte-d'Ivoire

[2]UFR Biosciences, Laboratoire de Zoologie et de Biologie Animale, Université ,Félix Houphouët-Boigny, 22 BP 582 Abidjan 22, Côte d'Ivoire

ABSTRACT

Prosoestus sculptilis and Prosoestus minor are female inflorescences of the oil palm pests. Integrated management against these insects requires a good knowledge of their biological cycles. The literature describes the biology of Prosoestus spp. without showing their stages of development. It is also not clear that the damage observed on the fruit is actually that of Prosoestus spp. The present work proposes to study the life cycle of P. sculptilis and P. minor by showing the damage caused by their development. Each of these two species was reared in cages on young female inflorescences under semi-controlled field conditions. The different stages of development of these insects have been described. The larvae of P. sculptilis develop by digging downward galleries inside the flower that will be destroyed at emergence of new adults. Those of P. minor develop by destroying the base of the stigmas. The development cycle of P. sculptilis is longer than that of P. minor (31.4 ± 1.82 days compared to 19 ± 1.22 days). These two species of Prosoestus are harmful to the oil palm, P. sculptilis being the most destructive species.

Keywords: Development cycle ; Prosoestus spp. ; oil palm tree ; inflorescences

1. INTRODUCTION

Oil palm Elaeis guineensisis native to the humid intertropical zone of Africa. Palm cultivation has been booming for the last twenty years; it produces palm oil and palm kernel oil, respectively extracted from the pulp of the fruit and almond (Jacquemard 1995). The oil palm is the first oil plant in the world and a strategic crop for many tropical countries (CIRAD, 2017). The unmet need for fats remains high with world demand increasing by 3% per year (CIRAD, 2017). This deficit is estimated at about 500,000 t in the WAEMU area and a little over 1,800,000 t within ECOWAS. Côte d'Ivoire has set a goal of increasing production from 400,000 t of crude palm oil to 600,000 t by 2020 (Anonymous, 2017). This issue may be compromised by attacks of various pests and diseases (Mariau 2000, Koua 2008, Tuo 2013). Prosoestus sculptilis Faust et Prosoestus minor Mshl (Coleoptera, Curculionidae) are important pests of female oil palm inflorescences (Philippe, 1993). The establishment of an integrated pest management method requires a good knowledge of their biological cycles. Philippe (1993) had certainly described the biology of these two insects but without presenting their different stages of development. The works of this author did not clearly show the responsibility of these two insects in the damage

observed on oil palm fruits. In addition, in the current context of climate change, it is important to update studies on the biology of major crop pests for better phytosanitary monitoring. The present work thus proposed to study the biological cycle of P. sculptilis and P. minor by showing irrefutably the damage caused by these insects during their development on the female flowers of the oil palm.

2. MATERIALS AND METHODS

2.1. Material

2.1.1. Plant material

The plant material is Elaeis guineensis, variety Tenera C1001F. This variety has a good oil production (4,3t / ha / year), a low growth rate in height (45cm / year), a good quality of oil and has a tolerance to fusarium wilt. The palms of the study were ten years old.

2.1.2. Animal material

The animal material is essentially the different stages of Prosoestus sculptilis and Prosoestus minor.

2.2 Methods

1.Breeding of Prosoestus spp.

Ten (10) female inflorescences were randomly labeled before flower development on an experimental plot. These inflorescences were removed from their husks and placed in muslin cages of dimensions 40 x 40 cm sides and 50 cm deep (Figure 1). Five (05) inflorescences were used for the breeding of P. sculptilis and five others for that of P. minor, so there were five replicates for each species and two series were made.

The evolution of these inflorescences was followed each day and as soon as a flower was observed (beginning of flowering), fifty (50) adult pairs of one of the two species of Prosoestus were introduced into the cage. When the inflorescences were late anthesis (end of flowering), all insects were removed from the cages.

2. Determination of the different development stages of Prosestus spp.

From the first day after introduction of couples in cages, spikelets was taken at random on each inflorescence and the flowers it bears were observed in the laboratory. This observation consists of looking for eggs, larvae and nymphs of the Prosoestus species considered. Larval galleries have also been observed. The daily removal of spikelet for observation was done until the emergence of new adult individuals.

After the emergence of the new generation, two young couples of these two species were released from five uncovered female inflorescences caged in muslin (five inflorescences per species). Spikelets still took each day on these inflorescences until observation of eggs.

Three (03) larval stages (L1, L2 and L3) were judged according to the description of Philippe (1993).

Figure 1 : Breeding cage of prosoestus spp posed on a young female inflorescence

Eggs and average incubation time

The egg on spikelets has been described for each species of the genus Prosoestus.

The average incubation time of the eggs (J0) and that of observation of the first larvae (JL1) of each group of 50 pairs.

$$\mathrm{D0} = \frac{\sum_{i=1}^{n}(\mathrm{JL1} - \mathrm{J0})i}{n}$$

With (JL1 - J0) *i* the period between the egg stage and the L1 stage of each group (repetition) and *n* the number of groups.

Durations of different larval stages

The different larvae observed were described for each species and the widths of the cephalic capsules were measured. Three (03) larval stages (L1, L2 and L3) were made according to the description of Philippe (1993). The durations of the different larval stages for each of the two species studied were determined.

Average duration of the 1st larval stage

The duration of the first larval stage (D1) was determined from the date of observation of the first stage larvae (JL1) and the observation period of the second stage larvae (JL2) of each group of 50 pairs.

$$D1 = \frac{\sum_{i=1}^{n}(JL2 - JL1)i}{n}$$

With (JL2 - JL1) *i* the period between stages L1 and L2 of each group (repetition) and *n* the number of groups.

Average duration of 2nd instar larval stage

The average duration of the 2nd instar larvae (D2) was determined from the date of observation of the first stage 2 larvae (JL2) and that of observation of the first stage 3 larvae (JL3) of each group of 50 couples.

$$D2 = \frac{\sum_{i=1}^{n}(JL3 - JL2)i}{n}$$

With (JL3 - JL2) *i* the period between stages L2 and L3 of each group (repetition) and *n* the number of groups.

Average duration of 3rd instar larval stage

Similarly, the average duration of the 3rd instar larval stage (D3) was determined from the date of observation of the first stage 3 larvae (JL3) and that of observation of the first nymphs (JN) of each group of 50 couples.

$$D3 = \frac{\sum_{i=1}^{n}(JN - JL3)i}{n}$$

With (JN - JL3) *i* the period between stages L3 and Nymph of each group (repetition) and *n* the number of groups.

Average duration of the larval stage

The average larval stage duration (LD) of each of the two Prosoestus species was calculated as follows:

DL = D1 + D2 + D3

Nymphs and average duration of the nymphal stage

The nymph has been described as well for P. sculptilisthanfor P. minor. The average duration of the nymphal stage (ND) was then determined from the observation date of the first nymphs (JN) and that of observation of the first immature adults (JAI) from each group of 50 couples.

$$\mathrm{DN} = \frac{\sum_{i=1}^{n}(\mathrm{JAI} - \mathrm{JN})i}{n}$$

With (JAI - JN) *i* the period between the nymphal stage and nthe immature adult stage of each group (repetition) and *n* the number of groups.

Average duration of pre-oviposition

The average duration of pre-oviposition (PD) was determined for each species from the date of observation of the first immature adults (JAI) and the date of the new egg laying (JP) of each group of 50 couples.

$$\mathrm{DP} = \frac{\sum_{i=1}^{n}(\mathrm{JP} - \mathrm{JAI})i}{n}$$

With (JP - JAI) i the period between the immature adult stage and nthe new egg laying of each group (repetition) and *n* the number of groups.

Average duration of the development cycle

The average duration of the development cycle (DC) of *P. sculptilis* and *P. minor* was calculated according to the following formula

DC=D0+DL+DN+DP

Sex-ratio of *P. sculptilis* and *P. minor*

The sex ratio of each species was determined by the ratio of the average number of males and females emerged.

$$Sr = \frac{\sum Mi}{\sum Fi}$$

Sr = sex ratio; Mi = number of males emerged by repetition; Fi = number of females emerged by repetition

Damage caused by the development of *P. sculptilis* and *P. minor* on the female flowers of the oil palm.

The damage observed on female flowers during the development of *Prosoestus spp*. were consulted. This description was made according to the stage of development and the species of Prosoestus considered.

3. DATA ANALYSIS

The average durations of each stage of development of the two species studied, as well as the respective standard deviations, were calculated using the Statistica 7.0 software.

4. RESULTS

Development cycle

Eggs and average incubation time

The egg of *P. sculptilis* is laid by the adult female at the base of the stigmas of the female flowers of the oil palm. It's color is yellow and it's shape is ovoid. This egg is 0.61 ± 0.03 mm long and 0.3 ± 0.02 mm wide. The average incubation time is 1.2 ± 0.45 days.

The adult female of *P. minor* lays her eggs in small holes that she digs on the stigmas of the female flowers. The egg of P. minor lasts a day is yellow and is 0.31 ± 0.02 mm long and 0.18 ± 0.01 mm wide. Incubation of the egg of *P. minor* lasts a day.

Larvae and average durations of the different larval stages

First larval instar

After hatching of *P. sculptilis* egg, the young larva obtained (L1) is pale yellow with an orange cephalic capsule. At this stage, the larva has mandibles already developed which it uses to feed itself by digging a gallery descending inside the flower. The first instar stage of *P. sculptilis* lasts 3.6 ± 0.55 days.

The young larva from the egg of *P. minor* is also pale yellow in color with an orange cephalic capsule. The anterior end of the larva of the first stage carries mandibles which it uses to feed by

digging a gallery in the stigmas of the flower. The duration of the first larval stage of *P. minor* is 2.2 ± 0.45 days.

Second larval instar

The second instar larva (L2) is almost identical to the first stage in color, the difference being in size. L2 is larger than L1, with a somewhat larger cephalic capsule (from 0.7 to 0.85 mm for *P. sculptilis* and 0.55 to 0.65 mm for P. minor).

The duration of the second larval stage of *P. sculptilis* is 5.4 ± 0.55 days. For *P. minor*, the second larval stage lasts an average of 3.4 ± 0.55 days.

Third larval instar

In the third stage (L3), the larva has a fatter appearance. It is much bigger with a larger cephalic capsule. It measures 0.9 to 1.05 mm for *P. sculptilis* and 0.7 to 0.8 mm for *P. minor*. The duration of the third larval stage of *P. sculptilis* is 11.4 ± 1.14 days. In P. minor, this larval stage lasts an average of 3.8 ± 0.84 days.

Total duration of the larval stage

The total duration of the larval stage is 19 to 23 days for *P. sculptilis* and 7 to 10 days for *P. minor.*

Nymph and average duration of the nymphal stage

The nymph of *P. sculptilis* is yellow-orange, 0.55 ± 0.04 mm long and 0.21 ± 0.03 mm wide. It stops feeding and no longer digs a gallery. The nymphal stage of *P. sculptilis* lasts 3.6 ± 0.55 days. The nymph of the species *P. minor* is yellow, it is 0.25 ± 0.04 mm long and 0.12 ± 0.03 mm wide. It no longer feeds and stops digging. The nymphal stage lasts 4.2 ± 0.45 days.

Pre-Oviposition, average duration of the development cycle and sex ratio

For *P. sculptilis*, the duration of pre-oviposition is 6.2 ± 0.84 days. The development cycle of this insect lasts 31.4 ± 1.82 days with a sex ratio of 0.6 ± 0.05 (Figure 2).

For *P. minor*, the pre-oviposition is 4.4 ± 0.55 days and the development cycle lasts 19 ± 1.22 days with a sex ratio of 0.56 ± 0.04 (Figure 3).

Damage caused by the development of *Prosoestus spp*. on the female flowers of the oil palm

8.Damage of *P. sculptilis*

As they develop, the larvae of *P. sculptilis* dig a descending gallery from the base of the stigmata to the ovary (Figure 4). The L1, which cephalic capsule has a small size, digs a gallery that measures 0.7 ± 0.07 mm in width. This gallery becomes wider and deeper with the development

of larvae which cephalic capsule becomes wider and the mandibles more powerful. Thus, the width of the larval gallery is 0.96 ± 0.11 mm at the L2 stage and 1.4 ± 0.16 m for the L3 stage. At the emergence of adults, the flower is completely destroyed (Figure 5).

9.Damage of *P. minor*

In contrast to the larva of *P. sculptilis*, which has a descending gallery, the larval gallery of *P. minor* is excavated around the base of the stigmata up to the style (Figure 6). The width of this gallery increases gradually with the development of the larva. 0.52 ± 0.08 mm wide when the larva is in stage L1, the gallery will pass to 0.68 ± 0.08 mm at stage L2 and then 0.9 ± 0.1 mm at stage L3. At the emergence of adults, the stigmas are severed and fall (Figure 7).

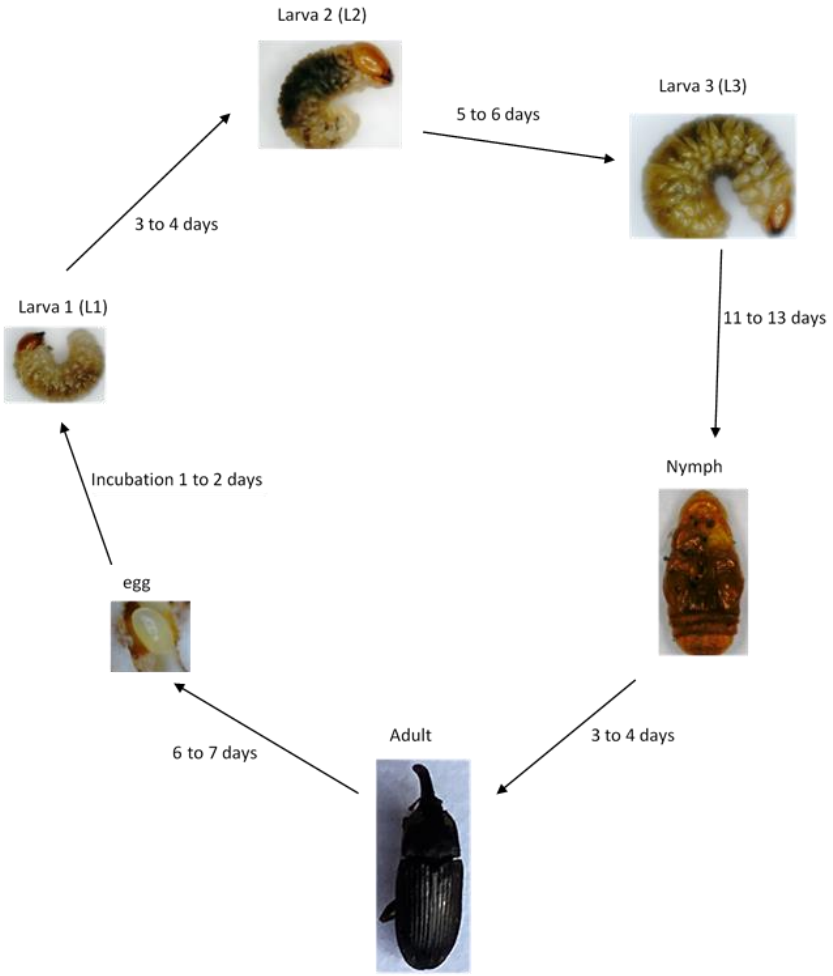

Figure 2 : *Prosoestus sculptilis* Life Cycle (28.36 ± 0.42 ° C, 79.62 ± 1.62% RH)

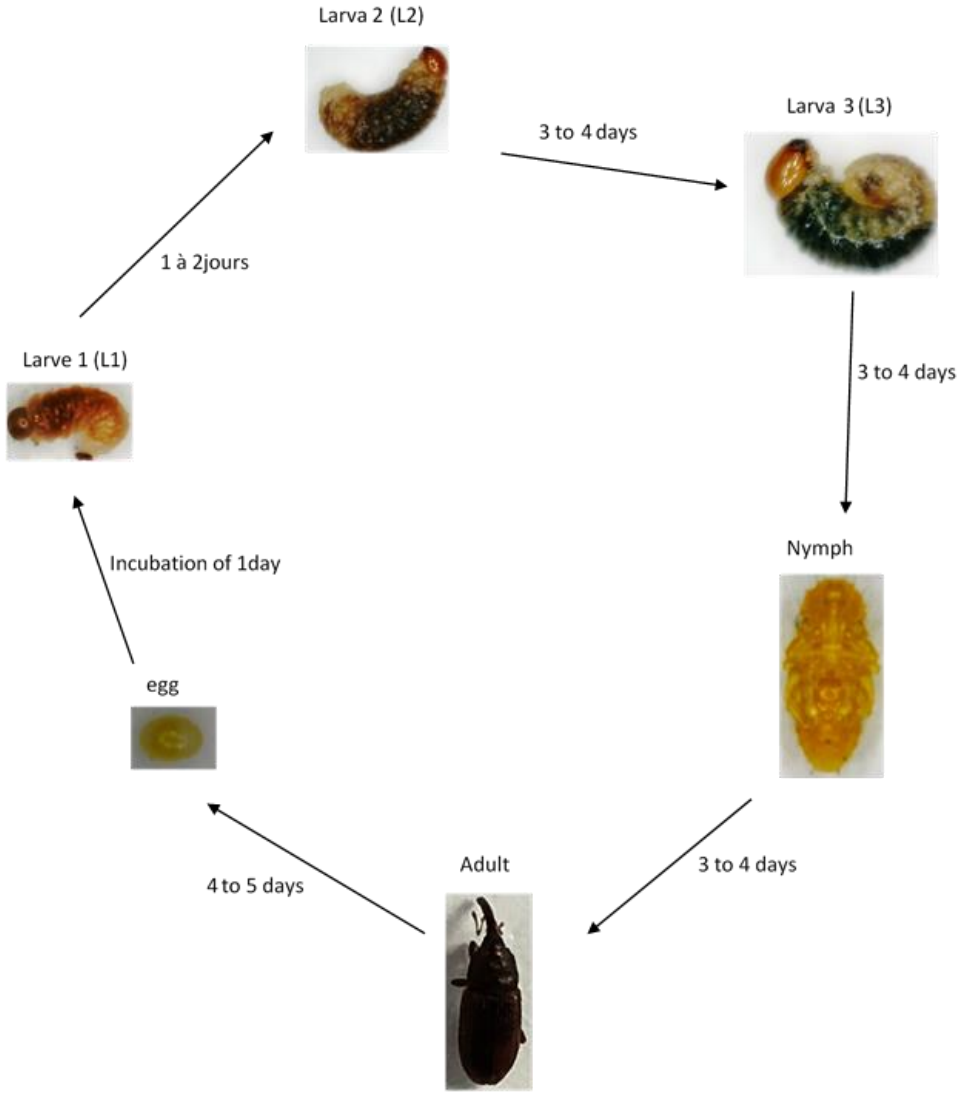

Figure 3 : *Prosoestus minor* Life Cycle (28.36 ± 0.42 ° C, 79.62 ± 1.62% RH)

Figure 4 : Larva of *P. sculptilis* creating a gallery inside the flower

Figure 5 : Flower destroyed by the emergence of a new adult *P. sculptilis*

Figure 6 : Larva of *P. minor* digging a gallery at the base of the stigmata

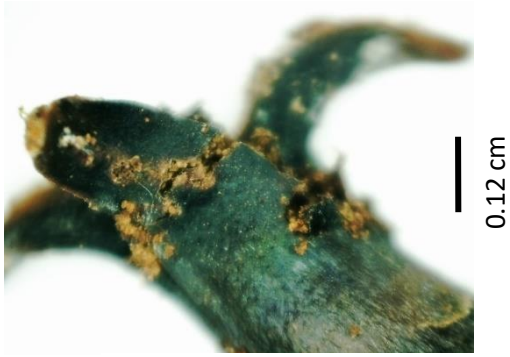

Figure 7 : Stigmas destroyed by P. minor

5. DISCUSSION

The results show that *P. sculptilis* and *P. minor* perform their entire development cycle on the female flowers of the oil palm. The different stages (egg, larva, nymph and adult) of each of these species have been observed. This confirmed the results of the work of Tuo (2013) who showed that *Prosoestus spp*. was more present on the female flowers compared to the flowers that these insects seemed to visit by "accident". The larvae of *Prosoestus spp*. are by far the most destructive, unlike adults who do only small perforations on the stigmas of the flower while feeding. This phenomenon is observed in other oil palm insect pests such as *Coelenomenodera lameensis*, whose leaf miner larvae make this insect the most important pest of this plant (Mariau et al., 1981, Koua, 2008). The larvae of *P. sculptilis* dig down galleries that completely destroy the flower, while those of *P. minor* only damage the stigmas. Similar results were obtained by Alibert (1938) and Philippe (1993). The duration of the development cycle was 31.4 ± 1.82 days for P. sculptilis and 19 ± 1.22 days for P. minor. Philippe (1993) obtained a duration of 30 to 35.5 days for the development of *P. sculptilis* and 18 to 19 days for that of *P. minor*. The sex ratio was 0.6 ± 0.05 in favor of females for *P. sculptilis*, which is contrary to that obtained in the work of Philippe (1993). This author obtained a sexual intercourse of 0.43 in favor of the males. Considering *P. minor* ratio sex ratio was identical (0.56 ± 0.04).

CONCLUSION

Prosoestus sculptilis and *P. minor* are two species of Coleoptera that live mainly on the female flowers of the oil palm. The larvae of *P. sculptilis* creep down the interior of the flower that will be destroyed when new adults emerge, while those of P. minor develop by destroying stigmas. The development cycle of *P. sculptilis* is longer than that of P minor (31.4 ± 1.82 against 19 ± 1.22). These two species of the genus Prosoestus are harmful to the oil palm, with *P. sculptilis* being the most destructive species.

REFERENCES

Alibert M. H, (1938) – Etude sur les insectes parasites du palmier à huile au Dahomey. Revue de Botanique appliquée et d'agriculture tropicale 50 (207) : 745-773.

Anonymous, 2017 – le palmier à huile : Importance de la culture. Ministère de l'agriculture de Côte-d'Ivoire.

http://www.agriculture.gouv.ci/index.php?option=com_content&view=article&id=72. Visité le 10 Juin 2017 à 11h.

CIRAD, 2017 – Palmier à huile.

http://www.cirad.fr/nos-recherches/filieres-tropicales/palmier-a-huile/contexte-et-enjeux. Visité le 10 Juin 2017 à 10h.

Jacquemard J.C., 1995 – Le palmier à huile. Le technicien d'agriculture tropicale. Maisonneuve et Larose, Vol. 33, 207p.

Koua K. H., 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 présentée à l'UFR Biosciences pour obtenir le grade de Docteur d'Etat des Sciences Naturelles, Spécialité : Entomologie ; Université de Cocody, Abidjan. 152 p.

Mariau D., 2000 – La faune du palmier à huile et du cocotier.1. Les lépidoptères et les hémiptères ainsi que leurs ennemis naturels. Montpellier : Les bibliographies du CIRAD, vol. 13 ; 97 p.

Mariau D., Desmier DE Chenon R., Julia J.F.,1981 – Les ravageurs du palmier à huile et du cocotier en Afrique occidentale (Oil palm and coconut pests in west africa). Oléagineux, 36 (4) : 169-228.

Morin J-P. &Mariau D., 1970 – Morphologie et étude du développement de *Coelaenomenodera elaeidis*. Oléagineux, 25 (1) : 11-16.

Pene C. B., Assa D.A.,2003 – Variations interannuelles de la pluviométrie et de l'alimentation hydrique de la canne à sucre en Côte-d'Ivoire, sècheresse (14) : 43-52.

Philippe R., 1993 – Etude de l'incidence des ravageurs sur les inflorescences femelles du palmier à huile en Afrique de l'Ouest. Oléagineux, 48 (10) 389 - 405.

Traore K., Mangara A.,2009 – Etude Phyto-Écologique des Adventices dans les Agro-Écosystèmes Élaeicoles de la Mé et de Dabou. European Journal of Scientific Research. 31 (4) :519 – 533.

Tuo Y., 2013 – Etat de l'entomofaune des inflorescences du palmier à huile en Côte d'Ivoire: cas de la station CNRA de La Mé. Thèse présentée à l'UFR Biosciences pour obtenir le titre de Docteur de l'Université Felix Houphouët-Boigny, Abidjan (Côte-d'Ivoire). 192 p.