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Spatio-temporal distribution of *Cœlaenomenodera minuta* Uhmann (Coleoptera: Chrysomelidae), a serious insect pest of oil palm (*Elaeis guineensis* Jacq.) in the south-west region of Cameroon

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Abstract:

The leaflet miner *Cœlaenomenodera minuta* is the main pest of oil palm in the south-west region of Cameroon. A 12 months study of spatio-temporal distribution was carried out on young and mature industrial plantations of 40 ha each at Tiko Benoe palm estate in the south-west region of Cameroon. The pest infestation (larvae and adult) distribution revealed the endemic existence of *C. minuta* in the mature oil palm plantation. Relative null pest infestations were recorded from the young plantation. Three infestation peaks were observed. Monthly significant difference of *C. minuta* infestation was also recorded. The highest number of insects captured (117.3 per tree) was in December. In addition, negative and relatively significant correlation was observed between monthly cumulative rainfall days and captured *C. minuta* individuals. These results can help to improve the conception and the implementation of an efficient control strategy against the pest.

Keywords: *Cœlaenomenodera minuta* Uhmann * oil palm * *Elaeis guineensis* Jacq. * insect pest control

1. Introduction

Oil palm is an important commercial crop and source of vegetable oil. Cultivated for palm oil and kernel oil, it is the highest yielding oil bearing crop per hectare, producing 4.5 to 9 tons per hectare a year depending on favorable climatic conditions, with the best production in south east Asia (Indonesia, Malaysia) [2, 17]. This production is 5 to 10 times more important than soybean, rape, sunflower (*Helianthus annuus*) colza (*Brassica napus*), and groundnut oils [19, 22].

In Cameroon, the 13th world producer, palm plantations cover more than 190 000 hectares, mainly distributed between smallholder plantations (131 140 hectares) and industrial plantations (58 860 hectares). In 2011, annual palm oil production was estimated at 230 000 tons (2/3 by agro-industries and 1/3 by smallholders). Given its insufficiency to satisfy national demands, an additional 25 000 tons were imported that same year [7]. Beside palm oil, kennel oil is equally extracted from the endocarp of the oil palm fruit and its world demand is currently high [6].

For many decades, the world consumption rate of palm oil continuous to significantly increase as compared with the other vegetable oils because of its multipurpose functions, both in the food and cosmetic industries coupled with its recent use as biofuel [19]. This situation calls for an increase in production to avoid that demand does not outweigh supply at the international scale. Increasing the sizes of plantations alone is not a solution enough to mitigate future demand and supply but this has to be synchronized with better pest management, planting of improved seedlings among other factors.

The insect pest pressure is one of the main factors which significantly contribute to reduce the production of oil palm in the different cultivation areas. *Coelaenomenodera minuta* Uh. is the most devastating pest of oil palm. The serious damages caused by this insect extremely induce a precocious drying of oil palm fronts. Severe defoliation caused by *C. minuta* can have significant decreases of about 50% of oil palm bunches production on the plantation within 2 to 3 consecutive years [9]. Many tests of control methods are still going on and the use of chemicals, biological control and the use of resistant palm varieties, have already been applied on plantations to reduce the insect spread [1, 10, 14, 18]. The morphological and developmental description studies of *C. minuta* have been realized [16]. The biology and reproduction studies of some *C. minuta*'s parasites were carried out by the same authors in 1971

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and they also showed in 1974, the natural mortality phenomenon of the larvae and eggs that can occur in the field. Other workers [11] showed the existing correlation between some abiotic factors and *Coelaenomenodera minuta* fertility in infested oil palm plantations.

In spite of available data [9, 13], more data are still needed to appreciate the spatio-temporal distribution of *C. minuta* in another complex agro-ecological oil palm cultivation zone to improve on the conception and implementation of an efficient control strategy. This study was carried out to determine the infestation situation on both young and mature plantations, the infestation periods of *C. minuta*, and the existing link between abiotic factors (cumulative rainfall day intervals) and *C. minuta*.

2. Materials and Methods

2.1 Study site

This study was conducted from August 2005 to July 2006, on a total of 80 ha of oil palm plantation at the Tiko Benoe Palm Estate of Cameroon Development Corporation (CDC) agro-industry located in the South-west administrative region of Cameroon. This area is covered by a wet dense forest tropical climate with a monomodal rainfall regime. The average annual rainfall varies between 1400 and 2000 mm. The average annual sunshine varies from 700 to 900 hours. This information was collected using the rain gauge and Cambell's Heliograph respectively.

2.2 Research methodology

The palm trees observed for this study were one year old for the young plantation (40 ha) and nine years old for the mature oil palm plantation (40 ha). The oil palm was *Tenera* variety of the second selection cycle provided by the Specialized Centre for Oil Palm Research (CEREPAH) of La-Dibamba in Cameroon. The Fisher block design with 10 replications was adopted for this study. Each block of 40 ha was divided into 10 plots of 4 ha each. Inside each plot a total of 20 palm trees were randomly selected and marked. On each palm tree, one frond or leaf was also chosen and marked. Weekly observations were done on each oil palm leaf to record data. The insects were captured manually from palm fronds since they are not swift in movement. The data were related to the captured adult *C. minuta*, and the observed larvae from galleries of the marked fronds. Three intervals (2, 7 and 30 days) of cumulative rainfall periods were applied in this study.

2.3 Statistical Analysis

The average number of insects (adults, larvae, nymphs) per palm tree per month was calculated using the Statistical Analysis System (SAS) software following the General Linear Model procedure. ANOVA permitted to appreciate the differences amongst treatments. Student Newman-Keuls test was used for mean separations and Pearson's correlation procedure permitted to evaluate relationship between abiotic factors and infestation rate of *C. minuta*

3. Results

Temporal distribution of C. minuta infestations

The monthly investigations showed that *Coelaenomenodera minuta* is permanently present in the field and number of captured insects seriously varied from one month to another during the one year of study. The highest infestations of *C. minuta* were mainly concentrated on mature oil palm trees and relatively null in the young plantation (Table 1).

Table 1. Monthly total number of captured *Coelaenomenodera minuta* per type of plantation at "Benoe Palms Estate" Tiko in the South-west administrative region of Cameroon.

Years	*Months*	*Young plantation (one year old)*	**Mature plantation (nine years old)**
2005	Aug	0	515
	Sept	0	2318
	Oct	0	1818
	Nov.	0	4293
	Dec.	0	7039
2006	Jan	0	4907
	Fev	0	2926
	Mar	0	1905
	Apr.	0	4229
	May	0	3526
	Jun.	10	2093
	Jul.	0	596

Statistical results revealed that differences between months were significantly high on the mean number of the captured *C. minuta* individuals per tree in the oil palm plantation ($F_{(11\ ;\ 696)}$= 10.45 ; P<0.0001). December 2005 recorded more spread of *C. minuta* (117.3 individuals per palm tree) as compared to other months. Low infestations were observed in August 2005 (8.6 individuals per palm tree) and July 2006 (9.9 individuals per palm tree) (Table 2). Three peaks of unequal intensities were observed during this study. Peaks were particularly high in December 2005 and April 2006. The peak infestation frequencies were not stable in the plantations from one peak to another (Figure 1).

3.2 Influence of cumulative rainfall days on infestation of C. minuta

Negative and significant correlation was observed between captured *C. minuta* adults and cumulative rainfall of 2; 7 and 30 day intervals. According to the total infestation, the correlation was negative and not significant for 2 day intervals of cumulative rainfall only, but it was significant and negative for the two other studied cumulative rainfall day intervals (7 and 30). However the correlation was negative and not significant between observed *C. minuta* larvae and cumulative rainfall day intervals at 5% threshold (Table 3).

Table 2. Monthly mean captured *C. minuta* individuals per tree from August 2005 to July 2006 at Benoe Palm Estate in Cameroon.

Years	*Months*	**Mean number of individuals per palm tree**
2005	Aug	8.6 d
2005	Sept	38.4 cd
2005	Oct	30.3 cd
2005	Nov.	71.5 cb
2005	Dec.	117.3 a
2006	Jan	81.8 b
2006	Fev	49.4 cb
2006	Mar	31.7 cd
2006	Apr.	70.5 cb
2006	May	58.8 cb
2006	Jun.	35.1 cd
2006	Jul.	9.9 d

Means on the same column with same letter are not significantly different in Student-Newman-Keuls test (P<0.05).

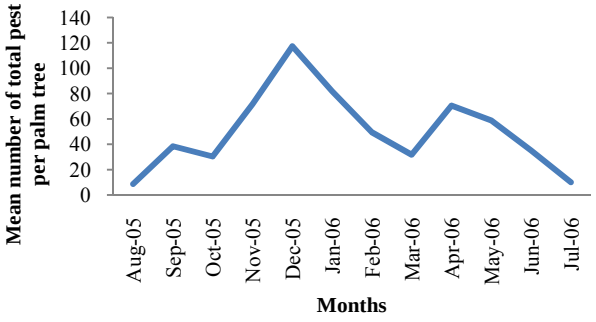

Figure 1. Temporal evolution of global C. minuta infestation in Benoe Palm Estate

Table 3. Correlation Coefficients between cumulative rainfall day numbers (2, 7 and 30 days) and the captured larvae, adult, and total pest individuals.

Cumulative rainfall day numbers	r_s *(larvaes)*	r_s *(adults)*	**r_s (total pest individuals)**
2days	-0.018 NS	-0.099*	-0.082 NS
7days	-0.051 NS	-0.165**	-0.118*
30 days	-0.032 NS	-0.225***	-0.131*

* : significant at α = 5% ; ns : non significant; *** : significant at α = 1% ; N=500 r_s : Pearson correlation coefficient

4. Discussion

The investigation of the leaf miner pest *C. minuta* in oil palm plantations of Tiko Benoe palm estate in Cameroon revealed that the mature oil palm plantation (nine years old) was strongly more infested than the young oil palm plantation (one year old). This suggests that the age of the host plant (oil palm), a biological factor, influenced the attraction of *C. minuta* individual insects. Some authors [4, 5, 21] showed that the population abundance of insects increases with the physiological development state of the host plant. This might be the case of leaf miner pest *C. minuta*, which was observed to be abundant in the mature plantation, where the pest can find its potential source of food and favorable conditions of its life cycle. However, it has been shown [20] that all old oil palm plantations can be attacked by *C. minuta*. Nevertheless, numerous factors can explain variation of insect populations including the favorable periods that increase fertility of *C. lameensis*, the agro-climatic conditions that favor development of the insect, the decrease of natural mortality and the inefficiency or low stability of the plant sanitary treatments [8].

The study of the temporal distribution of the infestations showed that there are periods of the year presenting marked peaks in Tiko Benoe Palm Estate.

September 2005, December 2005 and April 2006 respectively presented important peaks with 38.4, 117.3 and 70.5 insect individuals per palm tree. It appears obvious that certain periods of the year are more favorable to the infestation of *C. minuta* than others. The times or periods when infestation takes place were not stable or repetitive as that observed on a *C. lameensis* temporal distribution study [8], where, a cycle of 3 months of infestation and 8 infestation peaks in 24 months of study were recorded.

The results of the present study indicate that cumulative rainfall day intervals (2, 7 and 30 days) contributed to affect infestation in Tiko Benoe Palm Estate. In fact, negative and significant correlation was observed between captured *C. minuta* adults and cumulative rainfall of 2, 7 and 30 day intervals, and also between the total infestation and 7 and 30 day intervals of cumulative rainfall. Pearson's coefficient of correlation was negative and not significant for 2 day intervals of cucemulative rainfall and total infestations. However based upon captured *C. minuta* larvae number and cumulative rainfall day intervals (2, 7 and 30), the correlation was negative and not significant. Our investigation showed that as the Pearson's coefficients of correlation were relatively low; cumulative rainfall day intervals did not totally contribute to influence the *C. minuta* population. Thus other abiotic factors more important than the rainfall of the study region might influence *C. minuta* population. It has been shown [3] that cumulative rainfall interval periods of 2 days, 7 days and 30 days were strongly correlated with termites abundance in the soil galleries.

Abiotic factors (rainfall, relative humidity and temperature) were found not to correlate with infestations of *C. lameensis* [8] because during the period of study, no important variation of temperature and relative humidity were recorded in the study region. Work on spatio-temporal distribution of *Helicoverpa armigera* of tomato [15] showed that the population of pest insects was not influenced by simultaneously constant temperature and relative humidity. It had also been shown [12] that in the humid zones, the combined action of high fertility and low parasitism induces the genesis of *C. lameensis* spread in the field.

5. Conclusion

The temporal distribution of leaf miner, *Coelaenomenodera minuta* clearly showed the constant presence of this pest in Tiko Benoe Palm Estate of the south-west administrative region of Cameroon. The less than one year old young oil palm plantation did not need sanitary monitoring for *C. minuta* infestation. However, oil palm plantations above one year need a constant monitoring. Moreover, the periods of the year presenting infestation peaks must be subjected to particular monitoring of *C. minuta* infestation in the field. The cumulative rainfall days showed relative minor correlation on the level of infestation in Tiko Benoe Palm Estate. This study paves the way for the conception and implementation of an efficient control strategy against *C. minuta.*

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