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Impact of terrestrial spraying of thiocyclam hydrogen oxalate on oil palm pollinating insects

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The impact of terrestrial thiocyclam hydrogen oxalate (Evisect®) sprays an insecticide used against *Coelaenomenodera lameensis* the major pest of oil palm on pollinating insects was evaluated. Samples of pollinators were collected from both male and female oil palm inflorescences on untreated and treated plots. Means and standard deviations of the insects collected were compared by analysis of variance test and the post hoc Newman-Keuls. The results showed that insect populations of all species on female inflorescences (*Elaeidobius kamerunicus*, *E. plagiatus*, *E. subvittatus, E. bilineatus*, *E. singularis*, *Microporum congolense, M. dis*par, *Prosoestus minor, P.sculptilis* and *Atheta Burgeoni*) were significantly influenced by the spraying of Evisect® whilst the insects present on the male inflorescences were sensitive to the pesticide according to anthesis stages. In addition three of the four major pollinators of oil palm (*E. kamerinicus, E. subvittatus*, *E. plagiatus* and *E. singularis)* were sensitive to the chemical treatment by Evisect. The use of thiocyclam hydrogen oxalate to fight against oil palm pests reduces pollinating insect's populations and can also harm good productivity.

Keys words: terrestrial spraying; thiocyclam hydrogen oxalate; Evisect®; oil palm; pollinating insects.

Introduction

The oil palm *Elaeis guineensis* is a monoecious plant, which means that male and female inflorescences were separated from one another on the same vegetative axis. The oil palm thus requires cross-pollination. Pollination of oil palm is mainly provided by insects which commute between male and female inflorescences (Syed 1978, 1979).Twenty species of insects are known to pollinate the flowers of oil palm (Mariau *et al*., 1991). They belong to the genus *Elaeidobius (E.)*. They do not have all the same pollinating power however four species are distinguished: *E. kamerunicus, E. plagiatus, E. subvittatus and E. singularis*. They provide the largest share of pollination; the first two mentioned species are the most active (Mariau *et al.,* 1991). The presence of these insects therefore improves seed production. According to Ponnamma *et al.* (1986), the introduction of *E. kamerunicus* (Coleoptera, Curculionidae) in Malaysia in 1981 increased the yield by 20% and by 53% in Sabah the second state in Malaysia, the following years.

These insects are therefore of economic importance due to their pollination activities. Services rendered by the West African oil palm beetle pollinators to the Southeast Asia oil palm plantations were estimated at 150 million dollars (FAO 2007). Unfortunately, these insects come very often in contact with pesticides that prophylactic sprayed as they gather nectar and pollen from the treated trees. Phenomena of weakening of apiaries with a decreased activity have been observed in bees without pathogen presence due to pesticide spray (Faucon and Colin, 1983). This observation was also made by Tingle and Andrew (1998) in a Malgache region treated with an organophosphate (chlorpyrifos ethyl) and carbamate (pirimicarb).

In Sub-Saharan Africa, the knowledge of the risks associated with pesticide use is very superficial for

pollinators of oil palm. One of the major pests of oil palm is *Coelaenomenoderalameensis* (Berti and Mariau, 1999). During heavy infestation this beetle can cause a drop in the production of 50% in two years (Mariau *et al.,* 1981). In spite of this, insecticides remain the most effective means of controlling this pest to date. Insecticides are used by aerial spraying (aircraft), by terrestrial spraying (tractors or walking operator) or systemically (injected into the trunk of the oil palm tree). One of the most commonly used pesticides in oil palm is Thiocyclam hydrogen oxalate (Evisect®). It is an insecticide that acts by interrupting the transmission of nerve impulses in the synapses of the central nervous system of insects. While field technicians have been trained and assigned specifically to monitor the levels of infestation and carry out chemical treatments. Ecotoxicological risks are very often rarely considered. In practice, there are no toxicological tests suitable for assessing the effects of pesticides on pollinating insects. Knowledge of such effects is severely lacking in certain pesticide registration decisions. With regard to palm oil, the problem is even more important because pollination is mainly carried out by insects. The decrease in production observed in several oil palm plantations in spite of the important chemical control against pests could be explained by the hypothesis of a concomitant decline of pollinating insects.

This study aims to evaluate for the first time in Côte d'Ivoire, the impact of chemical pesticide treatments commonly used in oil palm plantations on pollinating insects.

Materials and methods

1- Study site

The experiments were carried out at LaMé experimental station (5°26, N, 3°50, W) about 30 km northeast of Abidjan, the economic capital of Côte d'Ivoire. The climatic condition at this site is equatorial, characterized by two distinct rainy seasons (March to July and November). These two seasons are alternated by two dry seasons: December to February and from August to October. The station annual rainfall of about 1500 mm, monthly mean temperature of 27°C and average annual sunshine of 1790 h. The average monthly relative humidity is about 81%.

2- Method of chemical treatment of Evisect

The treatment was carried out by thermonebulisation using Pusfog device K20/0 Model. This model is used for outdoor spraying with fuel or oil as adjuvant. The flow of the product of atomizing can reach 65 liters of oil per hour. Eight hundred (800) grams of Thiocyclam hydrogen oxalate was weighed and mixed thoroughly with 8 liters of diesel. The mixture was filtered and introduced into the tank of the sprayer.

The mixture of insecticide and diesel was applied onto the palms in the form of smoke. The treatment was carried out overnight in the absence of strong wind which would affect the intensity of the fog there by decrease the contact time of the toxic microparticles with the targets. The operators of the device run across 2.5 ha at a rate of 2 to 3 km / h.

3- Method of assessing the impact of chemical treatment on insects on male and female inflorescences

To assess the impact of Evisect on the insects on male and female inflorescences, the investigations were conducted on six plots of 25 ha each one. The device was randomized complete block. These plots were chosen in the same microclimate and outside the rainy season. A preliminary samples of the insect fauna of male and female inflorescences on these plots showed that the number of insects did not differ statistically. Thus, three plots were chosen for testing insecticides and three other for controls according to the device of fig.1.

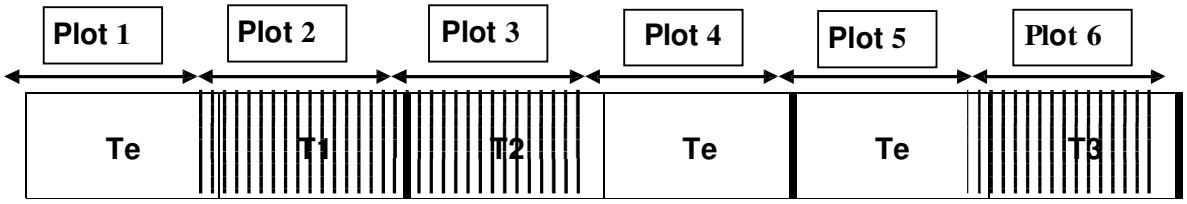


Fig. 1: Experimental device for the study of Evisect treatment Te: Controls. T1, T2, T3: Treatments with Evisect,

- For the male inflorescences, flowering lasts 6 to 7 days. Each flowering stage: beginning of anthesis (BA); full anthesis, three days after the beginning (FA) and end of anthesis two days after the full one (EA) were examined. Six inflorescences were taken from each plot at different stages of flowering. On each inflorescence, 4 spikelets were cut using a pair of secateurs. Each batch of spikelets thus taken was collected in a plastic bag and the insects found there were neutralized with an insecticide bomb. Insects each batch of spikel

were collected and stored in pillboxes containing 70 °alcohol. These insects were observed using a stereomicroscope and the identification was made using the reference collection of the entomofauna of the oil palm inflorescences of the National Center at Agronomic Research of Côte d'Ivoire. The insects were counted by species at each stage of flowering. Means and standard deviations of the insects collected on controls and treated plots were compared by ANOVA and post hoc test of Newman- Keuls. These comparisons were used to assess the impact of treatments on the population of insects living on the male inflorescences.

- For the female inflorescences**,** flowering lasts two days. A vacuum cleaner was used to collect insects on the inflorescences. The insects were collected during 10 minutes each hour from 6 am to 6 pm during the first and the second days of flowering. As in the previous case, the average population of insects collected on controls and treated plots were compared by analysis of variance test and the post hoc Newman- Keuls at α = 5% using the software Statistica version 7.0.The means analyzed were those of all insects on one hand and also those of each species taken separately

Results

1. Variation in the number of insects on male inflorescences

The insects collected on male inflorescences of oil palm mostly belong to *Elaeidobius* (E) genus with 5 species: *E. kamerunicus, E. plagiatus*, *E. subvittatus, E. singularis and E. bilineatus*. *Elaeidobuis* genus was Followed by *Microporum*(M) genus represented by *M. dispar* and *M. congolense* then by *Prosoestus* genus that includes *P. sculptilis* and *P. minor*. Species *Atheta burgeoni*, *Lithargus sp.*, *Anthocoride sp.*, *Thrips sp*, *Gabrius sp*. and bees (*Nomia sp* and *Apis mellifera*) were also observed.

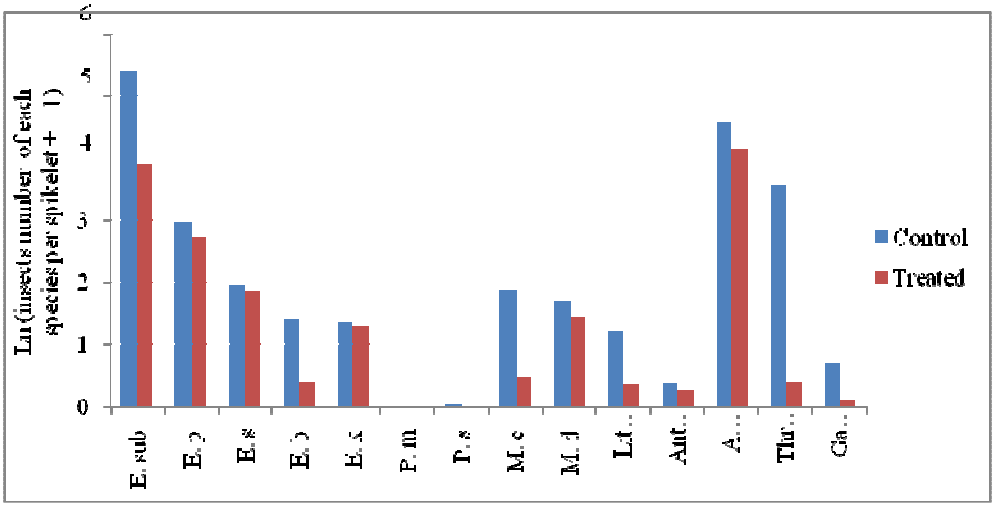
At beginning of anthesis, the average number of insects collected in the untreated plots (controls) was 398.46 ± 4.69 compared to 147.71 ± 2.8 in the treated plots,a 62.92% decrease. In full anthesis, the number of insects collected from the treated trees (683.21 ± 3.65) was 43.51% lower than those obtained in the untreated trees (1209.46 ± 4.67). For the end period of anthesis, only 348.21 ± 3.4 insects on average was collected in untreated zone against 292.88± 3.89 in the treated zone (Fig.2). The ANOVA conducted showed that there was no significant difference between these two averages.

At the beginning of anthesis, statistical tests also showed that the average number of individuals of the species *E. plagiatus*, *E. singularis*, *E. kamerunicus*, *P. sculptilis*, *P. minor*, *M. dispar*, *Anthocoris sp* and *Atheta burgeoni* in the treated area were not statistically different (P>0.05; df=46) from that recorded in the untreated area (Fig. 2A). On the other hand, the species *E. subvittatus*, *E. bilineatus*, *M. congolense, Lithargus sp*, *Thrips sp* and *Gabrius sp* were significantly influenced by chemical treatments.

At full anthesis, the number of individuals of each species *E. plagiatus*, *E. singularis*, *E. bilineatus*, *M. congolense*, *M. dispar*, *Anthocoris sp* and *A. burgeoni* were higher in the untreated plots than in the treated plots (Fig. 2B). On the other hand, *E. kamerunicus*, *P. minor*, *P. sculptilis*, *Lithargus sp*, *Thrips sp* and *Gabrius sp* were not significantly affected.

At the end of anthesis, only the species *M. congolense* and *Gabrius sp* presented population declines due to Evisect treatment (Fig.2C).

A



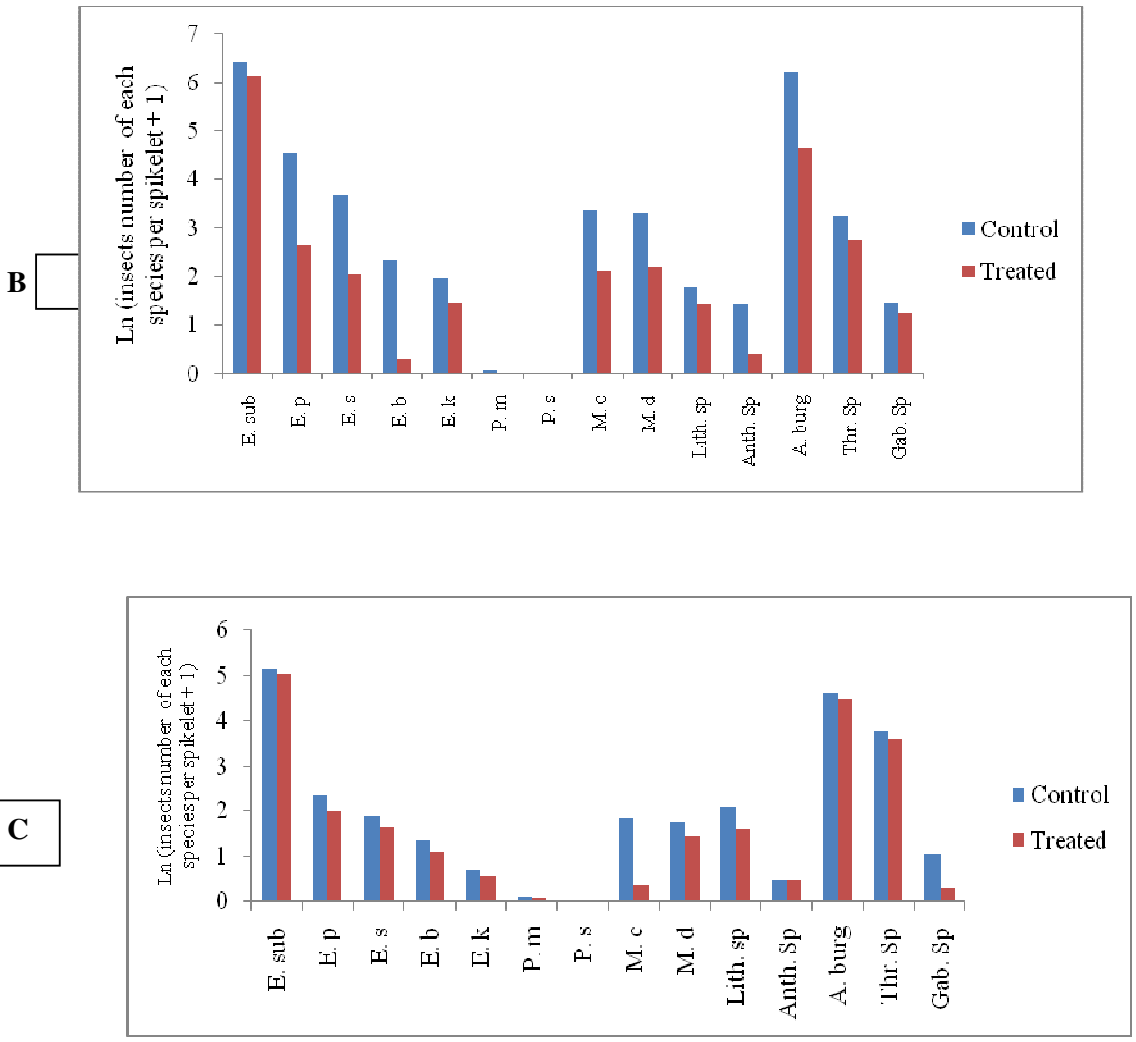


Fig.2: Effects of Evisect on insect populations of oil palm male inflorescences .Beginning (**A**), full (**B**), and end of anthesis (**C**).**E. sub**:*E. subvittatus*; **E.p**:*E. plagiatus;* **E.s**: *E. singularis*; **E.b**: *E. bilineatus*; **E.k**: *E. kamerunicus;* **P.m**:*P. minor*; **P.s**: *P. sculptilis*; **M.c**: *M. congolense*; **M.d**: *M. dispar*; **Lith. sp**: *Lithargus sp*;**Anth.sp**: *Anthocoride sp*; **A. burg**.:*A. burgeoni*; **Thr. sp**: *Thrips sp*; **Gab. sp**:*Gabruis sp*.

2. Variation in the number of insects on female inflorescences

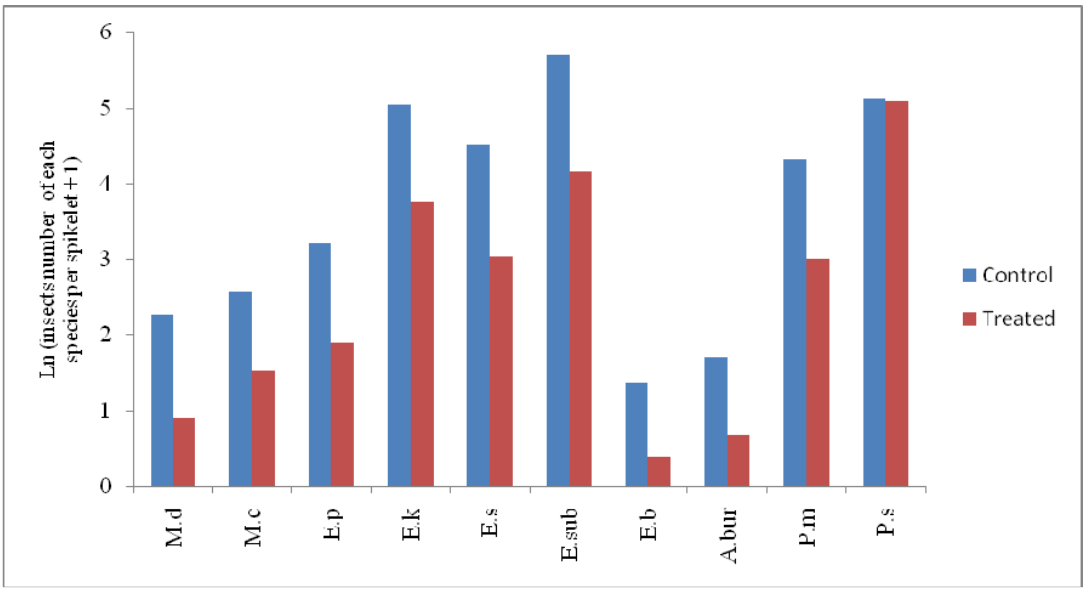
All species observed on male inflorescences were present on female inflorescences. It was noted the presence of: *E. kamerunicus*, *E. plagiatus*, *E. subvittatus, E. bilineatus*, *E. singularis*, *M. congolense, M. dis*par, *P. minor, P. sculptilis* and *Atheta burgeoni*.

2.1-First day of anthesis

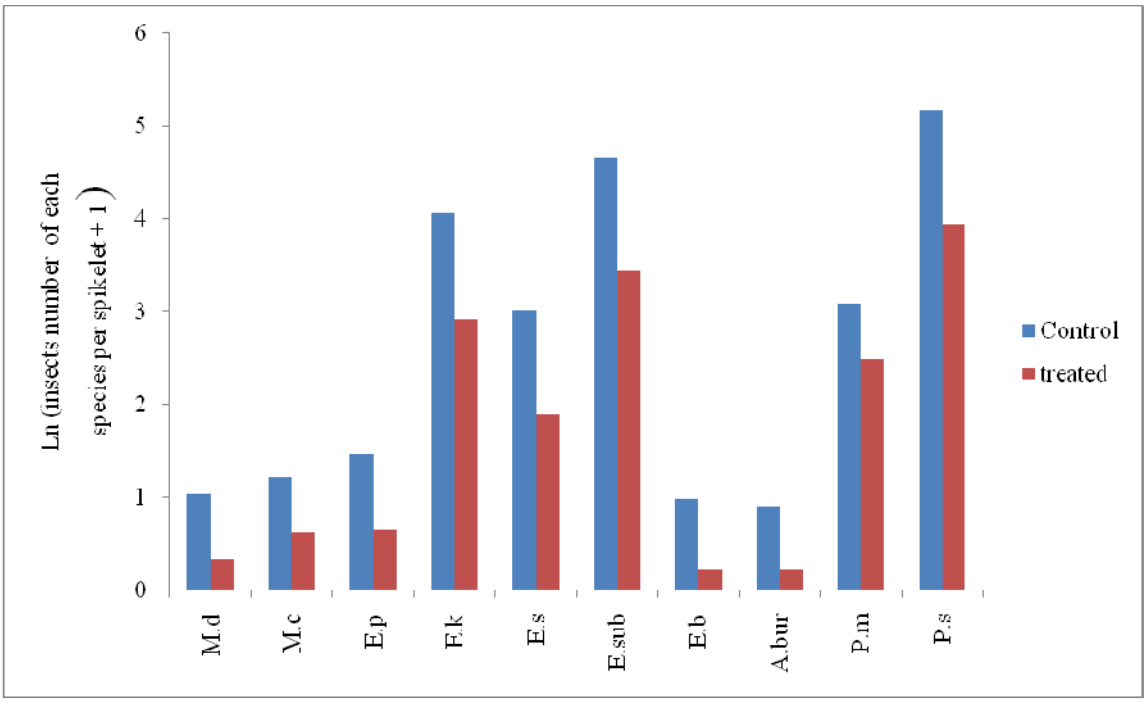
The average number of insects collected from the untreated plots (673.5 ± 5.55) was double of that obtained in the treated area (388.27 ± 6.36). All species of insects were significantly reduced in number by the chemical treatment except *P. sculptilis (*Fig.3A). There was more insect in the untreated plots than in the treated plots. These results were confirmed by analysis of variance and the Newman-Keuls test at α = 0.05 and df = 28.

2.2-Second day of anthesis

The average number of insect species collected on untreated plots (305 ± 8.51) was statistically higher than that collected after (172.93 ± 3.75) at α = 0.05 and df = 28. Chemical treatments thus significantly reduce the insect population of female inflorescences. In each case, the statistical analysis showed a significant difference between the insect population. All species of insects including *P. sculptilis* were significantly reduced in number by the chemical treatment (Fig. 3B).



A



B

Fig. 3: Effects of Evisect on insect populations of oil palm female inflorescences .First day of anthesis (**A**); Second day of anthesis (**B**), **E. sub**:*E. subvittatus*; **E.p**: *E. plagiatus;* **E.s***: E. singularis*; **E.b**: *E. bilineatus*; **E.k**: *E. kamerunicus;* **P.m**:*P. minor*; **P.s**: *P. sculptilis*; **M.c**: *M. congolense*; **M.d**: *M. dispar*; **A. bur**.: *A. burgeoni*.

Discussion

The results show that chemical treatment with thiocyclam hydrogen oxalate (Evisect®) can seriously affects the insect fauna of male and female inflorescences of oil palm. The investigations carried out on male inflorescences showed a decline of insect populations on the treated plots. Insects found on the male inflorescences constantly live in this place. These percentages can be explained by the accessibility of

insects at the stages of anthesis. Indeed, very exposed at early flowering, these insects are hidden in the stamens gradually which made contact pesticides- insects more difficult. In Côte d'Ivoire, 4 species of beetles of *Elaeidobius* genus (*kamerinicus, subvittatus*, *plagiatus* and *singularis*) provide the greatest share of pollination of oil palm (Mariau and Genty, 1988). Three of these four species: *E. subvittatus*, *E. plagiatus* and *E.singularis* were significantly affected by chemical treatments during the development of male inflorescences.

The female inflorescences are the ultimate place of pollination. All the insects species present were potentially pollinators. The arrival of insects on female inflorescences was due to the scent released by the female inflorescences. The observations showed that all species of insects were sensitive to treatment with Evisect. On female inflorescences, insects in search of nectar are much more exposed to the insecticide because of the food attraction and the fact that these insects suck nectar on the medial surface of the flower. Our results are different from those obtained by Philippe (1988) who reported that treating oil palm plantations with pesticides did not significantly affect the density of the pollinating fauna. The results of this author were difficult to explain. However, we issue the assumption that this difference can be explained by the fact that the author used a tractor with a speed higher than that of an operator that runs through the plantation by foot. The contact time of insecticide-plant may have varied considerably with any wind. Many studies have confirmed, however, the effects of insecticides on pollinators. Using trichlorfon in lucerne, Torchio (1983) observed that it can significantly reduce the fertility of females of the pollinator *Megachile rotundata* F.while Cox and Wilson (1984) found that permethrin can reduce the gathering activity of workers of honey bees. Pyrethroid, the most biodegradable pesticides and the most tolerant, has also been reported to significantly reduce populations of larvae *Megahile rotundata* (Tasei and Carré, 1987) in solitary bees.

This work shows that the treatments carried out with the thiocyclam hydrogen oxalate significantly influenced the dynamics of insect pollinators of oil palm. It is important to take into account the fact that pollination of oil palm is mainly entomophilous. To justify the value of the insecticides used against the pests of oil palm, it is imperative to make investigations of these pesticides on non-target organisms and on pollinators which are essential in the fructification of this crop. The unusual decrease in seed production could be partly explained by the use of doses of pesticides that are unfortunately deadly for pollinators.

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