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Effect of three synthetic chemical insecticides on *Cheilomenes sulphurea* (Coleoptera: Coccinellidae), a predatory insect in cotton fieldin Ferkéssedougou, northern Côte d'Ivoire.

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Abstract
Abusive use of pesticides in cotton plotsin Côte d'Ivoire is not without consequences for useful entomofauna. Very few studies based on the role of beneficial insects in pest management have been done. The study aims to knowthe effect of three pesticides on Cheilomenes sulphurea, in cotton plots. Hand capture of insect was conducted 24 hours before and 72 hours after each chemical spraying. Observations made before the first spraying showed the abundance of larvae (3.08 ± 1.83/30 plants) and adults (5.91 ± 2.6 /30 plants). Statistical analysis showed that there was no significant difference between the numbers of larvae (ddl = 11; F = 0.41 p = 0.75) and adults (ddl = 11; F = 0.13 p = 0.93). However, the number of larvae and adults of Cheilomenes sulphurea dropped considerably except in control plots after each spraying. All insecticides used were highly toxic on larvae (ddl = 11; F = 49 p = 0.000) and adults (ddl = 11; F = 50.80 p = 0.000). Cheilomenes sulphureaseems to be strongly influenced by synthetic insecticides.

Keywords: *Cheilomenes sulphurea, insecticide, cotton, Ivory Coast.*

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I. Introducion

In Côte d'Ivoire, cotton cultivation is the main source of income for the savannah populations and therefore plays a very important socio-economic role in local development [1], [2]. Cotton cultivation generates 7% of export income and contributes to 1.7% of national income [3]. The cotton sector produces an annual turnover of around 120 billion euros, 70 to 80 percent of which is in foreign currency [4].

However, the cotton sector is subject to strong pest pressure. Indeed, cotton pests in Côte d'Ivoire are particularly important and diversified [5]. During the vegetative stage, there is a dominance of stinging and sucking insects, while during the flowering and fruiting stages, it is mainly carpophagous that are the most damaging [6]. In the lack of phytosanitary protection, production losses due to arthropod pests can vary between 30 and 75%, depending on the year and the cotton-growing area [7], [8]. Several control methods have been developed through research with the objective of maintaining the level of pest damage in cotton plots at an economically acceptable level[8]. The use of chemicals for pest control remains the most widely used control method in cotton cultivation [9], [10]. However, the abuse of synthetic pesticides for the phytosanitary protection of cotton crops carries many risks for human health and the environment [11], [12]. Several studies showed that the useful entomofauna, naturally present in cotton plots and contributing effectively to the regulation of insect pest populations does not escape the toxic effect of synthetic pesticides.This is the case of *Cheilomenes sulphurea* (Coleoptera: Coccinellidae), a very abundant predator in cotton plots in Côte d'Ivoire [2]. The objective of the study wasto analyse the effect of three binary insecticides :Emamectine benzoate 24g/l and Acetamiprid 32 g/l (Thalis 56 EC) ; Profenophos 300 g/l and Cypermethrin 36 g/ l (Duel 336 EC) ; Acetamiprid 16 g/l and Cypermethrin 72 g/l(Conquest 88 EC) used in the field on the ladybird *Cheilomenes sulphurea*.

II. Materials And Methods

Study area

The work was carried out in an experimental condition in Tiékpè area, precisely in Tchologo region (9° 35′ 00″ north, and 5° 11′ 00″ west) located in the north of Côte d'Ivoire (Figure 1). The climate is Sudanese with two main seasons: a dry season from November to April characterised by the harmattan with peaks in December and February, and a rainy season from may to october with peaks in august and september. The Tchologo region has an average annual temperature of 26.4°C and a rainfall of 1260 mm.

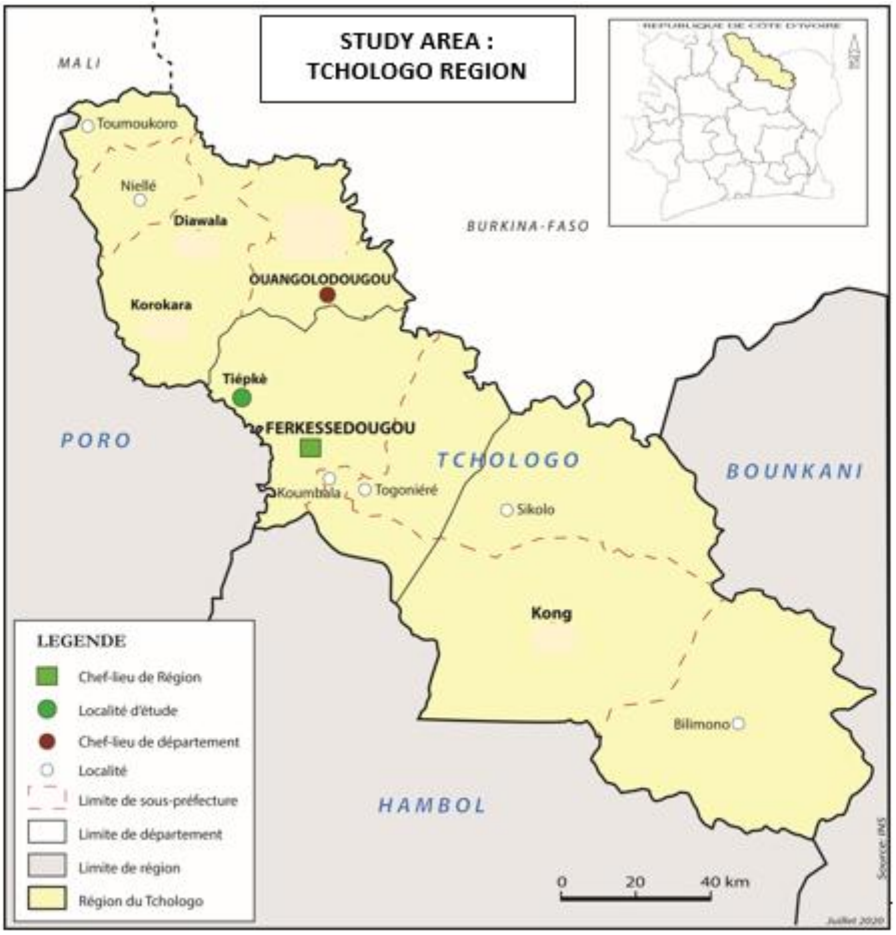

Figure 1 : Study Area

Vegetal material
The study was carried out with a variety of cotton plant *Gossypium hirsutum* L. It is GOUASSOU F1. This material is vulgarised for its agronomic performance (varieties with a high yield potential of 4000 kg/ha) and its tolerance to certain fungal diseases.

Animal material
The animal material consists of larvae and adults, one of the most abundant species of *Cheilomenes sulphurea*(Coleoptera : Coccinellidae), observed in cotton plots in Ferkéssedougou region [2].

Chemical material
The chemical material consisted of binary insecticides formulations with active ingredients most vulgarisedin Tchologo region (table).

Table : Liste of insecticid

Formulation	Active ingredient	Concentrations (g/l)	Chemical family	Rate of use (l/ha)
Thalis 56 EC	Emamectine benzoate	24	Avermectins	1
	Acetamiprid	32	Neonicotinoids	
Duel 336 EC	Profenophos	300	Organophosphates	1
	Cypermethrin	36	Pyrethroids	
Conquest 88 EC	Acetamiprid	16	Neonicotinoids	1
	Cypermethrin	72	Pyrethrinoids	

III. Methods

Experimental design

The trial was carried out in Fisher blocks with 4 treatments (Control plots, Thalis 56 EC, Duel 336 EC and Conquest 88 EC) and 3 repetitions. Each elementary plot was 10 m long and wide covering 6 seeding lines. The spacing between the lines was 80 cm. The distance between the plants in a row was 30 m. The distance between the blocks was 2 m.

Insecticide treatments

For each insecticide product, 6 treatments were carried out at intervals of 14 days, from the 45th to the 128th day after emergence: 2 treatments at the vegetative stage, 2 treatments at the vegetative-fruiting stage and 2 treatments at the fruiting stage. The quantities of product were brought back to the real surface of the plot and dissolved in the OSATU 16 sprayer with 15 liters of useful capacity. The control plots did not receive any insecticide treatment.

Sampling methods

Twelve (12) observation sessions were made by counting on each elementary plot according to the phenological stages of the cotton plant (the vegetative stage, the vegetative-fruiting stage and the fruiting stage) in order to evaluate the effect of insecticides. This method consisted in recording the larvae and adults of *Cheilomenes sulphurea* met on 30 cotton plants taken at random on each elementary plots following the diagonal. Observations were made at 24 hours before each spraying and 72 hours afterwards.

Data analysis.

The statistical analyses were carried out using IBM-SPSS statistical software. The various data were analysed using a parametric approach. One-factor analyses of variance (ANOVA 1) were carried out to compare the means obtained for each treatment. In the case of significant differences, the 5% Fisher multiple comparison test was carried out to identify homogeneous groups.

IV. Results

Effect of the three insecticides

Before the first spraying of the differentes insecticids in the plot, larvae (3.08 ± 1.83/30 plants) and adults (5.91 ± 2.6 /30 plants) of *C. sulphurea*were observed in all the plots. The results of analysis indicated that there was no significant difference between the numbers of larvae (ddl = 11; F = 0.41 p = 0.75), adults (ddl = 11; F = 0.13 p = 0.93) and treatments (Figure 2). However, 72 hours after the first spraying of insecticides,the number of larvae (1.5 ± 2.11 / 30 plants) and adults (3.00 ± 4.5 /30 plants) dropped considerably except in control plots after each spraying. The analysis of variance showed a highly significant effect of the active ingredients used on larvae (ddl = 11; F = 13.66 p = 0.002) and adults (ddl = 11; F = 17.87 p = 0.001). In fact, the average numbers of larvae and adults decreased considerably in the plots treated with the chemical Thalis 56 EC (emamectin benzoate 24 g/l and acetamiprid 32 g/l), Duel 336 EC (profenophos 300 g/l and cypermethrin 36 g/l) and Conquest 88 EC (acetamiprid 16 g/l and cypermethrin 72 g/l). A high population of larvae (1.66 ± 1.15 /30 plants) and adults (10.00 ± 3.46/30 plants) was observed in the untreated plots (Figure 3).

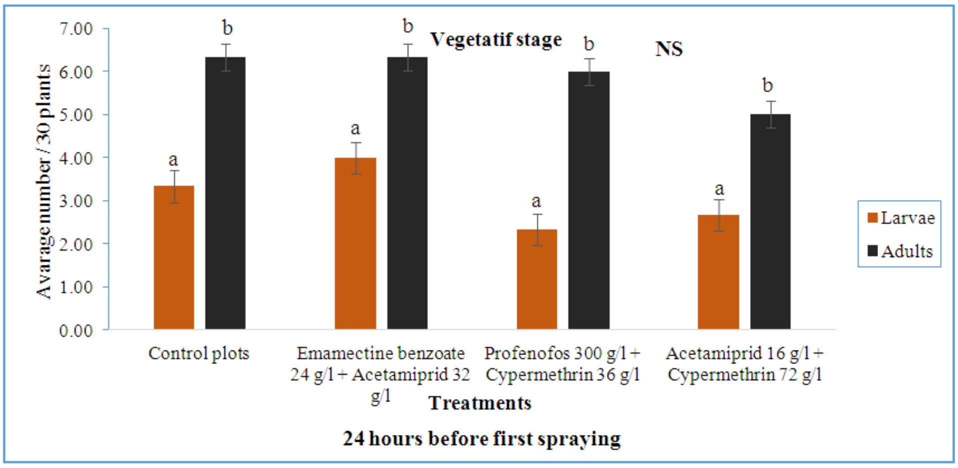

Figure 2: Mean number of larvae and adults of *Cheilomenes sulphurea*in different plots, 24 H before the first spraying

Histograms with the same letter do not differ statistically from each other (Fisher's test at the 5% threshold).

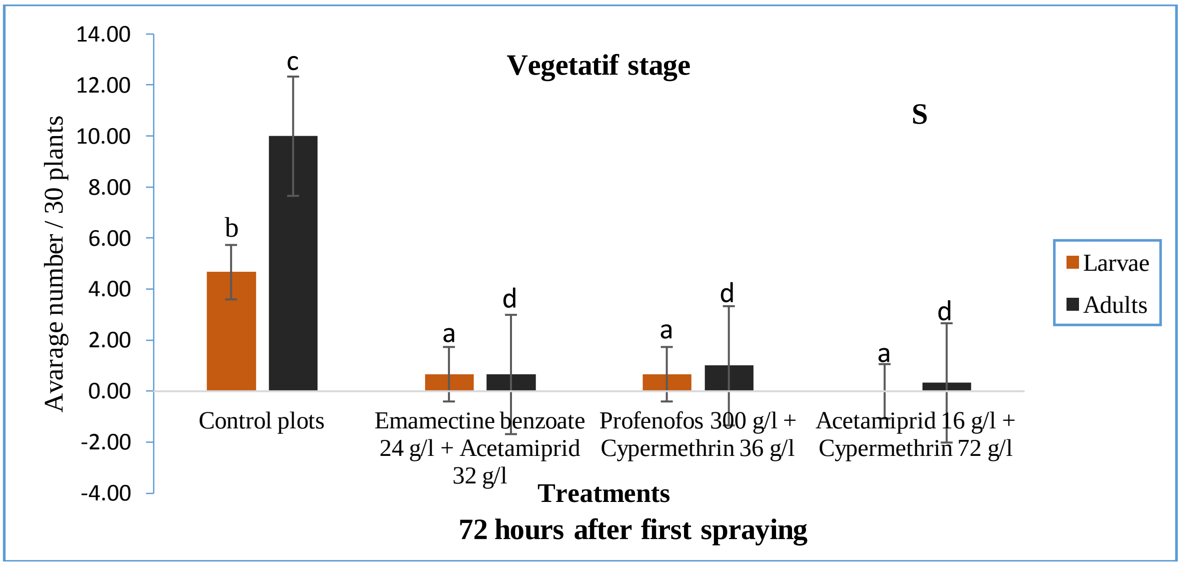

Figure 3: Effect of insecticides on *Cheilomenes sulphurea*, 72 after first spraying
Histograms with the same letter do not differ statistically from each other (Fisher's test at the 5% threshold).

Effects of the three insecticides on the fruiting and vegetative stage

During this stage, observations made on the different treatments showed higher average numbers of larvae (8.00 ± 5.29 / 30 plants) and adults (25.00 ± 14.17 /30 plants) in the control plots than in the treated plots, 24 hours before and 72 hours after the spraying of the insecticides. Also, the results of the analysis of variance indicate significant relationships between the different insecticides and the numbers of larvae and adults of Coccinellidae (Figure 4).

24 hours before the second insecticide application the analysis of variance showed a highly significant effect of the active ingredients used in the first insecticide application on larvae (ddl = 11; F =5.65 p = 0.002) and adults (ddl = 11; F = 7.99 p = 0.009) due to the remanence of the insecticides (Figure 4).The same observation was made during 72 hours post-use surveys on larvae (ddl = 11; F = 49 p = 0.000) and adults (ddl = 11; F = 50.80 p = 0.000) (Figure 5). Indeed, almost no larvae and adults of Coccinellidae were observed on the plots 72 hours after use of Thalis 56 EC, Duel 336 EC and Conquest 88 EC, compared to the first insecticide application (ddl = 11; F = 7.99 p = 0.009). The same observation was made during the 72 hours post-use surveys on larvae (ddl = 11; F = 49 p = 0.000) and adults (ddl = 11; F = 50.80 p = 0.000) (Figure 5). Indeed, almost no larvae and adults of Coccinellidae were observed on the plots 72 hours after the use of Thalis 56 EC, Duel 336 EC and Conquest 88 EC, as opposed to the control plots (07 ± 0.00 larvae /30 plants) and adults (24.66 ± 5.77 adults /30 plants).

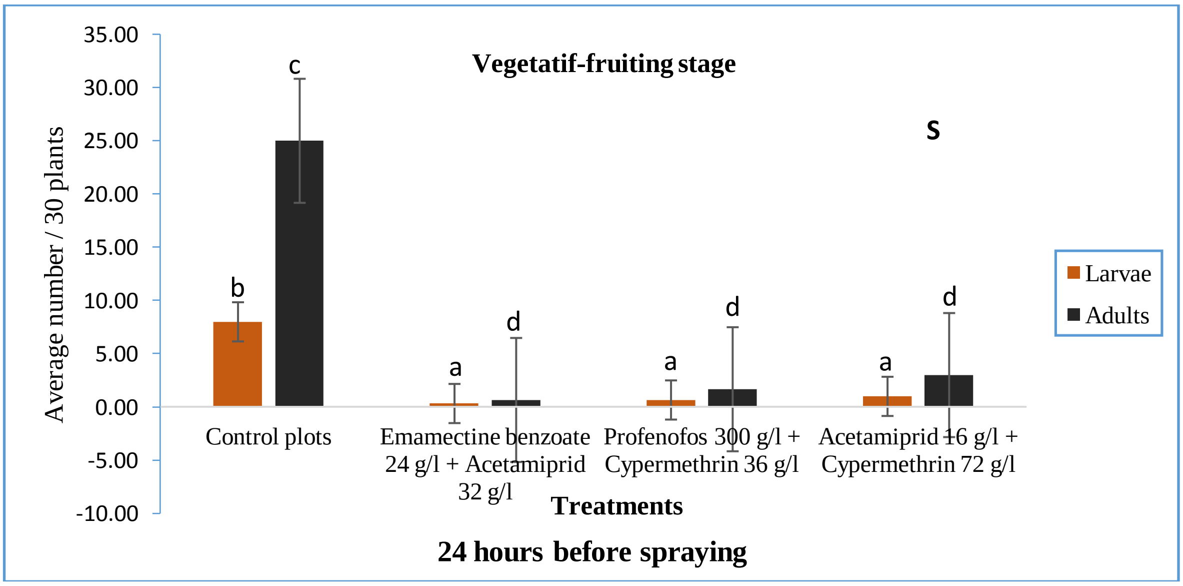

Figure 4: Effect of insecticides on *Cheilomenes sulphurea* 24 hours before the second spraying
Histograms with the same letter do not differ statistically from each other (Fisher's test at the 5% threshold).

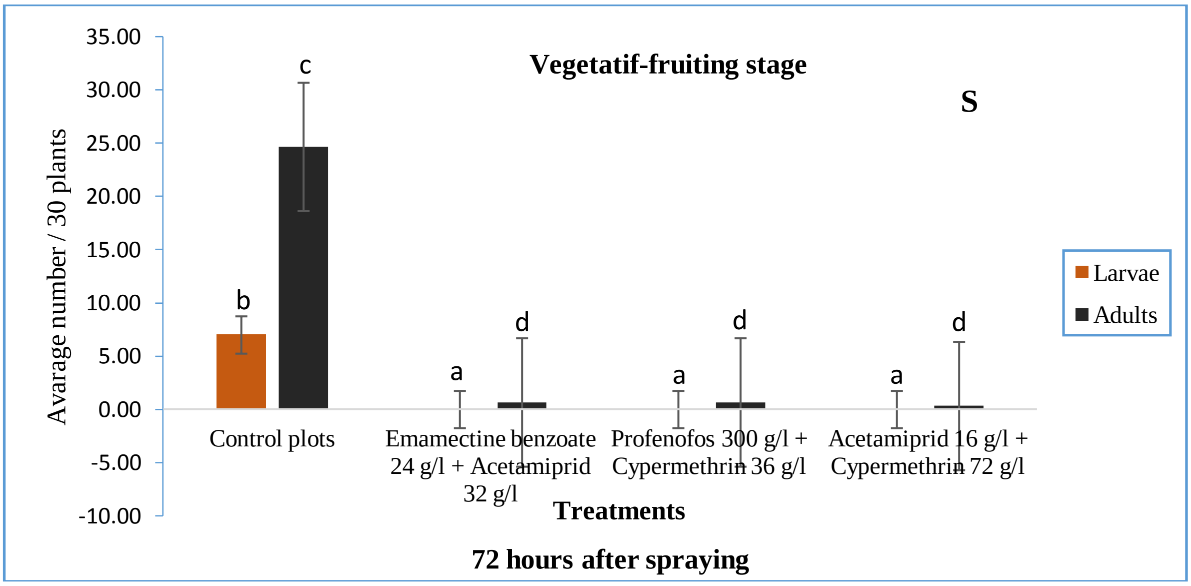

Figure 5: Effect of insecticides on *Cheilomenes sulphurea* 72 hours after second spraying
Histograms with the same letter do not differ statistically from each other (Fisher's test at the 5% threshold)

Effects of the three insecticides at the fruiting stage

The average numbers of larvae and adults of *Cheilomenes sulphurea* increased 24 hours before the third spraying of the plots compared to the last insecticide spraying of the vegetative-fruit stage. Thus, the respective mean numbers of larvae and adults (07.00 ± 01.00 / 30 plants) and (26.66 ± 5.03 /30 plants) were observed in the control plots. However, on plots sprayed with Thalis 56 EC (02.00 ± 1.00 larvae /30 plants) and (08.33 ± 0.57 adults /30 plants) were observed, for Duel 336 EC (01.66 ± 0.57 larvae /30 plants) and (06.33 ± 03.21 adults /30 plants) and on plots sprayed with Conquest 88 EC observed (01.66 ± 0.57 larvae / 30 plants) and (04.66 ± 1.52 adults / 30 plants). However, the results of the synthetic insecticide toxicity effect tests indicated that there was a highly significant difference between the numbers of larvae and treatments (ddl = 11; F = 32.70 p = 0.000) and between adults and treatments (ddl = 11; F = 30.79 ; p = 0.000) (Figure 6). But, 72 hours after spraying the insecticides, the numbers of larvae and adults observed are very significantly different on treatments. In fact, the results of the analysis of variance indicated a highly toxic effect of the insecticides on the survival of the populations of larvae (ddl = 11; F = 96.57 p = 0.000) and adults (ddl = 11; F = 117.56 ; p = 0.000) of Coccinellidae (Figure 7).

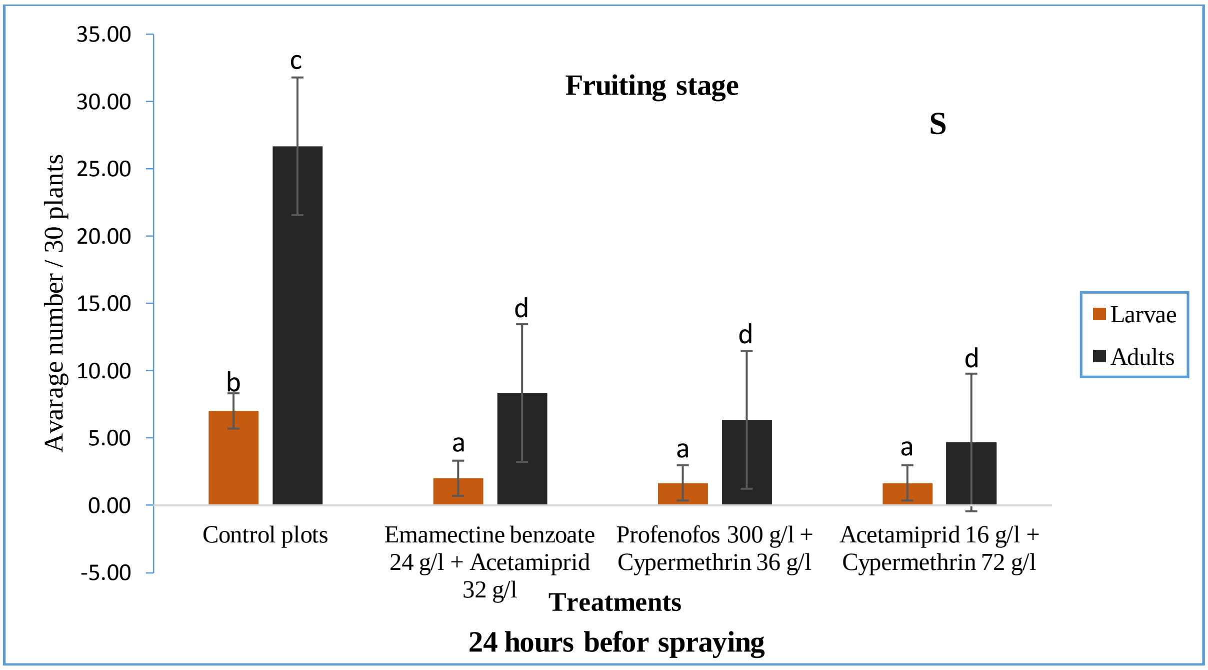

Figure 6: Effect of insecticides on *Cheilomenes sulphurea* 24 hours before the third spraying
Histograms with the same letter do not differ statistically from each other (Fisher's test at the 5% threshold)

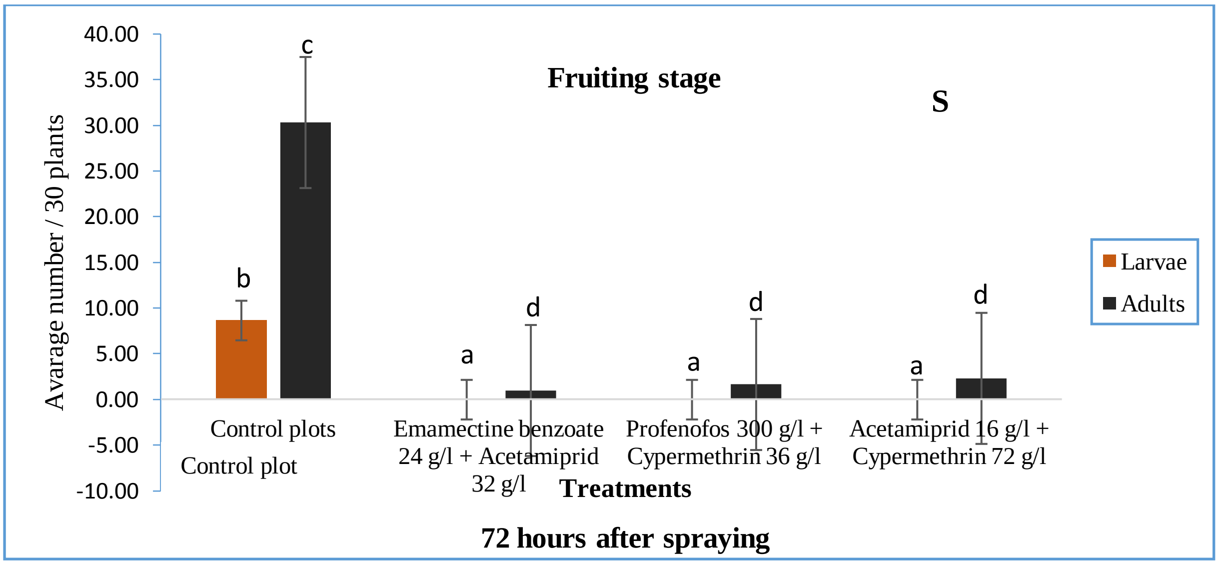

Figure 7: Effect of insecticides on *Cheilomenes sulphurea* 72 hours after third spraying
Histograms with the same letter do not differ statistically from each other (Fisher's test at the 5% threshold).

V. Discussion

The results show that, the beneficial insect *Cheilomenes sulphurea* is very sensitive to synthetic active ingredients of the avermectin, neonicotinoid, organophosphorus and pyrethroid families. These results show that the role of useful entomofauna in the regulation of cotton insect pests would not be taken into account in cotton phytosanitary protection programs in Côte d'Ivoire. These results are similar to those obtained by [9], who showed in their study, the effect of Lambdacyhalothrin 5% EC on *Cheilomenes lunata*, *Cheilomenes sulphurea* and *Cheilomenes propinqua* in cotton plots in Tanzania. Thalis 56 EC, mixed with emamectin benzoate 24 g/l, an active ingredient of the avermectin family, and acetamiprid 32 g/l of the neonicotinoid chemical family is used as an alternative to pyrethroids to manage *H. armigera* resistance in the phytosanitary control of cotton plants against insect pests of the vegetative stage of cotton. In fact, emamectin benzoate, an active ingredient with an ovo-larvicide effect acting by ingestion and contact, could have a very toxic effect on the larvae of *Cheilomenes sulphurea*. A similar observation was reported by [13] who indicated in their work the effect of emamectin benzoate in the host tree on the survival of the early larval stages of the boxwood borer. They showed the significant effect of emamectin benzoate treatment on the mortality of young larvae 9 to 11 days after oviposition. Similarly, the low numbers of larvae observed during spraying periods could be caused by the effect of insecticides on the reproductive cycle of *Cheilomenes sulphurea*.These results are close to those obtained by [14], mentioned by [15], who reported that abamectin 18g /L,use at 1.2 L/ha is very effecient on mites and then it can cause 100% mortality after the first treatment. The results of the study also show that Duel 336 EC, mixed with profenophos 300 g/l of the organophosphorus family and cypermethrin 36 g/l of the pyrethroid family, contributes to the reduction of *Cheilomenes sulphurea* populations in the sprayed plots. This reduction of the species could be due to the repellent effect of profenophos on larvae and adults and the high toxicity of pyrethroids on non-target insects. According to [16], insecticides could have a repellent effect on beneficial insects. This argument is in accordance with [17] who reported that the larvae and adults of the ladybird beetle (Coccinella septempunctata) consume a smaller quantity of aphids if they have been previously treated with dimethoate, an organophosphate. Similarly, the reduction in the larval and adult populations of *Cheilomenes sulphurea* could be explained by a change in the insect's physiology caused by the effect of insecticides. These chemicals could affect the development of Coccinellidae larvae and adults, as indicated by [16] in his work on the study of the effects of insecticide exposure on a model insect, *Drosophila melanogaster*, generally resulting in an increase in development time, the appearance of morphological malformations or an increase in larval or pupal mortality. These results are similar to those of [18], which showed that the development of the Asian ladybird *Harmonia axyridis* is delayed in the presence of sublethal doses of certain neurotoxic substances such as spinosad and indoxacarb.

VI. Conclusion

The active ingredients used in the farming environment to control cotton insect pests have shown very toxic effects on non-target insects, particularly *Cheilomenes sulphurea*. Analysis of the results showed that the active ingredients emamectin benzoate, acetamiprid, profenophos and cypermethrin are all highly toxic to the beneficial insect *Cheilomenes sulphurea*, which is very abundant in cotton plots in the Tchologo region.

However, more detailed studies are needed to determine the effect of new active ingredients on *Cheilomenes sulphurea* considering its important role in the phytosanitary protection of cotton.

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