INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
24–0550/2025/33:330314
http://www.fspublishers.org

Full Length Article

Control of Three Cotton Major Insect Pests in North-West of Côte d'Ivoire

Diabate Dohouonan[1*], Diby Yao Kan Seraphin[2], Fondio Drissa[3], Akpesse Akpa Alexandre Moïse[2] and Tano Yao[4]
[1]*University of Man, UFR Agronomic, Forestry and Environmental Engineering, Department of Agronomy and Forestry Department, BP 20 Man, Côte d'Ivoire*
[2]*University Félix Houphouët-Boigny, UFR Biosciences, 22 BP 582 Abidjan 22, Côte d'Ivoire*
[3]*University Jean Lorougnon Guédé, UFR Agroforestery, BP 150 Daloa, Côte d'Ivoire*
[4]*University Nangui Abrogoua, 02 BP 801 Abidjan 02, Côte d'Ivoire*
[*]For correspondence: diabdoh@yahoo.fr; ORCID ID 0000-0003-1911-5628
Received 26 October 2024; Accepted 25 November 2024; Published online 25 December 2024

Editor: Zafar Iqbal

Abstract

Cotton harbors a large number of insects that limit its yield despite insecticides spray. This study was carried out to evaluated the efficacy of new insecticides against three cotton insect pests during 2022–2024. Each insecticide and the control were sprayed on 0.5 ha divided into 5 equal parts. *Bemisia tabaci* adults, *Helicoverpa armigera* and *Earias* sp. larvae were recorded on a central line of 30 plants per elementary plot. The cotton bolls attacked rate and the yield of the treatments were evaluated. The effectiveness of CORONI 672 EC®cypermethrin 72 g/L + profenofos 600 g/L and ZIDANE 30W®flonicamide 30 g/kg were lower on *B. tabaci* than INDOXAN DUO 225EC®Indoxacarb 125 g/L + acetamiprid 100 g/L, JACOBIELLA 350EC®Pyridine 200 g/L + diamine 150 g/L and Tihan 175 OD®Spirotetramate 75 g/L + flubendiamide 100 g/L, respectively. All the insecticides were effective against *H. armigera*. Indoxacarb 125 g/L + acetamiprid 100 g/L (8 larvae), flonicamide 30 g/kg (2 larvae) and cypermethrin 72 g/L + profenofos 600 g/L (1, 25 larvae) were less effective on *Earias* sp. than Pyridine 200 g/L + diamine 150 g/L and Spirotetramate 75 g/L + flubendiamide 100 g/L. Boll attack rates were higher in the control plots CORONI 672EC® (3.36%) and lowest in plots treated with Tihan 175 OD (2.43%), ZIDANE + 30WG® (1.91%), INDOXAN DUO 225EC (1.67%) and JACOBIELLA 350EC® (0.93%). Cotton yields were higher with these these insecticides compared with the control CORONI 672 EC®. Acetamipride + Indoxacarb, Pyridine + Diamine, Acetamiprid + Lambdacyhalothrin and O,O-dimethyl s-phthalimidomethyl can be used for cotton protection.

Keywords: Acetamipride + indoxacarb; *Bemisia tabaci*; Cotton; *Helicoverpa armigera*; O,O-dimethyl s-phthalimidomethyl

Introduction

Cotton is an important cash crop that growing in the north and northwest of Côte d'Ivoire (Diabaté 2009, 2017, 2024). In West Africa and particularly in Côte d'Ivoire, insect pests reduced cotton yields and its quality (Brévault *et al.* 2019; Diabaté *et al.* 2024). *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) is a major pest of cotton (Haider *et al.* 2023; Tenguri *et al.* 2023). Without chemical control, *B. tabaci* (Gennadius) (Homoptera : Aleyrodidae) bites on cotton plants and injects viruses that reduced cotton quality and their yield (Brévault *et al.* 2019; El-Sherbeni *et al.* 2019; Diabaté *et al.* 2024). These insects settle in colonies on the underside of cotton leaves, sucking the sap and creating lesions on the leaves and stems. Its secretes honey dey that reduces cotton photosynthesis and the quality of harvested fibers, as well as yield (Diabaté *et al.* 2017; Brévault *et al.* 2019*)*. Yield losses can be as high as 100%. The larvae of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) and *Earias* sp. attacked cotton bolls and reduced cotton yield (Javed *et al*. 2018; Brévault *et al.* 2019; Diabaté *et al.* 2024). These insect pests were responsible for considerable yield losses by destroying cotton leafs and fruiting bodies, flower buds and young bolls, and damaging the fibers of older cotton bolls (Sagar and Nebapure 2018; Brévault *et al*. 2019; Jafari *et al*. 2023; Sheoran *et al.* 2023). Their larvae empty the inside of cotton bolls, causing them to rot and cotton yield losses ranging from 24.7 to 100% (Kranthi *et al.* 2002; Brévault *et al.* 2019). However, these insect pests are increasingly resistant to the insecticides commonly used by the farmers for cotton protection. Numerous studies have shown that insect populations develop resistance to organophosphates, carbamates, pyrethroids, diamide insecticides such as chlirantraniliprole, benzoates and

To cite this paper: Dohouonan D, DYK Seraphin, F Drissa, AAA Moïse, T Yao (2025). Control of three cotton major insect pests in North-West of Côte d'Ivoire. *Intl J Agric Biol* 33:330314. https://doi.org/10.17957/IJAB/15.2290

spinosad (Kranthi *et al*. 2002; Srinivas *et al.* 2004; Ghosh *et al.* 2010; Bade and Bhamare 2023) and to toxins derived from *Bacillus thuringiensis* (Zhang *et al*. 2011). These insecticide resistance is thought to be linked to the insecticide's inability to bind to acetylcholinesterase and render it inactive (Srinivas *et al.* 2004). Thus, insect control is becoming a major constraint for cotton production in Côte d'Ivoire. Then this study carried out to evaluate the efficacy of new insecticides against *B. tabaci*, *H. armigera* and *Earias* sp. on cotton cultivation in Odienné department, western of Côte d'Ivoire. The aim was to assess the efficacy of these insecticides on the number of these insect pest on cotton plants, on the bolls attacked rate, and on cotton yield, with a view to selecting the best insecticides for cotton protection.

Materials and Methods

Study site

The work was carried out at the Ivory Company's cotton observation stations in the Odienné department in north-west Côte d'Ivoire (6°49'W and 9°53'N). These experiments were carried out in the same agro-ecological zone. The climate of the study area is characterized by two seasons: a dry season from October to May and a rainy season from June to September. The average annual rainfall is 1,200 mm and the average annual temperature is 28°C (Saley 2003).

Experimental design

The experimental set-up used consisted of 5 treatments and 5 replications covering 2.5 hectares of cotton, established during the 2022–2023 and 2023–2024, respectively. Each treatment was carried out on 0.5 hectares divided into 5 equal parts and each part was an elementary plot. The control insecticide was CORONI 672EC (Table 1). Each half-hectare was widely spaced to avoid edge effects. The insecticides were applied between 6 a.m. and 8 a.m. on the same day every two weeks. The efficacy of the different treatments was determined by weekly insect surveys of *B. tabaci* on cotton plants and of *H. armigera* and *Earias* sp. on cotton bolls.

Sampling of *B. tabaci* adults on cotton plants

Sampling of *B. tabaci* adults were recorded each week, from 38^{th} to 59^{th} Day after emergence, three days after treatment, on a central line of 30 plants per elementary plot between 6 a.m. and 8 a.m., *i.e.*, on 150 plants per treatment. During each observation, one upper, one central leaf and one leaf in the lower part of each plant were observed. Thus, 90 cotton leaves were observed per elementary plot.

Sampling of *H. armigera* and *Earias* sp. larvae on cotton

Green cotton bolls were harvested according to the positions: 1–1 (first position on the lowest fruiting branch) on the 94^{th} day after emergence, 2–1 (first position on the second fruiting branch) on the 101^{st} day after emergence, 3–1 (first position on the third fruiting branch) on the 108^{th} day after emergence and 4–1 (first position on the fourth fruiting branch) on the 115^{th} day after emergence. The bolls were opened, the attacked and healthy bolls were separated and *H. armigera* and *Earias* sp. larvae were recorded. The attack rate of cotton bolls in the plots treated with the insecticides tested was calculated.

Cotton yield of different plots treated with the insecticides

Cotton yield for the insecticides tested was calculated from seed cotton harvested on four central lines of each elementary plot from 130 JAL to 175 JAL according to the following formula:

$$Y = \frac{W * 10000}{S} \qquad (2)$$

With:
Y = yield (kg/ha);
W = weight of the cotton collected on 32 m^2;
S = cotton harvesting area in m^2 (S = 32 m^2).

Results

Effectiveness of insecticides tested during the cotton season 2022–2023 on *B. tabaci* adults, *H. armigera* and *Earias* sp. larvae

During the cotton season 2022–2023, the insecticides CORONI 672 EC®Cypermethrin 72 g/L + profenofos 600 g/L (6.25 *B. tabaci* adults/plant) and ZIDANE + 30WG®Flonicamid 30 g/kg (3.75 adults/plant) were less effective on *B. tabaci* adults. INDOXAN DUO 225EC®Indoxacarb 125 g/L + acetamiprid 100 g/L, JACOBIELLA 350EC®Pyridine 200 g/L + diamine 150 g/L and Tihan 175 OD®Spirotetramate 75 g/L + flubendiamide 100g/L were highly effective against *B. tabaci* (F = 36.806; $P < 0.0001$). All the insecticides used in this study significantly reduced *H. armigera* larvae number on cotton plants. The insecticides CORONI 672 EC®, ZIDANE+ 30 WG®, INDOXAN DUO 225EC®, JACOBIELLA 350EC® prevented *H. armigera* from attacking cotton bolls. Some larvae of *H. armigera* (0.33 larvae/plant) were collected on cotton plants treated with Tihan 175 OD® (F = 1.64; $P = 0.198$). The efficacy of the insecticides INDOXAN DUO 225EC® (8 *Earias* larvae/plant), ZIDANE + 30 WG® (2 *Earias* larvae/plant) and CORONI 672 EC® (1.25 *Earias* larvae/plant) were lowest than those of JACOBIELLA 350EC® and Tihan 175 OD®. The insecticides JACOBIELLA 350EC® and Tihan 175 OD® prevented *Earias* sp. attack on cotton (F = 35.400; $P < 0.0001$) (Table 2).

Table 1: Insecticides used to spray cotton farms against insect pests during 2022–2023 and 2023–2024

Insecticides		Application year	Active substances	Concentration/ha
Control	CORONI 672EC	2022–2023/2023–2024	Cypermethrin 72 g/L + profenofos 600 g/L	500 mL/ha
Tested	THIAN 175 O-TEQ	2022–2023	Spirotetramate 75g/L + flubendiamide 100 g/L	200 mL/ha
Tested	JACOBIELLA 350EC	2022–2023	Pyridine 200 g/L + diamine 150 g/L	500 mL/ha
Tested	ZIDANE + 30 WG	2022–2023	Flonicamid 30 g/kg	150 kg /ha
Tested	INDOXAN DUO 225EC	2022–2023	Indoxacarb 125 g/L + acetamiprid 100 g/L	250 mL/ha
Tested	NICOMEDE 500 W	2023–2024	Flonicamid 500 g/kg	100 g/ha
Tested	TSUNAMIDE 280 OD	2023–2024	Flonicamid 200 g/L + flubendiamid 80 g/L	250 mL/ha
Tested	CYLODAN 42%	2023–2024	O,O-dimethyl s-phthalimidomethyl	500 g/ha
Tested	GARANT 200 WG	2023–2024	Acetamiprid 100 g/L + lambdacyhalothrin 100 g/L	0.1 kg/ha

Table 2: Effectiveness of insecticides against *B. tabaci*, *H. armigera* and *Earias* sp. on cotton bolls during cotton season 2022–2023

Insecticides tested 2022-2023	*B. tabaci*	*H. armigera*	*Earias* sp.	Healthy bolls	Attacked bolls	Total bolls	Attack rate (%)
Cypermethrin 72 g/L + profenofos 600 g/L / CORONI 672 EC	6.25c	0a	1.25b	230.5 b	8b	238.5b	3.36c
Indoxacarb 125 g/L + acetamiprid 100 g/L / INDOXAN DUO 225EC	0a	0a	8c	235 b	4ab	239b	1.67b
Pyridine 200 g/L + diamine 150 g/L / JACOBIELLA 350EC	0a	0a	0a	212 c	2a	214c	0.93a
Spirotetramate 75g/L + flubendiamide 100g/L / Tihan 175 OD	0a	0.33a	0a	251a	6.25ab	257.25a	2.43bc
Flonicamid 30 g/kg / ZIDANE + 30 WG	3.75b	0a	2b	231b	4.5ab	235.5b	1.91b
F	36.806	1.643	35.400	16.358	5.222	20.877	4.882
P	<0.0001	0.198	<0.0001	<0.0001	0.008	<0.0001	0.010

Means assigned to the same letter within the same column do not differ statistically (Fisher LSD test, $P < 0.05$)

Effectiveness of insecticides during the season 2022–2023 on cotton bolls and the yield

Similar total number of cotton bolls were harvested in plots treated with CORONI 672EC® (238.5 bolls), INDOXAN DUO 225EC® (239 bolls) and ZIDANE + 30 WG® (235.5 bolls). The lowest total number of cotton bolls was recorded in the plots treated with JACOBIELLA 350EC® (214 bolls) and the highest was in the plots treated with Tihan 175 OD® with a avarage of 257.25 cotton bolls (F = 20.877; $P < 0.0001$). The healthy cotton bolls harvested was average and similar in the plots treated with CORONI 672EC® (230.5 bolls), INDOXAN DUO 225EC® (235 bolls) and ZIDANE+ 30 WG® (231 bolls). Its were lower on plots treated with JACOBIELLA 350EC® (212 bolls) and higher on plots treated with Tihan 175 OD® with 251 healthy bolls (F = 16.358; $P <0.0001$). The lowest cotton bolls attacked by *H. armigera* and *Earias* sp. were recorded with JACOBIELLA 350EC® (2 attacked bolls) and followed by INDOXAN DUO 225EC® (4 bolls attacked), ZIDANE+ 30 WG® (4.5 bolls attacked) and Tihan 175 OD® with 6.25 bolls attacked. The highest cotton bolls attacked were recorded in the plots treated with CORONI 672 EC® with a avarage of 8 cotton bolls attacked (F = 5.222; $P = 0.008$). Cotton bolls attacked rates by *H. armigera* and *Earias* sp. were higher on plots treated with the insecticides CORONI 672 EC® (3.36%), medium with Tihan 175 OD® (2.43%), ZIDANE + 30 WG® (1.91%) and INDOXAN DUO 225EC® (1.67%) and lowest with JACOBIELLA 350EC® with a cotton bolls attacked rate of 0.93% (F = 4.882; $P = 0.010$) (Table 2).

In 2022–2023, The highest cotton yields were obtained with the two insecticides Tihan 175 OD (964.25 kg/ha) and ZIDAN + 30 WG (982 kg/ha). JACOBIELLA 350 EC (836 kg/ha) and INDOXAN DUO 225EC (822 kg/ha) and the control CORONI 672 EC (815.5 kg/ha) have similar cotton yield (Fig. 1).

Effectiveness of insecticides tested during the cotton season 2023–2024 on *B. tabaci* adults, *H. armigera* and *Earias* sp.

During the cotton season 2023–2024, *B. tabaci* was not observed on plots treated with the insecticides GARANT 200 WG®Acetamiprid 100 g/L + lambdacyhalothrin 100 g/L and NICOMEDE 500 WG®Flonicamid 500 g/kg. The insecticides CYLODAN 42%®O,O-dimethyl s-phthalimidomethyl (6 adults) and Tsunamide 280 OD®Flonicamid 200 g/L + flubendiamid 80 g/L (6 adults) and CORONI 672 EC®Cypermethrin 72 g/L + profenofos 600 g/L (5.75 adults) have similar effectiveness against *B. tabaci* (F = 25.228; $P < 0.0001$). The insecticides CORONI 672 EC®, CYLODAN 42%®, GARANT 200 WG®, NICOMEDE 500 WG® and Tsunamide 280 OD® had similar efficacy against *H. armigera* larvae on cotton plants. CYLODAN 42%® and GARANT 200 WG® prevented *H. armigera* from attacking cotton plants (F = 1.162 ; $P = 0.353$). GARANT 200 WG®, NICOMEDE 500 WG® and Tsunamide 280 OD® were most effective against *Earias* sp. than NICOMEDE 500 WG® (0.63 larvae), CORONI 672 EC® (0.75 larvae) and CYLODAN 42%® (1 larvae). *Earias* sp. larvae were not collected on plots treated with GARANT 200 WG® and Tsunamide 280 OD® (F = 5.970; $P = 0.002$) (Table 3).

Effectiveness of insecticides during the season 2023–2024 on cotton bolls and the yield

The number of cotton total bolls collected on plots treated with CYCLODAN 42% (313 bolls) and NICOMEDE

Table 3: Effectiveness of insecticides sprayed on cotton during 2023–2024 against *B. tabaci*, *H. armigera* and *Earias* sp., and on cotton bolls

Insecticides tested 2023–2024	*B. tabaci*	*H. armigera*	*Earias* sp.	Healthy bolls	Attacked bolls	Total bolls	Attack rate (%)
Cypermethrin 72 g/L + profenofos 600 g/L / CORONI 672 EC	5.75a	0.25	0.75ab	268.25b	4b	272.25b	1.48a
O,O-dimethyl s-phthalimidomethyl / CYLODAN 42%	6a	0	1a	311a	2ab	313a	0.64bc
Acetamiprid 100 g/L + lambdacyhalothrin 100 g/L / GARANT 200 WG	0b	0	0b	272b	2.5b	274.5b	0.92ab
Flonicamid 500 g/kg / NICOMEDE 500 WG	0b	0.33	0.67a	301.67a	3.67b	305.33a	1.23a
Flonicamid 200 g/L + flubendiamid 80 g/L / Tsunamide 280 OD	6a	0	0b	241c	0a	241c	0c
F	25.228	1.162	5.970	12.521	6.459	14.983	6.397
P	<0.0001	0.353	0.002	<0.0001	0.001	<0.0001	0.001

Means assigned to the same letter within the same column do not differ statistically (Fisher LSD test, $P < 0.05$)

500WG (305.33 bolls) were higher than those treated with the insecticides CORONI 672EC (272.25 bolls) and GARANT 200WG (274.5 bolls). The lowest total number of cotton bolls was collected on plots treated with Tsunamide 280 OD, with 241 bolls harvested (F = 14.983; $P < 0.0001$) (Table 3).

The healthy cotton bolls harvested from plots treated with CYCLODAN 42% (311 bolls) and NICOMEDE 500WG (301.67 bolls) were higher than those treated with CORONI 672EC (268.25 bolls), GARANT 200WG (272 bolls). The lowest number was recorded on plots treated with Tsunamide 280 OD, with 241 healthy bolls harvested (F = 12.521; $P < 0.0001$). Cotton bolls were not attacked in the plots treated with Tsunamide 280 OD. The number of cotton bolls attacked on plots treated with CYCLODAN 42% (2 bolls) and NICOMEDE 500WG (3.67 bolls), CORONI 672EC (4 bolls) and GARANT 200WG (2.5 bolls) were statistically identical (F = 6.459; $P = 0.001$). The cotton bolls attacked rates were highest on plots treated with CYLODAN 42% (1.67%), CORONI 672 EC (1.48%) and NICOMEDE 500 WG (1.23%), medium on plots treated with GARANT 200 WG (0.92) and were lower for CYLODAN 42% (0.64%) (F = 6.397; $P = 0.001$) (Table 3).

During the cotton season 2023–2024, yields were higher on plots treated with CYLODAN 42% (1716 kg/ha), medium with CORONI 672 EC (1444.75 kg/ha) and were lowest with NICOMEDE 500 WG (1347.33 kg/ha), GARANT 200 WG (1200.5 kg/ha), and Tsunamide 280 OD (1155 kg/ha). Only the insecticide CYLODAN 42% outperformed the control CORONI 672 EC (Fig. 2).

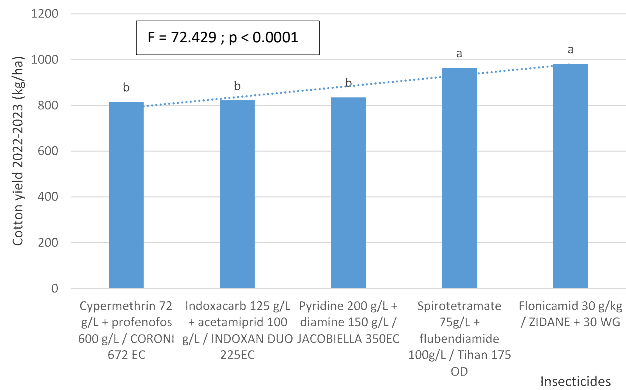

Fig. 1: Insecticides efficacies on cotton yields during 2022–2023

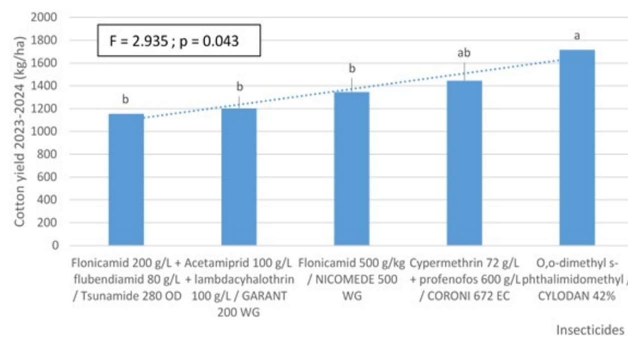

Fig. 2: Insecticides efficacies on cotton yields during 2023–2024

Discussion

In this study, the insecticides Tihan 175 OD®Spirotetramate 75 g/L + flubendiamide 100 g/L, ZIDANE + 30 WG®Flonicamid 30 g/kg, JACOBIELLA 350EC®Pyridine 200 g/L + diamine 150 g/L, INDOXAN DUO 225EC®Indoxacarb 125 g/L + acetamiprid 100 g/L and CYLODAN 42%®O, o-dimethyl s-phthalimidomethyl were effective against the insects studied and gave the best yields compared with the control insecticide CORONI 672 EC® Cypermethrin 72 g/L + profenofos 600 g/L. According to Brévault *et al.* (2009), Diabaté *et al.* (2024) and Hnialum *et al.* (2024), the lowest insect attacks on cotton were recorded when the insecticide used was effective. Thus, the highest yields in the plots treated with the insecticides was linked to their toxicity, repellency and antiappetent effects on *B. tabaci*, *H. armigera* and *Earias* sp. (Srinivas *et al.* 2004; Ghosh *et al.* 2010; Diabaté *et al.* 2014; Bade and Bhamare 2023). The combination of active ingredients Acetamiprid + lambdacyhalothrin was highly effective against *B. tabaci*, *H. armigera* and *Earias* sp. Then, the plots treated with these combined active ingredients showed lowest attack rate of cotton bollworms. These active ingredients can be applied during the cotton plant's reproductive phase. According to Diabaté *et al.* (2024), these active ingredients were not very effective against *A. biguttulla*, with a percentage reduction of -9.93% on cotton plants. Acetamiprid combined to indoxacarb (Acetamiprid 100 g/L+ Indoxacarb 125 g/L), were highly effective against *B. tabaci* and *H. armigera*, but its were not effective against *Earias* sp. Similar results were reported by Jadhav *et al*. (2019) who showed that the efficacy of indoxacarb + acetamiprid were effective on cotton pests. The lowest efficacy of Acetamiprid 100 g/L+ Indoxacarb 125 g/L against *Earias* sp. was thought to be linked to the emergence of resistance of *Earias* sp. to these active ingredients. Consequenly, highest cotton bolls attacked rate were recorded in the plots treated with these active ingredients. According to Ratan *et al.* (2017), Bade and Bahmare (2023) and Sheoran *et al*. (2023), *Earias* sp. showed resistance to a range of insecticides, notably indoxacarb. Acetamiprid + indoxacarb can be applied on cotton cultivation during the vegetative phase. Spirotetramate + flubendiamide were effective against *B. tabaci* and *Earias*, and were not effective against *H. armigera* and gave highest cotton bolls attacked rate. As a result, *H. armigera* was resistant to Spirotetramat + flubendiamide. These active ingredients can be applied during the vegetative phase of the cotton plant. Diamine + Pyridine prevents cotton plants colonization by *B. tabaci*, *H. armigera* and *Earias* sp. and their attack. Diamine + Pyridine can be used in cotton cultivation. According to Diabaté *et al.* (2024), Diamine + Pyridine were effective against biting-sucking insects, notably *A. bigguttula*, with a percentage reduction of 91.93%.

Cypermethrin + profenofos (Control) and Flonicamid applied alone on cotton cultivation were not effective against *B. tabaci*, *H. armigera* and *Earias* sp. and the highest number of these insect pests and of the cotton bolls attack rate were recorded with these treatments. The lowest efficacy of Cypermethrin + profenofos and Flonicamid is thought to be linked to the resistance of *B. tabaci*, *H. armigera* and *Earias* sp. to these insecticide active ingredients. According to Tenguri *et al*. (2023), Diabate *et al.* (2024) and Hnialum *et al.* (2024), several insects of cotton cultivation were developedresistance to cypermethrin and profenofos. Similar results were reported by Haider *et al.* (2023), who showed that flonicamid slightly reduced *B. tabaci* population. Furthermore, flonicamid + flubendiamid were highly effective against *H. armigera* and *Earias* sp. and cotton bolls were not attacked. Similar results were recorded with Haider *et al.* (2023) who showed that flonicamid combined with salicylic acid is highly effective against insects. On the other hand, the low yields obtained with flonicamid combined with flubendiamid are linked to attacks by *B. tabaci*, which considerably reduces cotton quality and cotton yield.

O,O-dimethyl s-phthalimidomethyl was effective against *H. armigera* and was less effective against *B. tabaci* and *Earias* sp. Consequently, highest yields were recorded in the plots treated with this active ingredient. Similar results were observed by Diabate *et al*. (2024), who showed that O,O-dimethyl s-phthalimidomethyl reduced *A. biguttulla* adults on cotton plants at the rate of 59.24% and gave highest yields. According to Diabaté *et al*. (2014), the efficacy of insecticides were linked to their toxicity, repellency and antiappetent effects on cotton insect pests.

Conclusion

Chemical control is the most widely used method of combating cotton insect pests. In this study, the insecticides Tihan 175 OD®Spirotetramate 75 g/L + flubendiamide 100 g/L, ZIDANE + 30 WG®Flonicamid 30 g/kg, JACOBIELLA 350EC®Pyridine 200 g/L + diamine 150 g/L, INDOXAN DUO 225EC®Indoxacarb 125 g/L + acetamiprid 100 g/L and CYLODAN 42%®O,O-dimethyl s-phthalimidomethyl gave highest yields than the control CORONI 672 EC. Acetamipride + indoxacarb can be used for cotton protection during the vegetable phase and, O,O-dimethyl s-phthalimidomethyl and Acetamiprid + lambdacyhalothrin during the reproduction phase.

Acknowledgements

This study was facilitated by the staff of Development and Innovation, Service of Ivoire Coton.

Author Contributions

Diabaté D. was responsible for stydy desingn and revising. All authors contributed equally for data collection, drafted, read and approved the final manuscript.

Conflict of Interest

The authors declare that they have no competing interests.

Data Availability

The datasets used during the study available from the corresponding author on reasonable request.

Ethics Approval

Not applicable

Funding Source

This work was not supported by any funding agency.

References

Bade AS, VK Bhamare (2023). Insecticidal resistance in *Helicoverpa armigera* (Hübner) infesting chickpea. *Ind J Entomol* 86:204–207

Brévault T, D Badiane, R Goebel, A Renou, I Téréta, P Clouvel (2019). Repenser la gestion des ravageurs du cotonnier en Afrique de l'Ouest. *Cah Agric* 28:25–32

Diabaté D (2009). *Etude de l'impact des méthodes d'application insecticides sur les insectes ravageurs et le rendement du cotonnier au nord et au nord-ouest de la Côte d'Ivoire. Diplôme d'Etudes Approfondies d'Entomologie, Option Entomologie Générale*, p:42. Université de Cocody-Abidjan, Côte d'Ivoire

Diabate D, EJB Ohoueu, D Fondio, Y Tano (2024). Efficacy of New Insecticides Against *Amrasca biguttula* in Odienné Cotton Cultivation. *J Agric Sci* 16:108–117

Diabaté D, OG Ochou, Y Tano (2017). Impact des méthodes d'application insecticides sur *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae), *Aphis gossypii* (Glover) (Homoptera: Aphididae) et sur le rendement du cotonnier en Côte d'Ivoire. *Eur J Sci Res* 147:65–74

Diabaté D, AJ Gnago, K Koffi, Y Tano (2014). The effect of pesticides and aqueous extracts of *Azadirachta indica* (A. Juss) and *Jatropha curcas* L. on *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrididae) and *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) found in tomato plants in Côte d'Ivoire. *J Appl Biosci* 80:7132–7143

El-Sherbeni AEE, MS Khaleid, SAEA AbdAllah, OSM Ali (2019). Effect of some insecticides alone and in combination with salicylic acid against aphid, *Aphis gossypii*, and whitefly *Bemisia tabaci* on the cotton field. *Bull Natl Res Cent* 43:57–63

Ghosh A, M Chatterjee, A Roy (2010). Bio-efficacy of spinosad against tomato fruit borer (*Helicoverpa armigera* Hub.) (Lepidoptera: Noctuidae) and its natural enemies. *J Hortic For* 2:108–111

Haider I, M Riaz, S Ali, Q Ali, A Noman, D Hussain, I Nadeem, MF Akhtar, A Abbas, A Aslam, HSB Mustafa, EU Hassan, M Zubair, M Saleem, MK Malik (2023). Efficacy of different insecticides alone and in combination with salicylic acid against cotton whitefly *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae). *Pak J Agric Res* 36:58–62

Hnialum M, VCB Naik, NV Lavhe, BKK Reddy (2024). Efficacy of insecticides against cotton pink bollworn *Pectinophora gossypiella* (Saunders). *Ind J Entomol* 86:180–183

Jadhav RP, DR Mundhe, BB Bhosle, GA Yadav (2009). Bioefficacy of new insecticide acetamaprid 20 SP and indoxacarb 14.5 SC against bollworm complex of cotton. *Pest Res J* 21:150–154

Jafari H, B Habibpour, SA Hemmati, LL Stelinski (2023). Population growth parameters of *Helicoverpa armigera* (Hübner) on various legume seeds reveal potential tolerance traits. *Sustainability* 15:7502

Javed M, M Majeed, M Sufyan, S Ali S, M Afzal (2018). Field efficacy of selected synthetic and botanical insecticides against lepidopterous borers *Earias vittella* and *Helicoverpa armigera* (Lepidoptera: Noctuidae), on okra (*Abelmoschus esculentus* (L.) Moench). *Pak J Zool* 50:2019–2028

Kranthi KR, DR Jadhav, S Kranthi, RR Wanjari, SS Ali, DA Russell (2002). Insecticide resistance in five major insect pests of cotton in India. *Crop Prot* 21:449–460

Ratan D, P Deb, H Pandey, M Sarkar (2017). Insecticidal resistance of okra fruit borer (*Earis vittella*) and its management. *Int J Curr Microbiol Appl Sci* 6:2932–2941

Sagar D, SM Nebapure (2018). Biology of spiny bollworm *Earias insulana* Boisduval. *Ind J Entomol* 80:1711–1713

Saley MB (2003). Cartographie thématique des aquifères de fissures pour l'évaluation des ressources en eau. Mise en place d'une nouvelle méthode d'extraction des discontinuités images et d'un SIHRS pour la région semi-montagneuse de Man (Nord-Ouest de la Côte d'Ivoire). *Thèse de Doctorat*, p:209. Université de Cocody-Abidjan, Côte d'Ivoire

Sheoran S, D Kalkal, R Chauhan, K Rolania, S Ahlawat, AM Gilpin (2023). Insecticide efficacy against Earias species infestation of Okra and residue analysis of Chlorantraniliprole under field conditions in India. *Horticulturae* 9:356

Srinivas R, SS Udikeri, SK Jayalakshmi, K Sreeramulu (2004). Identification of factors responsible for insecticide resistance in *Helicoverpa armigera*. *Compar Biochem Physiol C Toxicol Pharmacol* 137:261–269

Tenguri P, SP Gawande, R Kumar (2023). The outbreak of cotton whitefly *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) and its management in North India. *J Entomol Res* 47:21–27

Zhang H, W Yin, J Zhao, L Jin, Y Yang, S Wu, BE Tabashnik, Y Wu (2011). Early warning of cotton bollworm resistance associated with intensive planting of *Bt* cotton in China. *PLoS One* 6:e22874