EGYPTIAN ACADEMIC JOURNAL OF
BIOLOGICAL SCIENCES
F
TOXICOLOGY & PEST CONTROL

ISSN
2090-0791

WWW.EAJBS.EG.NET

Vol. 17 No. 1 (2025)

www.eajbs.eg.net

Citation: *Egypt. Acad. J. Biolog. Sci.* (F. Toxicology& Pest control) *Vol.17(1) pp33-43 (2025)*
DOI: 10.21608/EAJBSF.2025.433802

Egypt. Acad. J. Biology. Sci., 17(1):33-43 (2025)

Egyptian Academic Journal of Biological Sciences
F. Toxicology & Pest Control
ISSN: 2090 - 0791
http://eajbsf.journals.ekb.eg/

'Banker Plant' New Echo-Friendly Innovation of Cotton Bollworm Biological Control to Slow Insecticides Resistance Under Egyptian Field Condition

Hisham M. El-Bassouiny*; Walaa G. Ebrahlm; Haity M. Tadros, Abeer Sh. Awad and Aly Z. El-Naggar
Plant Protection institute - Agriculture Research Center- Doky- Giza – Egypt.
***E-mail:** bassouny_2004@yahoo.com**

ARTICLE INFO
Article History
Received:12/5/2025
Accepted:18//2025
Available:22/6/2025

***Keywords*:**
Insecticides, *Earias insulana, Pectinophora gosibella*, banker plant, resistance.

ABSTRACT

Pesticide resistance poses a major challenge to sustainable pest suppression, necessitating strategies to mitigate its development and reduce environmental contamination. The aim of the study evaluated resistance spectra in *Pectinophora gossypiella* (pink bollworm, PBW) and *Earias insulana* (spiny bollworm, SBW) field strains to common insecticides (cypermethrin, chlorpyrifos, spinosad, indoxacarb) over the 2022–2023 cotton seasons. We compared resistance levels in insecticide-treated fields versus fields using banker plants combined with *Trichogramma* parasitoid release, alongside a laboratory strain. Metabolic resistance mechanisms were also investigated. Results indicated that PBW and SBW strains from fields using the new echo-friendly innovation banker plants with *Trichogramma* release exhibited significantly lower Resistance Factor(RF) in throughout both seasons than strains from insecticide-treated fields. Conversely, insecticide-treated fields showed high RR values. Biochemical assays revealed significant differences in esterase, acetylcholinesterase (AChE), total protein, and total carbohydrate activity between field strains (from both conventional and banker plant systems) and the laboratory strain. Concluded that the integrating banker plants with Trichogramma releases reduces/slow insecticide resistance development in PBW and SBW, suggesting altered metabolic responses contribute to this effect.

INTRODUCTION

Cotton plant has willful specifically Characteristics to attract insects. It has green, succulent and juicy leaves, many considerable open flowers, nectarines on every leaf and flower, and a vast amount of green boll.

The pink bollworm (PBW) *Pectinophora gossypiella* (Saunders) and spiny bollworm (SBW) *Earias insulana* are worldwide pests of cotton, and in some regions of the world are the key cotton pests (El-Bassouiny *et al.,* 2022, El-Bassouiny 2021, Salama 1983). Traditional methods of integrated pest management (Chemical control), in many cases, has been applied in an attempt to achieve suppressing the pests which disquiet crops and farmers. Thus, it's not unveiled or new to say that the pests have adapted to these tactics in various ways (El-Bassouiny *et al.,* 2015, Awad *et al.,* 2014a, Awad *et al.,* 2014b). There has been widespread development of insecticide resistant strain of the world's most important crop pests. Secondary pests have been more popular and some are now major

important pest in some crops (e.g., *Heliothis* spp., spider mites in cotton) than the primary pests (Bergé and Ricroch 2010). Because of these problems, farmers have been forced to use increasingly more toxic chemicals, as a result has been more cases of poisoning of farm workers and applicators, contamination of the environment, destruction of non-target species and major disruption to ecosystem (Shelton *et al.,* 2007), In addition to the development of the resistance phenomenon. Therefore, a comprehensive understanding of pesticide resistance is essential to develop effective strategies for resistance management, which includes delaying, preventing, or reversing the development of resistance in pest populations while simultaneously fostering resistance in beneficial natural enemies (Xie *et al.,* 2023)..

In this study, we unleash the use of secondary plants or what is newly known as bank plants. Banker plants are non-crop plants strategically introduced into agricultural systems (like greenhouses or fields) to support populations of beneficial insects, primarily natural enemies of crop pests. These plants typically host an alternative, non-pest prey species or provide essential resources like nectar and pollen. This sustains a resident population of beneficial predators or parasitoids near the crop. When pest insects infest the main crop, the beneficial insects readily move from the banker plants to attack them. This technique provides continuous, sustainable biological pest control, reducing the need for chemical pesticides.

The rationale for integrating banker plants with *Trichogramma* releases centers on disrupting the cycle of pesticide resistance by providing a sustainable, chemical-free pest management strategy. Banker plants non-crop vegetation deployed within crops—sustain populations of *Trichogramma* parasitoids by offering alternative hosts or nutritional resources (nectar, pollen), ensuring their continuous presence even when pest densities are low (Zhang *et al.,* 2023) This system mitigates the need for broad-spectrum insecticides, which exert intense selection pressure driving pest resistance, as evidenced by rising Resistance Factorin key pests like *Helicoverpa armigera* and *Tribolium castaneum* (Terefe *et al.,* 2023). *Trichogramma* species (e.g., *T. chilonis*, *T. pretiosum*) directly suppress pest populations by parasitizing eggs, reducing reliance on pesticides and thus slowing resistance evolution (Xie *et al.,* 2023). Consequently, this synergy lowers selection for resistance while maintaining ecological balance through persistent biological control (Bale *et al.,* 2008, Zhang *et. al.,* 2022).

MATERIALS AND METHODS

Laboratory Strains:

In the present study used two bollworms, *Pectinophora gossypella* (Saunders) (Lepidoptera: Gelechidae) pink bollworm (PBW) and *Earias insulana* (Boisd.) (Lepidoptera: Noctuidae) spiny bollworm (SBW), which are the most economically major insect pests in Egypt cotton. were used Susceptible strains of two species were achieved from the Plant Protection Research Institute, Dokki, Egypt, where it had been maintained on artificial diet for several years and had not been exposed to insecticides. The laboratory strain from the Plant Protection Research Institute (PPRI) in Dokki, Egypt, serves as a susceptible reference strain for insecticide resistance studies, having been maintained for years on an artificial diet without any insecticide exposure. This strain provides a baseline for comparative toxicological research, enabling scientists to assess resistance development in field populations by preserving "naïve" genetic traits. PPRI's work aligns with its objectives to develop sustainable pest management strategies and reduce reliance on chemical pesticides through such controlled biological resources.

Field Colonies:

Full grown larvae of both PBW and SBW were used to conduct the courses of these studies. The insects were collected from Berket Ghatas village, Abo-Hommos district, El-Behira Governorate, during two fields cotton successive seasons (2022 and 2023) that, which exposed to sequential spraying schedule which was established by the Egypt Ministry of Agriculture for pest control in cotton. Egypt Agricultural Ministry program relay on spraying conventional insecticides including organophosphate, pyrethroids, spinosad and indoxycarb which were applied in 20 feddans at the rate of 5 feddan for each tested compound (treatment), each treatment was divided into four replicates.

Banker Plant:

We used okra as banker plants, which were planted as rows in of the treatment plots at a distance of 3.5 m from the edge of the plot for the first row, then at a distance of 7 m for the other rows, with the emergence of the first fruitful branch of the cotton plant cards of the parasitoid *T. evanescens* were manually hung prior to sunset above the banker plants (Mesbah *et al.,* 2024).

Field Release of *Trichogramma evanescens*:

Trichogramma evanescens pupae were introduced at a density of 12,000 per faddan, housed within parasitized *Sitotroga cerealella* (Angoumois grain moth) eggs. A protective device—crafted by folding a thick paper card (8 x 12 cm) into a compact 8 x 6 cm container—was used to shield the parasitoids from predators and harsh environmental conditions while minimizing labor requirements. Each release involved three cards (1 x 1 cm) containing *S. cerealella* eggs, with parasitoid pupae at distinct developmental stages (1, 2, and 3 days prior to emergence). These cards were manually suspended 50 cm above the cotton plants before sunset, deploying approximately 42 cards per faddan per release. Release points were positioned 3.5 meters inward from field edges and spaced 7 meters apart. Across two growing seasons, parasitoid introductions were timed to coincide with the emergence of the cotton plants' first fruiting branches (Mesbah *et al.,* 2024).

Field Bioassays:

Field biological during throughout both season (2021&2022) tests were carried out by tested bolls each treatment was green bolls in the end of throughout both resistance, respectively, 100 green bolls were randomly selected from each sample, externally inspected, and subsequently dissected for internal examination Live second instar larvae for each insecticide (treatment) were collected and exposed to laboratory concentrations of the tested pesticides and mortality data for each insecticide were analysis (Finney, 1971) to determine regression values, LC_{50}% and LC_{90}. Abbott's formula (1925) was used to correct for mortality.

Laboratory Bioassays:

Five different concentrations of each insecticide were tested in bioassays using the reference strain. Each concentration per insecticide was replicated three times, with each replicate containing 10 larvae across separate experimental inserts. The larvae were maintained under controlled environmental conditions at 21±3°C and 95±5% relative humidity, with mortality rates assessed at 12-, 24-, and 48-hours post-treatment. The mortality data were analyzed using probit analysis to determine the lethal concentrations (LC50 and LC90). Resistance Factor (RFS) at LC50 and/or LC90 levels were calculated by dividing the LC50 value of the field strain (for each species) by the corresponding LC50 of the laboratory (reference) strain (Alzahrani, 2021).

Biochemical Activity:

Acetylcholinesterase Activity: It was measured according to the method described by (Simpson *et.al.* 1964), using acetylcholine bromide (AchBr) as substrate.

Nonspecific Esterase: Alpha esterases (α-esterases) and beta esterases(β-esterases) were determined according to (Van Asperen I962).
Determination of Total Carbohydrates: It was extracted and prepared for assay according to (Crompton and Birt 1967).
Total Proteins: It was determined by the method of (Bradford I976).
Statistical Analysis:

The data was determined by one-way ANOVA, L.S.D and TUKEY HSD in SPSS version 16.0 software. Differences between treatment means were considered statistically significant at P= 0.05.

RESULTS

Toxicity of Tested Insecticides against 2nd Instar of Bollworm Larva:

1. Laboratory Strain:

Data in Table (1), show responses of laboratory strain pink bollworm (PBW) larva susceptible to selected insecticides. At LC_{50} level, data indicated that, after 12 h of incubation, Chlorpyrifos was the least toxic compound (13.6mg/L) followed by cypermethrin (6.9 mg/L), Spinosad (5.5mg/L) and Indoxycarb (5.1 mg/L). Also the results showed increasing in the toxicity of most selected insecticides between 24 and 48 h of incubation. At 48 h, Spinosad and Indoxycarb appeared to be the most toxic compounds compared to other compounds, indicating the lowest LC_{50} values: 1.9 and 1.5 mg/L respectively. Wherever, the LC_{90} values recorded (16.1& 26.1 mg/L) for cypermethrin and Indoxycarb respectively compared by Spinosad and Chlorpyrifos (39.7 & 40.0 mg/L) respectively. On the other side the laboratory strain spiny bollworm (SBW) larva susceptible to selected insecticides using indicated that LC_{50} level, after 12 h of spiny bollworm laboratory strain incubation by the selected insecticides (Chlorpyrifos, cypermethrin, Spinosad and Indoxycarb) recorded (20.6, 16.9, 16.4 and 12.7mg/L), respectively. Similarly, the results showed increasing in the toxicity of most selected insecticides between 24 and 48 h of incubation.

Table 1: Tested insecticides toxicity of 2nd instar bollworms larva from laboratory strain**.**

Insecticides	Time (hour)	Pink bollworm larva		Spiny bollworm larva	
		LC_{50}(mg/L)	LC_{90}(mg/L)	LC_{50}(mg/L)	LC_{90}(mg/L)
Chlorpyrifos	12	13.6 (10.5-17.8)	216.4 (85.5-578.2)	20.6 (19.3-22.3)	314.3 (252.3-470.0)
	24	4.8 (3.7-16.6)	146.4 (61.8-370.2)	8.9 (7.3-11.1)	198.2 (143.0-244.3)
	48	3.3 (3.8-5.6)	40 (24.5-67.2)	4.6 (3.8-5.6)	36.6 (26.7-57.3)
Cypermethrin	12	6.9 (4.3-7.8)	66.4 (32.0-152.1)	16.9 (12.3-23.5)	358.1 (347.4-1214. 3)
	24	2.8 (2.5-3.4)	33.9 (18.2-69.2)	8.9 (7.3-11.2)	159.2 (85.1-332.6)
	48	2.1 (1.7-2.3)	16.1 (10.3-26.5)	5.1 (4.0-6.3)	65.3 (22.1-75.5)
Spinosad	12	5.5 (5.0-5.9)	63.3 (54.5-70.4)	16.4 (12.6-24.6)	542.6 (503.0-589.2)
	24	3.2 (1.8-4.6)	47.2 (43.0-57.6)	8.3 (6.8-9.8)	232.1 (218.0-257.6)
	48	1.9 (1.7-2.8)	39.7 (23.2-41.0)	6.5 (4.3-6.9)	86.5 (71.9-120.2)
Indoxycarb	12	5.1 (3.6-6.5)	60.4 (56.3-66.5)	12.7 (8.9-17.8)	635.2 (155.6-703.9)
	24	2.9 (2.2-5.1)	50.3 (44.6-55.0)	8.3 (6.0-11.0)	95.2 (73.3-131.6)
	48	1.5 (0.8-2.0)	26.1 (22.9-38.3)	5.5 (4.8-6.7)	63.3 (54.5-76.4)

2. Insecticides Area:

Concentration-mortality response and Resistance Factorfor selected insecticides to the field strain of both bollworms, caught from fields exposed only to commercial insecticides are shows in Table (2). The results indicated that the PBW gave higher LC_{50} values of Chlorpyrifos, cypermethrin, compared with the susceptible laboratory strain. At the LC_{50}, Resistance Factor (RF), after 12 h of treatment, to Chlorpyrifos (38.0-fold), followed by cypermethrin (25.6-fold) while at 48 h, Resistance Factor of Chlorpyrifos and cypermethrin keep increasing (97.4-fold & 55.1-fold) respectively than the other two compounds (Spinosad and Indoxycarb) that recorded low Resistance Factor (5.6-fold & 4.4-fold) at 12h and (11.7-fold & 6.8-fold) at 48h individually. Though, the LC_{90} Resistance Factor (RF) after 48 h of Chlorpyrifos and cypermethrin are still much higher (11.5-fold & 9.4-fold) compared with Spinosad and Indoxycarb (1.5-fold). Also, the response and Resistance Factorfor selected insecticides to the field strain of SBW larvae; it is gave a like reflection of PBW where declared that LC_{50} of Chlorpyrifos and cypermethrin are higher (RF) at 12h, 48h of exposed time of treatment (55.4-fold, 149.6-fold & 23-fold, 85.9-fold) respectively, compared with Spinosad and Indoxycarb which recorded low Resistance Factor (10.6-fold, 22.4-fold & 13.6-fold, 19.9-fold) at 12h, 48h respectively. The Resistance Factor at LC_{90} shows low values compared with LC_{50} along the exposed time of treatment.

Table 2: Tested insecticides toxicity of 2nd instar bollworms larva collected from cotton field insecticides-area.

Insecticides	Time (hour)	Pink bollworm larva				Spiny bollworm larva			
		LC_{50}(mg/L)	LC_{90}(mg/L)	RR* LC_{50}	RR LC_{90}	LC_{50}(mg/L)	LC_{90}(mg/L)	RR* LC_{50}	RR LC_{90}
Chlorpyrifos	12	514.8 (493.3-523.2)	1233.2 (892.8-1575.5)	38.0	5.7	1141.0 (1127.0-1166)	624.1 (479.4-752.0)	55.4	2.0
	24	443.8 (384.7-478.9)	885.6 (665.6-970.1)	92.5	6.1	911.9 (902.6-923.0)	400.0 (307.0-522.0)	102.5	2.5
	48	321.5 (315.3-331.2)	460.4 (430.0-623.7)	97.4	11.5	688.3 (681.0-796.6)	255.0 (212.0-207.9)	149.6	7.5
Cypermethrin	12	176.4 (156.3-197.9)	419.5 (326.8-1222.1)	25.6	8.7	392.3 (356.5-440.8)	1082.0 (728.2-1610)	23	3.5
	24	121.1 (118.7-144.3)	293.6 (178.7-551.0)	43.3	6.3	314.0 (288.0-341.5)	702 (527.1-933.0)	37.3	4.4
	48	115.7 (113.4-117.8)	158.3 (153.4-373.7)	55.1	9.4	738.6 (677.6-806.0)	565.5 (427.2-726.0)	85.9	6.6
Spinosad	12	30.7 (28.5-34.1)	92.3 (88.4-98.5)	5.6	1.5	174.0 (158.8-190.5)	754.0(526.0-821.2)	10.6	1.4
	24	26.1 (24.3-28.1)	79.9 (75.4-83.3)	8.3	1.7	150.0 (127.3-151.9)	480.2(372.0-620.1)	18.1	2.1
	48	22.2 (19.8-23.0)	66.7 (53.2-78.3)	11.7	1.5	114.0 (105.0-124.0)	306.1(258.0-365.0)	22.4	3.5
Indoxycarb	12	22.5 (19.4-25.5)	72.5 (63.3-81.2)	4.4	1.2	173.0 (157.1-188.4)	711.3 (526.7-725.6)	13.6	1.1
	24	17.2 (14.4-18.5)	56.3 (45.2-59.8)	5.9	1.3	135.0 (123.7-147.3)	456.0 (357.2-515.4)	16.3	4.8
	48	10.2 (8.7-13.2)	39.3 (33.3-40.0)	6.8	1.5	109.4 (100.9-118.1)	262.0 (226.5-305.4)	19.9	4.1

*RR=Resistance Ratio, calculated by dividing the LC_{50}, LC_{90} for cotton field by laboratory strain (LC_{50}, LC_{90}).

3. Banker Plant Area:

Data in Table (3), refer to the concentration-mortality response and Resistance Factorfor selected insecticides to the field strain of both bollworms moths; caught from fields exposed to the effect of banker plant and/or release of *T. evanescens*. The results concluded that the Resistance Factor at LC_{50} and LC_{90} shows low values comparable with the rustles from insecticides area. Although, LC_{50} (RF) of Chlorpyrifos and cypermethrin (24.1-fold, 51.6-fold & 20.5-fold, 20.1-fold) in (PBW and SBW) at 12h respectively, were

higher than Spinosad and Indoxycarb (3.3-fold, 7.1-fold & 3.2-fold, 11.3-fold at 12h in both bollworms respectively. While the Resistance Factor at LC_{90} shows low values compared with LC_{50} along the exposed time of treatment.

These findings indicate that insecticide resistance in field populations can emerge even in regions with minimal or no insecticide application, as the high migration capacity of insects and genetic mixing between populations in the field enable the swift dissemination of resistance alleles across otherwise isolated groups.

Table 3: Tested insecticides toxicity of 2nd instar bollworms larva collected from cotton field banker plant-area**.**

Insecticides	Time (hour)	Pink bollworm larva				Spiny bollworm larva			
		LC_{50}(mg/L)	LC_{90}(mg/L)	RR* LC_{50}	RR LC_{90}	LC_{50}(mg/L)	LC_{90} (mg/L)	RR* LC_{50}	RR LC_{90}
Chlorpyrifos	12	327.7 (299.3-356.1)	1017.1 (973.9-1556.3)	24.1	4.7	1063.3 (971.0-1165.7)	564.1 (474.0-682.6)	51.6	1.7
	24	258.8 (233.4-276.2)	822.4 (676.6-968.1)	53.1	5.6	809.0 (734.1-890.0)	373.0 (324.0-451.0)	91.0	1.8
	48	198.7 (183.2-214.4)	388.3 (311.3-509.7)	60.2	9.7	453.1 (494.0-618.3)	190.0 (158.0-219.2)	98.5	5.2
Cypermethrin	12	141.7 (129.7-153.9)	292.2 (280.5-416.7)	20.5	4.4	340 (311.5-370.2)	976.0 (842.0-1075)	20.1	2.7
	24	111.3 (98.7-121.3)	213.6 (198.9-267.8)	39.8	6.3	233.7 (231.7-242.6)	455.0 (390.0-660.0)	27.8	2.9
	48	86.3 (77.6-92.4)	119.1 (102.1-195.6)	41.1	7.4	270 (200.0-240-5)	326.5 (224.5-425.5)	41.2	5.0
Spinosad	12	8.3 (17.3-19.9)	83.3 (75.9-87.4)	3.3	1.3	116.7 (109.0-126.0)	665.2 (595.0-928.7)	7.1	1.2
	24	15.4 (15.0-16.8)	56.6 (51.7-72.0)	4.5	1.2	97.8 (90.6-105.5)	445.1 (360.1-575.0)	11.8	1.9
	48	12.4 (12.6-14.3)	43.8 (33.8-48.3)	6.2	1.1	78.2 (71.8-85.3)	232.4 (222.5-355.0)	12.0	2.6
Indoxycarb	12	16.3 (14.3-18.9)	78.8 (69.3-84.9)	3.2	1.3	143.3 (133.3-151.6)	665.0 (545.0-928.0)	11.3	1.2
	24	13.1 (12.5-13.7)	59.3 (55.8-63.3)	4.5	1.1	109.0 (99.5-122.3)	361.0 (342.5-411.3)	13.1	3.7
	48	9.3 (9.0-11.8)	34.0 (22.4-51.0)	6.2	1.3	89.9 (84.7-94.5)	245.6 (237.0-288.6)	16.2	3.9

*RR=Resistance Ratio, calculated by dividing the LC_{50}, LC_{90} for cotton field by laboratory strain (LC_{50}, LC_{90}).

Activity of Biochemical:

Data in Table (4), summarize the difference in (AChE) activity between - laboratory and field Aggregations of pink bollworm, larvae collected from cotton fields. The results indicated a significantly higher enzyme activity (270 µmol/min/mg) in the field colony collected from cotton fields treated with conventional insecticides, followed by that collected from fields treated with banker plant and/or release of *T. evanescens* (239.7 µmol/min/mg), as compared with that of the Laboratory strain (200.4). At 1.35-fold and 1.2-fold differences in activity AChE were reported between the two field colonies and Laboratory strain, respectively.

Also, the data indicated a higher significantly of esterases activity in both field colonies collected where Active ratio recorded (1.19-fold) and (1.19-fold), in both field colony from cotton fields treated with conventional insecticides and fields treated with banker plant and/or release of *T. evanescens* respectively complicate with that of the Laboratory strain.

Likewise, Total proteins and Total carbohydrate gave higher significant between the two-field colony collected from cotton fields and Laboratory strain where the Active ratio recorded gave (0.53-fold, 0.93-fold & 0.47-fold, 0.73-fold) at Total proteins and Total carbohydrate in both field colony collected from cotton fields respectively.

Table 4: Effect of tested technics on the biochemical activity of pink bollworm.

Treatment	Ach µmol/min/mg	R/S Active ratio	α-esterase µmol/ α-naphthol /min/mg	R/S Active ratio	Total proteins	R/S Active ratio	Total carbohydrate	R/S Active ratio
Laboratory strain	200.4±2.3$_c$	-	630±9.1 $_c$	-	15±0.7 $_a$	-	40.33±1.3$_a$	-
Banker P- field area	239.7±5.2$_b$	1.19	646±9.2$_b$	1.02	14±1.3$_b$	0.93	29.7±1.3$_b$	0.73
Insecticides field area	270±2.2$_a$	1.35	750±11.5$_a$	1.19	8±0.3$_c$	0.53	19±0.5$_c$	0.47
***P* values**	0.0001		0.0001		0.0001		0.0001	

Column values followed by different letters are different significant (*P*=0.05, L.S.D test)
R/S= biochemical activity field area dividing activity Laboratory strain.

Results presented in Table (5), indicated the same results for acetyl cholinesterase (AChE) activity in the spiny bollworm larvae, the where recorded a significantly higher enzyme activity in both field colonies compared to that in the Laboratory strain. Also, for esterase activity in the spiny bollworm, similar results to those observed in the pink bollworm were obtained (Table 5). The data declare a higher significantly esterase activity in both field colonies of spiny bollworm larvae either collected from insecticide-treated area or from dispersing. Similarly, Total proteins and Total carbohydrate gave higher significant between the two field colony collected from cotton fields and Laboratory strain where the Active ratio recorded gave (0.48-fold, 0.84-fold & 0.49-fold, 0.94-fold) at Total proteins and Total carbohydrate in both field colony collected from cotton fields respectively.

Table (5): Effect of tested technics on the biochemical activity of spiny bollworm.

Treatment	Ach µmol/min/mg	R/S Active ratio	α esterase µmol/ α-naphthol /min/mg	R/S Active ratio	Total proteins	R/S Active ratio	Total carbohydrate	R/S Active ratio
Laboratory strain	67.5±2.3$_c$	-	19.61±3.5 $_c$	-	9.8±0.3 $_a$	-	16.92±0.7 $_a$	-
Banker P- field area	84±3.3$_b$	1.24	20.6±3.4$_b$	1.05	8.3±1.2$_b$	0.84	15.98±1.3$_b$	0.94
Insecticides field area	128±1.3$_a$	1.89	25.33±2.7$_a$	1.29	4.7±1.3$_c$	0.47	8.3±0.3$_c$	0.49
***P* values**	0.0001		0.0001		0.0001		0.0001	

Column values followed by different letters are different significant (*P*=0.05, L.S.D test).
R/S= biochemical activity field area dividing activity Laboratory strain.

DISCUSSION

Our results conflict with the achieved by (Mohamady 2017) Resulted that, pyrethroid lambda cyhalothrin was the most effective insecticide with low to moderate resistance levels, whereas the organophosphate chlorpyrifos was the least toxic insecticide with high resistance level. (Radwan and El Malla (2015) found that the pyrethroid insecticide lambda-cyhalothrin exhibited the highest toxicity against field-collected P. gossypiella moths, with the insects displaying minimal resistance to it. In contrast, the organophosphate profenofos, though effective as a toxicant, was linked to the highest resistance levels observed in the pest population. This study highlights the varying efficacy and resistance dynamics between these two insecticide classes. (Qayyum *et al.,* 2015) when studied multiple resistances against traditional insecticide (Organophosphates, Pyrethroids), and un- traditional insecticide (Newer- Insecticides) in populations of *Helicoverpa armigera* reported that lower LC50 and LC90 values for un-traditional insecticide groups than the traditional insecticides tested; resistance to organophosphates ranged from moderate to very high, while resistance to pyrethroids varied from very low to high. In contrast, unconventional insecticides showed resistance levels that were consistently very low. The feedback implies that insecticides with newer chemical formulations, which employ distinct modes of action, may either be integrated into sequential insecticide strategies or replace conventional products altogether. Also, (Ahmad

and Mehmood 2015) investigated study of the level of resistance to new chemistry insecticides, having novel modes of action, provided that it has a low to moderate resistance in the Pakistani field populations of *S. litura*.

Importantly, the emergence of resistance may be influenced by migration patterns with (Yang *et al.,* 2022) showed that the resistance of oriental armyworm *(Mythimna separata)* to Due to its unstable nature, λ-cyhalothrin is likely metabolized rapidly in biological systems. driven by enhanced P450 activity mediated by the overexpression of multiple P450 genes. Also, (Cordeiro *et al.,* 2020) reported that the Introgression between invasive and native pests may dramatically impact the development of host area and resistance management.

Also, the changed level of lipid, protein, α esterase and Acetyl cholinesterase activities agreement with (El-Bassouiny *et al.,* 2022) provided that insecticides caused high mortality in *Earias insulana* and gave different level of lipid, protein and Acetyl cholinesterase activities compared by untreated check. (Mohamady 2017) concluded that the elevation in protein content, α-esterase activities may be involved in increased detoxification of the organophosphate and pyrethroid insecticides in the field populations, which may facilitate the development of insecticide resistance.

CONCLUSION

Results obtained in this study reveal that banker plant with release of *T. evanescens* can reduce the use of the pesticides meanwhile growing season, and after season. Reducing sequences pesticides applications and using preventive ways when the pest is most susceptible reconnaissance before and after pesticide application to correctly identify the pest and to determine if the application provided effective control. All of these measures together, are one of the arrangements that should be included in the guidelines to Slowing and Combating insect resistance to insecticides.

Declarations:

Ethical Approval: The research does not include human or animal subjects.

Competing interests: The authors declare that there is no conflict of interest.

Author's Contributions:

H. M. El-Bassouiny: Validation, Statistical Analysis, Data Curation, Resources, Writing - Review and Editing.

Walaa G. Ebrahlm: Review and Editing

Haity M Tadros: Provision of Treated Insect Rearing.

Abeer Sh Awad: Provision of Treated Insect Rearing.

Aly Zakria El-Naggar: Toxicity tests Analysis, Provision of Chemicals

Funding: This study received no funding from any sources.

Availability of Data and Materials: All data sets are available in the manuscript and supplementary file.

Acknowledgments: The authors extend their gratitude to the Berket Ghatas Agricultural Association in Abo Hommos District, El-Beheira Governorate, Egypt, for their invaluable contributions to this research. Their expertise and support in facilitating fieldwork and data collection within this agriculturally significant region were instrumental to our study.

REFERENCES

Abbott, W.A. (1925). A method for computing the effectiveness of an insecticide. *Journal of Economic Entomology,* 18:265-267.

Ahmad, M., and Mehmood, R. (2015). Monitoring of resistance to new chemistry insecticides in Spodoptera litura (Lepidoptera: Noctuidae) in Pakistan. *Journal of Economic Entomology,* 108(3), 1279-1288.

Alzahrani, S. M. (2021). Evaluation of triflumuron and pyriproxyfen as alternative candidates to control house fly, Musca domestica L.(Diptera: Muscidae), in Riyadh city, Saudi Arabia. *Plos one,* 16(4), e0249496.

Awad, H. A., El-Naggar, A. Z., El-Bassouiny, H. M., & M Tadros, H. (2014a). Evaluation of Certain Insect Growth Regulators and some Insecticides against The Cotton Leaworm and Bollworms in Field Cotton and Their Effect on Yield. *Alexandria Science Exchange Journal,* 35(April-June), 80-86.

Awad, H. A., El-Naggar, A. Z., EL-Bassouiny, H. M., & M Tadros, H. (2014b). Efficiency of certain evaluated IGRs and conventional insecticides on the incidence of common lepidopterous insect-pests of cotton plant. *Alexandria Science Exchange Journal,* 35(April-June), 87-97. https://doi: 10.21608/ jppp. 2021.193801

Bale, J. S., Van Lenteren, J. C., & Bigler, F. (2008). Biological control and sustainable food production. *Philosophical transactions of the Royal Society B: Biological Sciences,* 363(1492), 761-776. https://doi.org/10.1098/rstb.2007.2182

Bergé, J. B., & Ricroch, A. E. (2010). Emergence of minor pests becoming major pests in GE cotton in China: what are the reasons? What are the alternatives practices to this change of status?. *GM crops,* 1(4), 214-219. https://doi.org/10. 4161/ gmcr.1.4.13421

Bradford, M. M. (I976) A rapid and sensitive method for the quantitation of microgram quantities of proteins utilizing the principle of protein-dye binding. *Analytical Biochemistry,*72: 248-254.

Cordeiro, E. M., Pantoja-Gomez, L. M., de Paiva, J. B., Nascimento, A. R., Omoto, C., Michel, A. P., & Correa, A. S. (2020). Hybridization and introgression between *Helicoverpa armigera* and *H. zea*: an adaptational bridge. *BMC Evolutionary Biology,* 20(1), 1-12. https://doi.org/10.1186/s12862-020-01621-8

Crompton, M. and Birt, L.M. (1967).changes in the amounts of carbohydrates, phosphagen,and related compounds during the metamorphosis of the blowfly *Lucilia cuprina*. *Journal of Insect Physiology,* 13:1575-1595. https://doi. org/ 10. 1016/0022-1910(67)90180-1

El-Bassouiny, H. M., Tadrose, H. M., & El-Nagger, A. Z. (2015). Cotton bollworm Helicoverpa armigera: control by Biorational insecticides. *Journal of Plant Protection and Pathology*, *6*(12), 1703-1709.

El-Bassouiny, H. M. (2021). Environmental friendly technique to control cotton pink bollworm Pectinophora gossypiella in Egypt. *International Journal of Tropical Insect Science,* 41(2), 1683-1687. https://doi.org/10.1007/s42690-020-00369-4

El-Bassouiny, H. M., Ahmed, A. F., Madany, W. A., & Selim, S. (2022) Impact of tetramic acid derivatives compounds against cotton Lepidoptera pests' neonate larvae *Earias insulanaare* (Boisd.). *International Journal of Entomology Research,* 7(4): 170-176. http://www.entomologyjournals.com

El-Bassouiny, H. M., El-Medany, W. A., & Kandil, M. A. (2022). The Impact of Magnetic Field on Insecticide Toxicity Measured by Biological and Biochemical Parameters of Earias insulana (Boisd). *Bioelectromagnetics,* 43(6), 368-380. https://doi.org/10.1002/bem.22418

Finney, D.J. (1971). Probit Analysis (3rd Ed.) (Combride Univ. Press, London).

Mesbah, H. A., Massoud, M. A., El-Kady, M. B., Henady, Z. M., & El-Bassouiny, H. M. (2024). Role of "banker plants" as a sustainable integrated Pectinophora gossypiella (Saunders) and *Earias insulana* (Boisd.) management. *Arab Journal of Plant Protection,* 42, (1): 113-119. https://doi.org/10.22268/AJPP-001213

Mohamady, A. H. (2017). Monitoring of insecticides resistance level and biochemical changes in two field populations of pink bollworm, Pectinophora gossypiella (Saunders). *Journal of Biological Chemistry,* 34, 510-522.

Qayyum, M. A., Wakil, W., Arif, M. J., Sahi, S. T., Saeed, N. A., & Russell, D. A. (2015). Multiple resistances against formulated organophosphates, pyrethroids, and newer-chemistry insecticides in populations of *Helicoverpa armigera* (Lepidoptera: Noctuidae) from Pakistan. *Journal of Economic Entomology,* 108(1), 286-293.

Radwan, E. M. M. and El-Malla, M. A. (2015). Toxicity of Insecticides against the Laboratory and Field Moths *Pectionophora Gossypiella* (Saunders). *Egyptian Scientific Journal of Pesticides,* 1(1): 1-9.

Salama HS (1983) Cotton pest management in Egypt. *Crop Protection,* 2:183– 191. https://doi.org/10.1016/0261-2194(83)90043-1

Simpson , D.R.; D.L. Bulland D.A. Linquist (1964) A semimicrotechnique for estimation of cholinesterase activity in boll weevils. *Annals of the Entomological Society of America,* 57: 367-371

Shelton, A. M., Roush, R. T., Wang, P., & Zhao, J. Z. (2007). Resistance to insect pathogens and strategies to manage resistance: an update. In Field Manual of Techniques in Invertebrate Pathology: Application and Evaluation of Pathogens for Control of Insects and other Invertebrate Pests (pp. 793-811). Dordrecht: Springer Netherlands.

Terefe, B., Danish, M., Faisal, S., Holmes, K. A., Luke, B., & Williams, F. (2023). Gender analysis of uptake of *Trichogramma chilonis* to control *Helicoverpa armigera* on tomato crops in Pakistan. *Sustainability,* 15(3), 2214. https:// doi. org/10.3390/ su15032214

Van Asperen K. (I962). Astudy of house fly esterase by means of sensitive colourimetric method. *Journal of Insect Physiology,* 8: 401-416

Xie, L. C., Jin, L. H., Lu, Y. H., Xu, H. X., Zang, L. S., Tian, J. C., & Lu, Z. X. (2022). Resistance of lepidopteran egg parasitoids, *Trichogramma japonicum* and *Trichogramma chilonis*, to insecticides used for control of rice plant hoppers. *Journal of Economic Entomology,* 115(2), 446-454.

Yang, X., Li, X., Cang, X., Guo, J., Shen, X., & Wu, K. (2022). Influence of seasonal migration on the development of the insecticide resistance of oriental armyworm (Mythimna separata) to λ-cyhalothrin. *Pest Management Science,* 78(3), 1194-1205. (wileyonlinelibrary.com) DOI 10.1002/ps.6736

Zhang, J., Huang, J., Tang, Y., Lu, Y., & Zhou, Z. (2023). Construction of a Banker Plant System via the Host Switch Trait of a Natural Enemy Aenasius bambawalei. *Life,* 13(11), 2115. https://doi.org/10.3390/life13112115

ARABIC SUMMARY

"النباتات الحاضنة" ابتكار جديد صديق للبيئة لمكافحة ديدان لوز القطن بيولوجيًا لإبطاء مقاومة المبيدات الحشرية في ظل الظروف المصرية

هشام محمد محمد البسيونى، ولاء جميل إبراهيم، عبير شعبان عبد الرحيم، هايتى مكرم عبيد تادرس، على زكريا النجار

معهد بحوث وقاية النباتات-مركز البحوث الزراعية – الدقى – الجيزة - مصر

تعتبر مقاومة المبيدات الحشرية مشكلة رئيسية في استخدام أساليب قمع الآفات، لذلك كان من الضروري إيجاد تقنيات لإدارة المقاومة (إبطاء أو منع أو عكس) تطور مقاومة المبيدات الحشرية للحد من التلوث البيئي. الهدف من الدراسة هو تقييم مقاومة المبيدات الحشرية الموصى بها والأكثر شيوعًا (السايبرمثرين، الكلوروبيرفوس، سبينوساد، والإندوكسيكارب) ضد سلالات الحقل من دودة اللوز القرنفلية *Pectinophora gosibella* ودودة اللوز الشوكية *Earias insulana* *المعرضة* لهذه المبيدات خلال موسمين متتاليين من القطن (2022-2023) ومقارنتها بالسلالة المعملية والسلالات الحقلية مع نباتات حاضنة بالتزامن مع إطلاق طفيل *Trichogramma* بالإضافة إلى ذلك، تم فحص الآليات الأيضية المحتملة التي قد تشارك في تعجيل المقاومة. أشارت النتائج إلى أن نظام نباتات المصدر المبتكر الأخضر مع إطلاق حشرة التريكوجراما سجل مستوى منخفض من نسبة عامل المقاومة (RF) للقرنفلية و الشوكية في الموسمين على التوالي، في حين تم تسجيل قيم عالية من RF في الحقل المعالج بالمبيدات الحشرية خلال الموسمين على التوالي. أظهرت البيانات الأخرى أهمية مختلفة لنشاط الإستريز وأستيل كولينستراز (Ach) والبروتينات الكلية والكربوهيدرات الكلية التي لوحظت في سلالات حقل المبيدات الحشرية من القرنفلية و الشوكية التي تم جمعها من المبيدات الحشرية و / أو النظام البيئي للنباتات الحاضنة مع إطلاق *Trichogramma* خلال موسم القطن مقارنة بالسلالة المعملية في المختبر