Effect of treated and untreated cotton fields with pesticides on the population fluctuations of the most important cotton pests and their associated insect predators

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ABSTRACT

The cotton variety *Gossypium barbadense* was planted in experimental fields during the March (2022, 2023, and 2024) seasons, and the studies continued for five months. Field studies were carried out at El-Zagazig distract Sharkia Governorate to compare the effect of insecticide-treated and untreated cotton fields on average monthly numbers, the seasonal fluctuations of the most important cotton pests, and the common insect predators associated with cotton pests. The results showed that the treated and untreated cotton fields significantly affected the average monthly numbers of the four cotton pests *Aphis gossypii, Bemisia tabaci, Spodoptera littoralis*, and *Pectinophora gossypiella* and five associated common insect predators *Chrysoperla carnea, Coccinella undecimpunctata, Scymnus* spp., *Orius* spp. and *Paederus alfierii* during the three cotton seasons. Furthermore, the average monthly number of the four cotton pests and their accompanying predators in untreated cotton fields was greater than that of those treated with pesticides. The fluctuations of four insect pests in the treated and untreated cotton fields were recorded at 53 peaks; it was 24 peaks in the treated fields and 29 in the untreated fields. On the other hand, predators recorded 41 peaks; 18 were in treated fields and 23 in untreated fields. Thus, it is clear our study showed *S. littoralis* was the most common of the four pests, and *C. carnea* was the most common predator of the five predators in both treated and untreated cotton fields. Thus, the study recommended that preserving natural enemies is a key tactic in IPM.

Keywords: Cotton crop; Pesticide; Cotton pests; Predator; Seasonal abundance

INTRODUCTION

Gossypium barbadense L., or cotton, is a significant cash crop that is essential to Egypt's agricultural economy. Nevertheless, during Egypt's growing season, a variety of insect pests assaults the cotton cultivation. In Egypt's cotton fields, the most destructive pests include the cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae); the pink bollworm, *Pectinophora gossypiella* (Saund.) (Lepidoptera: Gelechiidae); and the spiny bollworm, *Earias insulana* (Boisd.) (Lepidoptera: Nolidae) (El-Husseini *et al*., 2018). Al-Shannaf, (2010) reported that the important pests on cotton were *P. gossypiella*, *E. insulana*, *S. littoralis*, *Aphis gossypii*, *Bemisia tabaci*, *Empoasca lybica*, *Thrips tabaci* and red spider mite *Tetranychus* spp. Cotton pests around the world are mostly controlled through the extensive use of pesticides. However, the concept of Integrated Pest Management (IPM) suggests low-risk pesticides to lessen the impact on beneficial insect arthropods and the environment. This poses a problem for IPM practitioners and researchers (Lima, 1967 and Sujii *et al.,* 2006).

Natural enemies facilitate the natural demise of pests. However, comprehending and implementing IPM is difficult because to the intricacy of their interactions with crops and pests (Macfadyen *et al*., 2014; Macfadyen *et al*., 2015; Zalucki *et al.*, 2015). Natural enemies have a significant role in controlling pests, according to research on their primary biological control roles. Farmers are informed of the study' findings, which also validated the insecticides' suggested selectivity for use in cotton field tests (Naranjo and Ellsworth, 2009a; Vandervoet *et al*., 2018; Bordini *et al*., 2021). One of the primary elements that made the integrated pest control plan successful was the introduction and appropriate application of selective pesticides. (Reisig *et al*., 2019; Romeis *et al.,* 2019). The Arizona Integrated Cotton Pest Control Research Program is a successful example of a global experience in this area. It has been able to understand how predators and pests interact and show farmers how to apply this knowledge practically by demonstrating how potential chemical and biological controls can be integrated into pest sampling and economic thresholds (Naranjo and Ellsworth, 2009b; Reisig *et al*., 2019; Romeis *et al.*, 2019). The

persistence of this effective integrated control strategy is dependent on a number of parameters, including the insecticides' selectivity for controlling other arthropod pests in the cotton system in addition to these primary pests. In our system, however, the selectivity of new insecticides with respect to natural enemies is unknown. However, information from manufacturers and product costs were the main factors that influenced farms' decisions to utilize it. The group of primary whitefly predators that inhabit the cotton food web and greatly contribute to the decline in whitefly populations have been better understood and used in our system thanks to research and the application of selective pesticides. (Vandervoet *et al.*, 2018). Thus, our study aimed to study the effect of pesticide-treated and untreated cotton fields on the seasonal abundance of the most important cotton pests and their accompanying insect predators.

MATERIAL AND METHODS

Studies were conducted in El-Zagazig, Sharkia Governorate, Egypt (30.7ºN 31.63ºE), during the cotton growing seasons for the years 2022, 2023 and 2024. Two feddans (0.84 hectare) of agricultural land were selected to conduct the study and divided into eight experimental plots. Four plots of land have been allocated to be treated with normal practices of pesticides and the other four without any use of pesticides. The seeds of the cotton plant *Gossypium barbadense* L. variety Giza 94 was sown on 25, 20 and 30 March during the first, second and third seasons, respectively. The farming procedures were in accordance with the agricultural practices of the region. The cotton pests control program approved by the Egyptian Ministry of Agriculture and Land Reclamation (MALR) and applied in areas treated with cotton pesticides. The study was extended from the first week of May till the last week of September during the three successive seasons to study the densities and population fluctuation of four insect cotton pests. Which were *B. tabaci, A. gossypii, S. littoralis and P. gossypiella* and its associated predators that were *C. carnea, C. undecimpunctata, Scymnus spp, Orius spp and P. alfierii*.

For studying the densities of *B. tabaci* and *A. gossypii*, twenty-five leaves/samples/plot/six days were collected from pesticide-treated and untreated cotton plots, then packed in paper bags and transported to the laboratory for examination. Each sample was repeated four times per treatment for the season, during 2022, 2023 and 2024. *B. tabaci* density was examined on the lower surface of the cotton leaf under magnification on a 3.88 cm^2 (1.528 inches) disc taken in each leaf. The density of eggs and nymphs (first to fourth instars and pupae) was estimated by counting numbers. The nymphs of *A. gossypii* were estimated to be on the lower surface of the cotton leaf (on 3.88 cm^2 /leaf) (Naranjo and Flint, 1994). *S. littoralis*, density of immature stages, egg masses, and larvae were estimated by direct count method on 200 cotton plants 25 plants/plot/six days were randomly inspected from pesticides-treated and untreated plots. *P. gossypiella,* density of larvae was detected in green cotton squares its age larger than twelve days and green cotton balls from fifteen to thirty days. 200 squares and 200 bolls (25squares and 25bolls/plot/six days) were randomly collected from pesticides-treated and untreated plots. Then, they packed into cloth bags and were taken to the laboratory and inspected by dissect. Arthropods of the five predators were sampled with a direct counting method on 200 cotton plants (25 plants/plot/six days). They were randomly inspected from pesticides-treated and untreated plots. *C. carnea and C. undecimpunctata,* the density of them being immature stages, eggs, larvae, and pupae was estimated by counting numbers. The density of *Scymnus* spp, *Orius* spp and *P. alfierii* was adult stage. Data were analyzed as one way ANOVA completely randomized and means were compared by LSD range test (*P*≤0.05 level) using Costat program, 2005.

RESULTS

The average monthly abundance number of four cotton pests:

The data in (Tables 1-5) showed the effect of two cotton fields, one treated with pesticides and the other not treated, on the average monthly numbers and the percentage of decrease among them for four cotton pests, *A. gossypii*, *B. tabaci*, *S. littoralis* and *P. gossypiella*. The trial period spanned five months from the first week of May to the last week of September for each season during three consecutive seasons 2022, 2023 and 2024.

*A. gossypii***:**

The average monthly numbers of *A. gossypii* immature stages in the two cotton fields significantly affected during the three cotton seasons (Table1). In the treated fields, the highest rate was in August 2022 season with 16.75 numbers, with a very large difference from other months, then September with 9.50 numbers, far ahead of other months. May and June came with 1.35 and 0.85 numbers in third place. In the untreated fields, the average

monthly pests were higher in August, reaching 132.35 numbers, which differs significantly from other months. September came in second place with 21.75 numbers. The months of May and June were with 1.50 numbers. The reduction percentages were 87.34, 56.32, 43.33 and 10.00 % in August, September, June and May, respectively. In the second season 2023, in the treated fields, the highest monthly population average was in September 1.80 numbers and August 1.30 numbers with a very large difference from the other two months. There was a significant difference between (May and July) and the other two months, September and August. The same trend occurred in untreated fields. As for the percentage reduction, it was arranged in descending order as follows (August, July, May and September) with 46.94, 41.67, 41.18 and14.29%, respectively.

In the 2024 season, in the treated fields, the average monthly population was higher in August 30.20 numbers, with a very large difference from the other four months. While, the months of May and June were recorded as the lower average monthly numbers. In the untreated fields, July and August was the highest, which recorded 223.45 and 157.85 numbers, which differs significantly from the other three months. May and June recorded the lower average numbers, with a wide difference between them and the previous months. The percentage reduction was in descending order as follows in July, June, August, May and September with 94.47, 86.84, 80.87, 75.00 and 41.30%, respectively. In the average of the three seasons, in the treated and untreated fields, the average monthly population of *A. gossypii* was higher in the three months of August, July and September. The lowest was in the two months of May and June. The decrease in the percentage came in descending order as follows in July, August, June, September and May by 94.33, 83.51, 67.65, 46.46 and 37.31%, respectively, with an average of 65.85%.

Table 1. Monthly mean numbers and reduction percentages of *A. gossypii* in treated and untreated cotton fields at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024)

Months	2022			2023			2024			Average		
	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction
May	1.35c	1.50c	10.00	0.50b	0.85b	41.18	0.25d	1.00d	75.00	0.70c	1.112b	37.31
June	0.85c	1.50c	43.33	.	.	.	0.25d	1.90d	86.84	0.55c	1.70b	67.65
July	.	.	.	0.35b	0.60b	41.67	12.35c	223.45a	94.47	6.35c	112.03a	94.33
Aug.	16.75a	132.35a	87.34	1.30a	2.45a	46.94	30.20a	157.85b	80.87	16.08a	97.55a	83.51
Sep.	9.50b	21.75b	56.32	1.80a	2.10a	14.29	16.70b	28.45c	41.30	9.33a	17.43b	46.46
Average	7.11	39.28	49.25	0.99	1.50	36.02	11.95	82.53	75.70	6.60	45.97	65.85
F	30.30	1406.99		16.43	13.40		268.84	273.52		8.67	8.42	
P	**	**		**	**		**	**		**	**	
LSD	4.22	5.16		0.61	0.77		2.61	18.59		7.38	58.47	

***B. tabaci*:**

The average monthly numbers of the pest during the three seasons showed a significant effect between each treatment (Table 2). In the first season 2022, in the treated fields, the highest pest abundance was recorded in August with 34.35 numbers followed by July with 13.85 numbers then June with 0.75 numbers, a large difference between them and the previous months. In the untreated field, the highest was in August with 53.40 numbers, which differs significantly from the other four months. The reduction percentages were 66.67, 59.26, 39.91 and 35.67 % in May, June, July and August, reaching, respectively.

In the 2023 season, in the treated field, the average was highest in September 55.30 numbers and August 50.45 numbers with a very significant difference from the other two months, followed by July 10.00 and June. In the untreated field, the highest was in September and August with a very large difference from the other two months, followed by July then and June with significant differences between them. As for the percentage reduction, it was arranged in descending order as follows August, September, July and June with 83.04, 82.84, 59.02 and 37.50, respectively.

In the 2024 season, in the treated field, the averages of monthly population were higher in August at 67.25 numbers, with a very large difference from the other four months. Then July was with 48.05 numbers, September with 24.45 numbers. In the untreated field, the averages of monthly population took the same trend. The percentage reduction was in descending order as follows in July, August, May, June and September, with 53.08, 43.77, 28.13, 25.00 and 15.83%, successively, which differed slightly.

In the average of the three seasons, in the treated and untreated fields, the average monthly population of *B. tabaci* was higher in the three months of August, July and September. The lowest averages were in June and May. The decrease in percentage came in descending order as follows in September, August, July, May and June by 77.3, 67.7, 52.0, 50.0 and 43.3 %, respectively, with an average of 58.05%.

Table 2. Monthly mean numbers and reduction percentages of *B. tabaci* in treated and untreated cotton fields at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024)

Months	2022			2023			2024			Average		
	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	%Red	Treated	Untreated	% Reduction
May	0.50c	1.50c	66.67	.	.	.	0.67d	1.00d	25.00	0.63c	1.25b	50.0
June	0.75 c	1.80c	59.26	0.50c	0.80b	37.50	1.15d	1.60d	28.13	0.79c	1.4b	43.3
July	13.85b	23.05b	39.91	10.00b	24.40b	59.02	48.05b	102.40b	53.08	23.97b	49.95b	52.0
Aug.	34.35a	53.40a	35.67	50.45a	297.45a	83.04	67.25a	119.60a	43.77	50.68a	156.82a	67.7
Sep.	.	.	.	55.30a	322.30a	82.84	24.45c	29.05c	15.83	39.88a	175.68a	77.3
Average	12.36	19.94	50.38	29.06	161.24	65.60	28.33	50.73	33.16	23.19	77.02	58.05
F	97.00	258.21		83.11	214.11		230.69	224.58		30.10	10.07	
P	**	**		**	**		**	**		**	**	
LSD	4.98	4.69		9.41	36.26		6.54	11.36		13.41	83.46	

S. littoralis:

The data in (Table 3), the first season 2022, in the treated fields, the highest number of *S. littoralis* was recorded in August with 11.60 numbers, in May with 9.00 numbers, and in June with 5.00 numbers. July recorded the lowest numbers. In the untreated cotton fields, the highest number was recorded in August 19.15, while the lowest number was recorded in July with 5.90 numbers, with significant difference between them. The reduction percentages were in July, June, August and May with 72.88, 54.55, 39.58 and 7.69%, respectively.

In the second season, in the treated fields, the highest average pest abundance was recorded in June, with 2.35 numbers. There were non-significant differences between them. In the untreated field, the average numbers were 15.10, 8.25 and 3.05 numbers in June August and September, consecutively. May and July followed and found statistically significant differences between them. The percent reductions in August, June, September, July and May were 84.34, 84.11, 55.56 and 36.00%, successively. In the 2024 season, in the treated fields, the average monthly population was highest in June with 3.20 numbers, with a very large difference from the other four months. Then, they were July, August and September. In the untreated fields, the highest was in July, followed by August, June and September. There were statistically significant differences between them. The percentage reduction was in descending order as follows for September, August, July and June with 82.86, 77.97, 73.33 and 44.83%, respectively.

In the three seasons, in the treated and untreated fields, the average monthly population of *S. littoralis* fluctuated in the two treatments and ranged from 0.9 numbers in September in the treated fields and 11.10 numbers in August in the untreated fields. The decrease in percentage came in descending order as follows in September, July, June, August and May with 72.73, 70.92, 66.85, 57.48 and 13.47%, respectively, with an average of 56.29%.

Table 3. Monthly mean numbers and reduction percentages of *S. littoralis* in treated and untreated cotton fields at El-Zgazyg district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024)

Months	2022			2023			2024			Average		
	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction
May	9.00b	9.75b	7.69	1.63	2.50c	36.00	.	.	.	5.31a	6.13b	13.47
June	5.00c	11.00b	54.55	2.35a	15.10a	84.11	3.20a	5.75a	44.83	3.52a	10.62a	66.85
July	1.55d	5.90c	72.88	1.15a	2.65c	55.56	1.95b	7.45a	73.33	1.55b	5.33b	70.92
Aug.	11.60a	19.15a	39.58	1.25a	8.25b	84.34	1.30c	5.90a	77.97	4.72a	11.10a	57.48
Sep.	.	.	.	1.15a	3.05c	61.29	0.55d	3.50b	82.86	0.90b	3.28b	72.73
Average	6.80	11.46	43.68	1.54	6.34	64.26	1.78	5.68	69.75	3.20	7.30	56.29
F	31.27	34.88		2.67	202.66		41.48	9.57		3.72	7.17	
P	**	**		ns	**		**	**		**	**	
LSD	2.44	2.91		0.942	1.16		0.54	1.62		3.10	4.13	

P. gossypiella:

In green cotton squares, the data presented in **(**Table 4) showed a significant effect of insecticide-treated and untreated fields on the average monthly numbers of pink bollworm larvae during the three seasons. In the 2022 season, in the treated fields the ranking was September 8.60, August 0.80 and July 0.30 larvae. The same trend was found in the untreated fields. In the second season 2023, in treated fields, the ranking was September 1.15, June 0.75, July 0.75 and August 0.80 larvae. In the untreated fields it was September 2.85, June 1.40, August 2.00 and July 1.75 larvae. In the three seasons 2022-2024, in the treated and untreated fields, the average monthly population of *P. gossypiella* larvae, in cotton squares fluctuated in the two treatments and ranged from 0.72 larvae in July in the treated fields and 9.00 numbers in September in the untreated fields. The decrease in percentage of reduction came in descending order as follows in August, June, July and September by 69.54, 59.77, 58.25 and 52.78 %, respectively, with an average of 60.08%.

Table 4. Monthly mean numbers of infested squares and reduction percentages of *P. gossypiella* in treated and untreated cotton fields at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024)

Months	2022			2023			2024			Average		
	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	% Reduction	%Red	Treated	Untreated	% Reduction
May	.	.	.	0.75a	1.40b	59.77	1.88b	5.13a	59.77	1.31b	3.26b	59.77
June	0.30b	0.65b	58.25	0.75a	1.75ab	58.25	1.10c	2.75b	58.25	0.72b	1.72b	58.25
July	0.80b	2.15b	69.54	0.80a	2.00ab	69.54	0.70c	3.40b	69.54	0.77b	2.52b	69.54
Aug.	8.60a	18.40a	52.78	1.15a	2.85a	52.78	3.00a	5.75a	52.78	4.25a	9.00a	52.78
Sep.	3.23	7.07	56.63	0.86	2.00	55.81	1.67	4.26	62.66	1.76	4.12	60.08
F	267.08	154.21		0.82	7.45		20.28	11.34		10.20	8.40	
P	**	**		ns	**		**	**		**	**	
LSD	0.91	2.54		0.94	0.70		0.69	1.29		1.83	3.98	

P. gossypiella:

Larvae in green cotton bolls, the data presented in (Table 5) showed a significant effect of the two treatments on the average monthly numbers of pink bollworm larvae for each season and during the three seasons. Except for the fields treated in the 2023 season, there was insignificant difference between Months. In the treated fields, in the 2022 season, the rankings were September, July and August. For the 2023 season, the standings were in August, July and September. In 2024, the order is September, August and July, with significant differences between them. In the untreated fields, the highest populations in the three seasons were in September and August followed by July. The percentage of decrease in the monthly average differed in the three seasons, in the 2022, the highest percentage of decrease was August and July followed September. The average of the three seasons, the order of months differed, which was the highest reduction in September and August followed by July. As for the monthly reduction rate in the three seasons, it ranged between 34.80 and 96.77% and the average ranged between 69.60 and 90.93%, with an average of 77.83%. **Table 5.** Monthly mean numbers of infested green cotton bolls and reduction percentages of *P. gossypiella* in treated and untreated cotton fields at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024).

Table 5. Monthly mean numbers of infested green cotton bolls and reduction percentages of *P. gossypiella* in treated and untreated cotton fields at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024).

Month	2022			2023			2024			Average		
	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction
July	3.33b	8.17c	59.18	4.53a	6.90b	34.94	1.27b	18.53b	93.24	3.04b	11.19b	72.95
Aug.	1.90b	22.60b	91.59	5.30a	22.00a	75.91	1.75b	54.10a	96.77	2.98b	32.90a	90.93
Sep.	25.95a	39.80a	34.80	4.50a	22.20a	79.73	4.80a	53.95a	91.10	11.75a	38.65a	69.60
Average	10.39	23.52	61.86	4.77	17.04	63.53	2.60	42.18	93.70	5.92	27.58	77.83
F	209.81	125.36		2.02	64.31		49.57	49.31		7.74	15.18	
P	**	**		ns	**		**	**		**	**	
LSD	2.98	4.52		1.02	3.50		0.87	9.34		5.22	10.69	

Monthly abundance of five predators associated with four cotton pests:

The data in (Tables 6-8) showed the effect of both insecticide-treated and untreated cotton fields against cotton pests on the average monthly numbers and percentage reduction of the five predators' *C. carnea, C. undecimpunctata, Scymnus* spp, *Orius* spp and *P. alfierii* associated with the four cotton pests. During five months, it was May, June, July, August and September of each season and for three consecutive cotton seasons.

C. carnea:

The data presented in (Table 6) showed a high significant effect of the two treatments on the average monthly numbers of *C. carnea*, in each season and during the three seasons. In the 2022 season, in the treated area, June was the most populous month, with 17.90 numbers. Then the average monthly populations were 10.95, 6.80, 4.60 and 2.60 numbers for September, August, July, and May, respectively. In the untreated fields, the average monthly predator was higher in June, with 36.60 numbers, which differs significantly from the other four months. However, the lowest number recorded in May with 3.20 numbers with a wide difference between them and the previous months. The percentage of reduction was arranged in descending order as follows: June, July, August, September and May with values of 51.09, 40.26, 38.46, 20.65 and 18.75%, consecutively.

In the 2023 season, in the treated fields, September was the most population month, with 19.25 numbers, with a significant difference from the other four months. However, May had the lowest number, with 2.25 people,

which is very different from the other four months. The percentage reduction were arranged in descending order as follows July, May, August, June and September at 87.11, 72.05, 67.89, 53.41and 24.21%, respectively.

In the 2024 season, in the treated fields, September was the most population month, with 7.65 numbers, with a significant difference from the other four months. While the lowest number of *C carnea* was recorded in May with 1.25 numbers. In the untreated fields, the average monthly population was higher in September with 19.50 numbers, which differs significantly from the other four months, and August 5.40, but July 2.60 and June 2.25 numbers. There was a significant difference between the 1.45 persons in May and those in the preceding months. The reduction percentages were arranged in descending order as follows September, July, August, May and June where the values were 60.77, 48.08, 41.67, 13.79 and 6.67 %, successively. In the average of the three seasons 2022, 2023 and 2024 in the two treatments, the highest average monthly population was in September, June and August followed by July and May. The percentage reduction ranged between 35.52 and 70.69%, with an average of 52.62%.

Table 6. Monthly mean numbers and reduction percentages of *C. carnea* in treated and untreated cotton fields at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024)

Months	2022			2023			2024			Average		
	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction
May	2.60e	3.20d	18.75	2.25c	8.05d	72.05	1.25d	1.45d	13.79	2.03c	4.23c	51.97
June	17.90a	36.60a	51.09	5.8b	12.45c	53.41	2.10c	2.25c	6.67	8.60b	17.1ab	49.71
July	4.60d	7.70c	40.26	2.30c	17.85b	87.11	1.35d	2.60c	48.08	2.75c	9.38bc	70.69
Aug.	6.80c	11.05b	38.46	6.55b	20.40b	67.89	3.15b	5.40b	41.67	5.50bc	12.28abc	55.22
Sep.	10.95b	13.80b	20.65	19.25a	25.40a	24.21	7.65a	19.50a	60.77	12.62a	19.57a	35.52
Average	8.57	14.47	33.84	7.23	16.83	60.94	3.10	6.24	34.19	6.30	12.51	52.62
F	175.99	154.49		254.22	43.16		211.43	172.52		13.78	6.24	
P	**	**		**	**		**	**		**	**	
LSD	1.38	3.15		1.32	3.11		0.55	1.74		3.34	6.93	

C. undecimpunctata:

The data in **(Table 7)** showed a high significant effect of the two treatments on the average monthly numbers of predator associated with cotton pests, for each season, during the three cotton seasons. In the 2022 season, in the treated fields, June was the most population month, with 2.80 numbers; it is different from the other four months. Then the average monthly population for May with 2.05 and July was 1.30 numbers. August and September recorded the lowest numbers with 0.75 numbers. In the untreated fields, the highest monthly average population was in June followed by the other four months. The percentage of reduction was descending order as follows: August, September, July, June and May at 72.73, 66.67, 57.38, 37.78 and 36.92%, respectively.

In the 2023 season, the treated fields recorded the highest population in June, with 2.60 numbers, making it the peak month. Then the other four months were in second place. In the untreated fields, the average monthly population of predators followed the same trend. June, July, May, September and August were significant difference between them. The percentage of reduction was arranged as follows: June, July, May, September and August at 53.15, 48.39, 37.93, 31.82 and 6.25%, respectively.

In the 2024 season, in the treated fields, June was the most population month at 1.45 numbers; July came with 1.30 populations in second place. Then the other three months, August with 1.05, May with 1.00 and September with 0.80 populations, came in third place with insignificant difference between the five months. In the untreated fields, August recorded the highest number with 6.25 numbers. The percentage reduction was arranged in descending order as follows: August, September, July, May and June with values of 83.20, 74.19, 72.04, 37.50 and 36.96%, respectively. In the average of the three seasons 2022,2023 and 2024in the two treatments, the highest average monthly population was differed among the five months in treated and untreated fields. The percentage reduction ranged between 37.30 and 73.98%, with an average of 56.68%.

Table 7. Monthly mean numbers and reduction percentages of *C. undecimpunctata* in treated and untreated cotton fields at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024)

Months	2022			2023			2024			Average		
	Treated	Untreated	% Reduction	Treated	Untreated	%Red	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction
May	2.05ab	3.25b	36.92	0.90b	1.45b	37.93	1.00a	1.60d	37.50	1.32b	2.10b	37.30
June	2.80a	4.50a	37.78	2.60a	5.55a	53.15	1.45a	2.30cd	36.96	2.28a	4.12a	44.53
July	1.30bc	3.05b	57.38	0.80b	1.55b	48.39	1.30a	4.65b	72.04	1.13b	3.08ab	63.24
Aug.	0.75c	2.75b	72.73	0.75b	0.80b	6.25	1.05a	6.25a	83.20	0.85b	3.27ab	73.98
Sep.	0.75c	2.25b	66.67	0.75b	1.10b	31.82	0.81a	3.06c	74.19	0.77b	2.14b	64.34
Average	1.53	3.16	54.29	1.16	2.09	35.51	1.12	3.58	60.78	1.27	2.94	56.68
F	9.92	8.50		3.97	57.87		2.33	31.19		9.85	3.53	
P	**	**		**	**		ns	**		**	**	
LSD	0.85	0.87		1.22	0.78		0.50	1.01		0.55	1.28	

***Scymnus* spp, *Orius* spp and *P. alfierii*:**

The data in (Table 8) showed a very significant effect of the two treatments on the average monthly numbers of the three predators associated with cotton pests, during the three seasons. In the 2022 season, in the treated fields, July and June were the most population months with 6.05 and 5.35 numbers, respectively. Then August, May and September where values were1.15, 1.05 and 0.80 numbers, consecutively. In the untreated fields, the highest monthly average population in June and July where values were 18.95 and 13.90, successively, while, the other three months came in second place with a significant difference between them. The percentage of reduction ranged between 56.25 to 71.77%. During the 2023 season, June had the highest population in the treated fields, with 2.40 numbers, ranking it as the most populous month. Then the other four months came second. In the untreated fields, the order was descending the same as the previous one, with a significant difference. The percentage of reduction ranged between 11.76 to 40.74%.

In the 2024 season, in the treated fields, June with 3.30 and July with 2.55 numbers were the most populous during the months unlike the other three months, May, August and September came second. In the untreated fields, the average monthly population in June was 8.70 and in July with 8.45 numbers the largest population during the two months in contrast to the other three months. September came second. August and May came in third place. The percentage of reduction ranged between 56.86 to 83.67%. In the average of the three seasons 2022, 2023 and 2024 in the two treatments, the highest average monthly population was differed among the five months in treated and untreated fields. The percentage reduction ranged between 56.57 to 70.81%, with an average of 62.89%. Monthly abundances of five predators associated with four cotton pests, namely *C. carnea, C. undecimpunctata, Scymnus* spp, *Orius* spp and *P. alfierii*, were significantly affected by untreated and pesticide-treated cotton fields against cotton pests.

Table 8. Monthly mean numbers and reduction percentages of *Scymnus* spp, *Orius* spp and *P. alfierii* in treated and untreated cotton fields at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024)

Months	2022			2023			2024			Average		
	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction	Treated	Untreated	% Reduction
May	1.05b	2.40c	56.25	.	.	.	1.10b	2.55c	56.86	1.08b	2.48b	56.57
June	5.35a	18.95a	71.77	2.40a	4.05a	40.74	3.30a	8.70a	62.07	3.68a	10.57a	65.14
July	6.05a	13.90b	56.47	0.75b	0.85b	11.76	2.55a	8.45a	69.82	3.12a	7.73a	59.70
Aug.	1.15b	2.75c	58.18	0.75b	1.25b	40.00	0.80b	3.15c	74.60	0.90b	2.38b	62.24
Sep.	0.80b	2.25c	64.44	0.75b	0.90b	16.67	0.80b	4.88b	83.67	0.78b	2.68b	70.81
Average	2.88	8.05	61.42	1.16	1.76	27.29	1.71	5.55	69.41	1.91	5.17	62.89
F	59.51	90.94		3.78	46.18		18.48	70.31		11.64	9.24	
P	**	**		*	**		**	**		**	**	
LSD	1.01	2.48		1.31	0.70		0.80	1.04		1.38	4.22	

Population fluctuation of the four cotton pests:
The data in (Fig. 1) showed that the population fluctuations of four insect pests A. *gossypii, B. tabaci, S. littoralis* and *P. gossypiella* in the cotton field treated with pesticides or untreated began with appear in both treatments in the samples from the first sample to the fourth sample with small numbers. Then the population continued to fluctuate until the end of the season. In the 2022 season, *A. gossypii* recorded three peaks with 176, 101 and 85 numbers on July 18, August 11 and September 4, respectively in the pesticide-treated field. One peak with 959 numbers was recorded on August 29 in the untreated field. *B. tabaci* took the same fluctuation that caused two peaks with 208 and 363 numbers on August 4 and September 10, respectively for pest occurrence in the pesticide-treated field. While three peaks with 510, 301 and 102 numbers occurred on 5, 17 August and 4 September in the untreated. *S. littoralis* recorded three peaks with 30, 204 and 19 numbers on June 18, August 17 and September 10, respectively in the treated field and three peaks with 116, 84 and 214 numbers on June 24 and August 5 and 29, respectively in the untreated field. As for the infestation of the pink bollworm *P. gossypiella*, one peak was recorded at the end of the season in the treated and untreated cotton fields in squares 53, 105 and green bolls with 178, 196 green squares and bolls infected, respectively.

In the 2023 season, the data showed a fluctuation of four pests of cotton. *A. gossypii* population recorded a peak in the treated and untreated field with 10 and 16 numbers on August 23 and 29, respectively. The whitefly, *B. tabaci*, which caused two peaks with 39 and 215 numbers on July 12 and September 4, respectively for the pest that occurred in the pesticide-treated or untreated field, peaked with 1680 numbers on September 4. *S. littoralis,* a peak with 20 numbers was recorded on 12 June in the treated field and three peaks with 31, 96 and 41 numbers on 6 June, 5 August and 4 September, respectively in the untreated field. As for the pink bollworm *P. gossypiella* in the infected squares, the population recorded one peak on September 16 for both treated and untreated with 6 and 16 affected squares, respectively. While in the affected bolls, the population recorded two peaks of each of 35 affected bolls on August 29 and September 16, respectively, in the treated areas. The population recorded three peaks with 79, 151 and 156 affected bolls on August 11, 29 and September 16, respectively, in the untreated areas. In the 2024 season, *A. gossypii* population recorded two peaks with 162 and 108 numbers on August 6 and September 5, respectively, in the pesticide-treated field. In the untreated field, the pest also recorded two peaks, with 1359 and 933 numbers on 13 and 31 July, respectively. The whitefly, *B. tabaci*, took the same fluctuation, causing two pest peaks in the pesticide-treated or untreated field also.
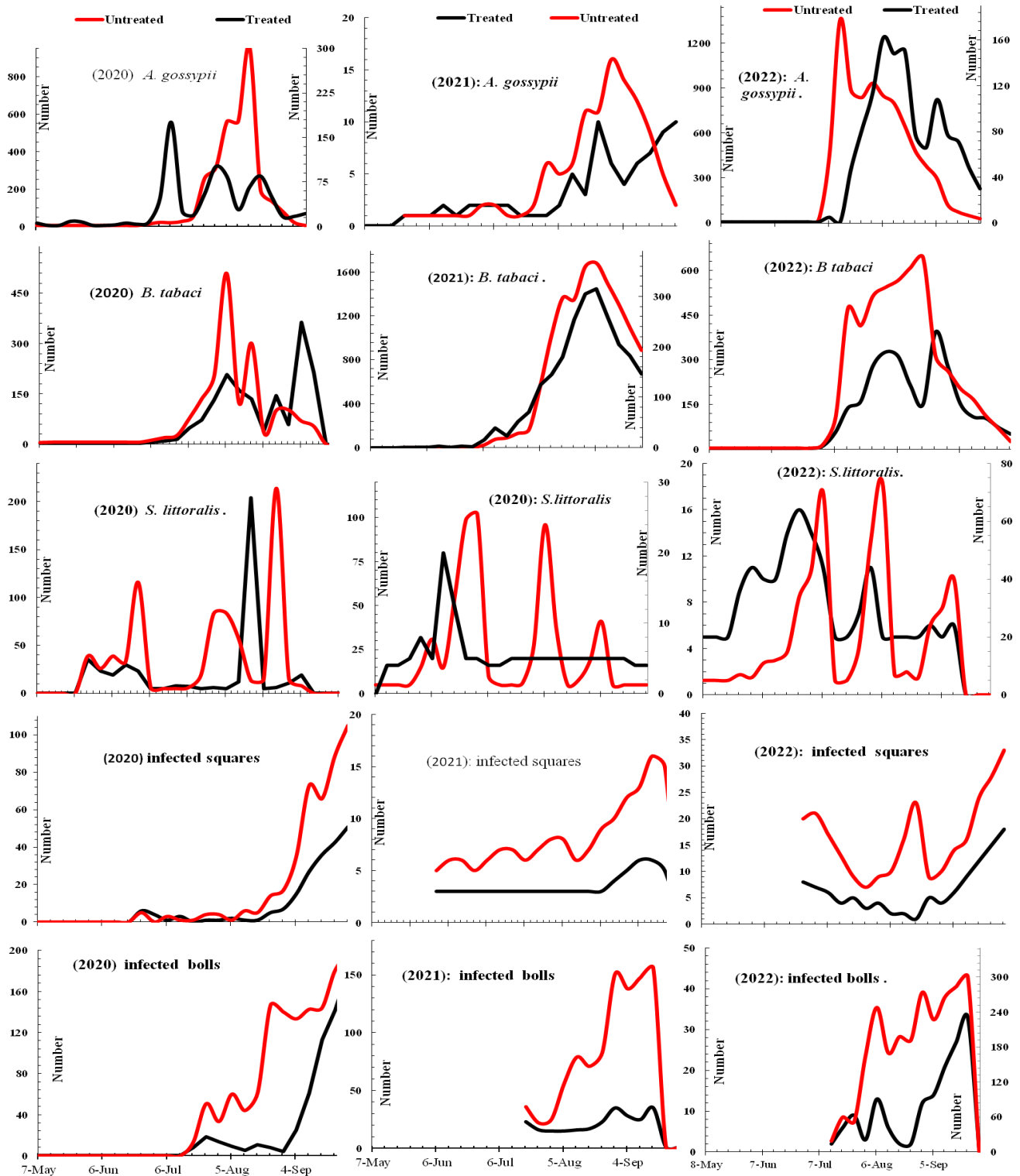
Fig. 1. Population fluctuation of *A. gossypii*, *B. tabaci*, *S. littoralis* and *P. gossypiella* in treated and untreated field conditions at El-Zagazig district, Sharkia Governorate during three Growing cotton seasons (2022, 2023 and 2024) The number of cottons leafworm *S. littoralis* recorded two peaks in the treated field and the untreated. As for the number of pink bollworm *P. gossypiella* in squares and green cotton bolls, one peak was recorded at the end of the season for squares and bolls in treated field. And in untreated fields, two and three peaks were recorded, respectively.

Population fluctuation of the five common insect predators associated with four cotton pests:

The data in (Fig. 2**)** showed the population fluctuations of the numbers of the five predators, *C. carnea, C undecimpunctata*, *Scymnus* spp, *Orius* spp and *P. alfierii* in cotton fields treated and untreated with pesticide against cotton pests, during the three seasons 2022, 2023 and 2024.

In the 2022 season, *C. carnea* fluctuated, causing four peaks with 91, 75, 23 and 36 numbers on June 9, 27, July 27 and August 14, respectively in the pesticide-treated field. Four peaks with 196, 50, 51 and 79 numbers on June 21, July 27, August 14, and September 13, respectively in the untreated areas. The *C. undecimpunctata* population recorded a peak with 16 numbers on 3 June in the field treated with pesticide. Two peaks with 23 and 13 numbers were recorded on 9 June and 2 August, respectively, in the untreated field. The number of the three predators, *Scymnus* spp, *Orius* spp and *P. alfierii*, on 27 June and 21 July, in the pesticide-treated and untreated field, recorded two peaks for both fields, on the same dates with 58, 34 and 162, 66 numbers, respectively. The 2023 season, *C. carnea*, took the same oscillation, causing four peaks with 64, 15, 27 and 90 numbers on June 21, July 12, August 17, and September 28, respectively, for the predator to occur in the pesticide-treated field. Five peaks with 113, 66, 129, 106 and 108 numbers on 6 and 24 June, 18 July, 17 August, and 28 September, respectively in the untreated. *C undecimpunctata* population recorded a peak with 17 numbers on 6 June in the pesticide-treated field, two peaks with 50 and 12 numbers were recorded on June 18 and July 24, respectively, in the untreated field. The numbers of the three predators, *Scymnus* spp*, Orius* spp and *P. alfierii* recorded a peak in the two treatments, with 16 numbers on 6 June in the treated field and 28 numbers on 18 June in the untreated field. In the 2024 season, three peaks of *C. carnea* with 14, 26 and 68 numbers occurred on June 11, August 22 and September 15, respectively, in the pesticide-treated field. In the untreated field, it was recorded three peaks with 13, 44 and 107 numbers on June 29, August 28 and September 21, respectively. Population *C undecimpunctata* recorded a peak of 8 numbers on 11 June in the pesticide-treated field, two peaks with 13 and 39 numbers were recorded on 11 June and 29 July, respectively, in the untreated field. The number of the three predators, *Scymnus* spp, *Orius* spp and *P. alfierii*, recorded a peak with 22 numbers on 17 June in the treated field and three peaks with 45, 51 and 24 numbers on 17 June, 23 July and 9 September, respectively, in the field untreated.
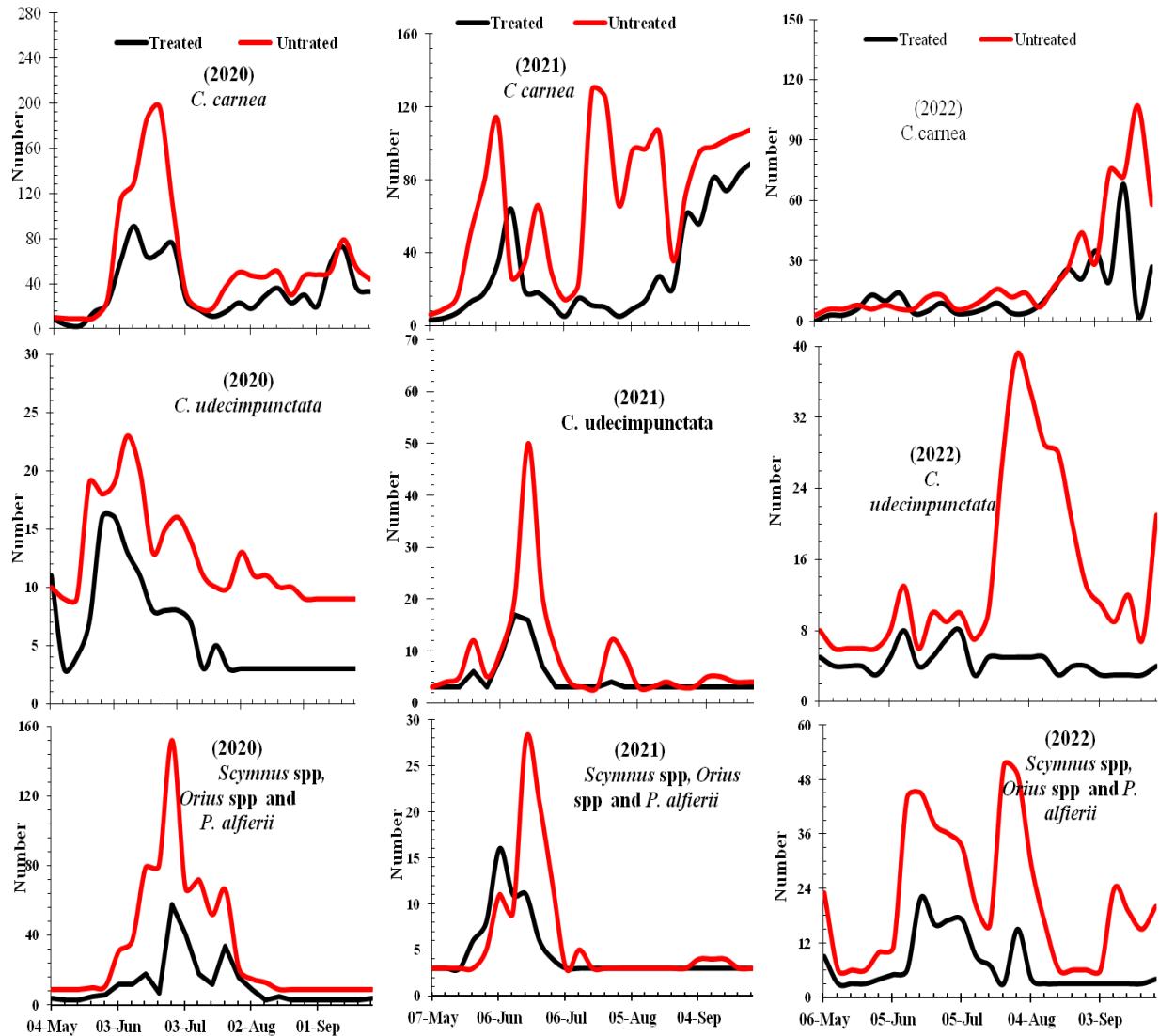
Fig. 2. Monthly mean numbers of *Scymnus* spp,; *Orius* spp and *P. alfierii* in treated and untreated field conditions at El-Zagazig district, Sharkia Governorate during three growing cotton seasons (2022, 2023 and 2024).

DISCUSSION

The average accompanying monthly predators in an untreated cotton field was greater than those treated with insecticides. The percentage of reduction varied for the five months each and during the three seasons. The overall average for the three seasons of predators was 52.62, 56.68 and 62.89 %, respectively. In addition, he found that treatment with a combination of insecticides and insect growth regulators (IGRs) resulted in the highest reduction of all predators examined except for *C. carnea*, which amounted to between 84 and 100% *P. alfierii* and *Scymnus* spp. Treatments with a combination of conventional insecticides with insect growth regulators (IGRs) resulted in a reduction in the number of some cotton pests by 75 and 92% compared with untreated pesticides (Al-Shannaf, 2010). Bhute *et al.* (2023) indicated that among all insecticides the chlorantraniliprole 18.5 % SC found most effective for control of rosette flower, green boll damage, larval population, open boll damage and locule damage. Regardless of whether the insecticides were applied in a sequence or individually, Somaa (2021) discovered that all insecticide treatments used to control cotton pests were linked to the greatest decrease in the populations of common cotton predators, with the ranges of 65.60 to 69.90% and 70.34 to 76.14 percent, respectively. By contrast, the use of biocides Agren (*Bacillus thuringensis*) had minimal side effects on beneficial predators with an average of (29.05%). Solangi *et al*. (2008) indicated that the predators were active throughout the cotton season

due to the non-application of pesticides in and around the experimental area of cotton. It led to the sucking insect pests in cotton being below the economic injury level at all phenological stages of the cotton plant due to the regular increase in predator population. After three days of IGR application, the numbers of all examined predators fell, but after seven days in both seasons they increased again, according to El-Sayed *et al.* (2015). Out of all the tested predators, chlorfluazuron was the most toxic. According to Machado *et al.* (2019), agricultural fields subjected to selective and untreated management practices exhibited a two-fold increase in the seasonal abundance of predatory insects in cotton compared to fields managed under non-selective recommendations. The introduction of Bt cotton cultivation in China in 1997, which involves reduced pesticide application relative to non-Bt cotton, has led to significant alterations in the composition and dynamics of natural enemy communities within cotton agroecosystems, as documented by Ali *et al.* (2016). El-Hadary and Ahmed (2021) observed that the population dynamics of *Bemisia tabaci* displayed two distinct peaks during the first growing season and four peaks during the second, whereas *Aphis gossypii* (cotton aphid) exhibited four population peaks in the first season of 2018 and three in the second. Additionally, *C. undecimpunctata* (ladybird beetle) demonstrated seven population maxima across both seasons. In contrast, *C. carnea* populations peaked seven times during the 2020 season and eight times during the 2021 season.

Ashfaq *et al.* (2011) reported that the densities of both insect pests and natural enemies in cotton agroecosystems reached their highest levels between June and October. The highest densities of pests and predators were 5.7 and 2.61 numbers/leaf for *B. tabaci* and *A. gossypii* on August 10 and June 20, respectively, and 1.42 numbers/leaf for *C. septempunctata* on August 10. After mid-October, the natural enemies and pests vanished entirely. The results of our tested chemicals showed that two bio-based chemical insecticides, namely Radiant and Movento Energy, showed less harm to beneficial predatory fauna while controlling the sucking pest populations (Nadeem *et al.,* 2022). The study also found that the natural enemies were rarely seen in May during the early stages of the crop (Ramzan *et al.*, 2019). One important strategy in Integrated Pest Management (IPM) is the preservation of natural enemies. By making agricultural ecosystems more favorable to the presence, survival, and expansion of natural enemy populations, additional biological control services can be obtained. For instance, the diffusion of artificial or plant-derived compounds that resemble those the plant releases in response to pest attacks is a strategy that can be used in a variety of growth systems.

CONCLUSIONS

The study examined the average monthly numbers and population fluctuation among four cotton pests, *A. gossypii*, *B. tabaci*, *S. littoralis*, and *P. gossypiella*, as well as five predators associated with these pests, *C. carnea*, *C. undecimpunctata*, *Scymnus spp.*, *Orius spp.*, and *P. alfierii* that were found in two cotton fields that were treated with insecticides and those that were not. The study found that treated cotton fields had the lowest numbers of *A. gossypii* immature stages during the 2022-2024 seasons. There were significant differences in the number of *B. tabaci* pests in treated and untreated sites. The average monthly number of *P. gossypiella* larvae was significantly impacted by insecticide treatment. Population fluctuation, *A. gossypii* reached three peaks in fields treated with insecticides, while *B. tabaci* and *S. littoralis* had the highest populations in both treated and untreated locations. Preserving natural enemies is a key Integrated Pest Management (IPM) tactic. Strengthening agricultural ecosystems to be more conducive to the existence, survival, and growth of natural enemy populations can achieve more biological control services.

Conflict of interest statement:
We declare that we have no conflict of interest.

Availability of data and materials:
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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تأثير حقول القطن المعاملة وغير المعاملة بالمبيدات على تذبذب تعداد أهم آفات القطن ومفترساتها الحشرية

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تم زراعة القطن صنف جوسيبيوم باربادينس في الحقول التجريبية خلال مواسم مارس (2022، 2023، و2024)، واستمرت الدراسات لمدة خمسة أشهر، وتم إجراء الدراسات الحقلية في منطقة الزقازيق بمحافظة الشرقية لمقارنة تأثير حقول القطن المعاملة وغير معاملة بالمبيدات الحشرية على متوسط الأعداد الشهرية، والتقلبات الموسمية لأهم آفات القطن، والمفترسات الحشرية الشائعة المرتبطة بها. أظهرت النتائج أن حقول القطن المعاملة وغير معاملة أثرت بشكل كبير على متوسط الأعداد الشهرية لآفات القطن الأربعة من القطن ، ذبابة القطن البيضاء، دودة ورق القطن و دودة اللوز القرنفلية وخمس مفترسات حشرية شائعة مرتبطة بها اسد المن ، أبو العيد 11 نقطة ، سكيمنوس ، جنس الأوريوس والحشرة الرواغة خلال المواسم الثلاثة. علاوة على ذلك، كان متوسط التعداد الشهري لآفات القطن الأربعة والمفترسات الحشرية المصاحبة لها في حقول القطن غير المعاملة أكبر من تلك المعاملة بالمبيدات الحشرية. بلغت تقلبات الآفات الحشرية الأربعة في حقول القطن المعاملة وغير المعاملة 53 ذروة؛ كانت 24 ذروة في الحقول المعاملة و 29 في الحقول غير المعاملة. من ناحية أخرى، سجلت والمفترسات 41 ذروة؛ كانت 18 في الحقول المعاملة و 23 في الحقول غير المعاملة. وبالتالي، من الواضح أن دراستنا أظهرت أن دودة ورق القطن كانت الأكثر شيوعًا من بين الآفات الأربع، وكان اسد المن هي المفترس الأكثر شيوعًا من بين المفترسات الحشرية الخمسة في كل من حقول القطن المعاملة وغير المعاملة. وبالتالي، أوصت الدراسة بأن الحفاظ على الأعداء الطبيعية هو تكتيك أساسي في إدارة الآفات المتكاملة.

الكلمات المفتاحية: محصول القطن ، المبيدات ، افات القطن ، المفترسات و التقلبات الموسمية