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Distribution and Abundance of Predatory Insect Species Identified in Cotton Fields in the Southeastern Anatolia Region

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Abstract

This study investigated the prevalence and density of predatory insect species in cotton fields across the provinces of Diyarbakır, Şanlıurfa, and Mardin in the Southeastern Anatolia Region from 2021 to 2024. Surveys were conducted biweekly using a D-vac device. A total of 28 predatory insect species were identified, including 9 species from the *Coccinellidae* family (*Coleoptera*), 7 from *Geocoridae*, 4 from *Miridae*, 3 from *Nabidae*, 2 from *Anthocoridae*, and *Reduviidae* species *(Hemiptera)*, 1 species from *Chrysopidae* (Neuroptera), and 1 species from Thysanoptera. The most prevalent species varied by location and year: In Diyarbakır, *Chrysopidae* dominated throughout the study. In Şanlıurfa, *Chrysopidae* were the most common in 2021 and 2023–2024, while *Geocoridae* prevailed in 2022. In Mardin, *Chrysopidae* remained dominant for the first three years, but *Miridae* became the most prevalent in 2024. The most abundant beneficial insect species in 2021 were *Anthocoridae* in Diyarbakır (mean density: 5.51) and Chrysoperla carnea *(Chrysopidae)* in Şanlıurfa (7.60) and Mardin (7.51). In 2022, *Cicadellidae* species showed the highest densities in Diyarbakır (124.74), Şanlıurfa (114.78), and Mardin (65.33). By 2023, C. carnea *(Chrysopidae)* was dominant in Diyarbakır (3.34) and Şanlıurfa (4.51), whereas Geocoris spp. *(Geocoridae)* led in Mardin (5.88). In 2024, *Coccinellidae* species were most abundant in Diyarbakır (3.34) and Şanlıurfa (4.51), while *Anthocoridae* dominated in Mardin (7.31). Co-occurrence rates of multiple predatory species were highest in Mardin in 2021 (48.72%, 2 species) and 2023 (41.67%, 3 species), whereas Şanlıurfa had the highest rates in 2022 (34%, 3 species) and 2024 (46.81%, 2 species).

Keywords: Predatory Insects; Cotton Fields; Biodiversity; Biological Control; Southeastern Anatolia

Introduction

Cotton (*Gossypium hirsutum*) is a strategic agricultural crop that underpins the global textile industry, with worldwide production exceeding 25 million tons [1]. As the primary raw material for textile products, cotton serves as a crucial link between the agricultural and industrial sectors. While cotton fibers are processed in textile factories, the agricultural sector provides the necessary resources for cotton cultivation [2]. The leading countries in global cotton production include India, China, the United States, Brazil, Pakistan, and Uzbekistan, respectively. Turkey ranks as the 7th largest cotton producer worldwide. In our country, the Southeastern Anatolia Region holds the top position, accounting for 60.6% of the cotton cultivation area and 61.3% of seed cotton production [3].

Cotton, which grows primarily in hot and semi-arid climates, faces significant sustainability challenges due to its high water and pesticide demands. Insect pests are responsible for 20-50% yield losses in cotton production, leading to annual economic damages exceeding 5 billion US dollars [4]. In areas where cotton is produced, sap-sucking pests such as aphids, mites, thrips, and leafhoppers, along with damaging insects like bollworm, spiny bollworm, and Lygus species that inflict serious harm on reproductive organs, present considerable challenges [5]. The management of these factors that affect yield and quality often depends on the use of pesticides. These pesticides, which can create significant problems for human and environmental health, may lead to both direct and indirect negative side effects on predatory insects

found in cotton fields [6,7]. Pests such as aphids (*Aphis gossypii Glover (Hemiptera: Aphididae)*), whiteflies *(Bemisia tabaci (Genn.) (Hemiptera: Aleyrodidae))*, and bollworm *(Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae))* have developed resistance to pesticides, making chemical control ineffective [8]. Consequently, biological control strategies have emerged as a crucial element of sustainable cotton agriculture.

Various studies conducted in Turkey have reported the widespread presence of predator species such as *Chrysoperla carnea* Steph. *(Neuroptera: Chrysopidae)*, *Orius* spp. *(Hemiptera: Anthocoridae)*, *Nabis* spp. *(Hemiptera: Nabidae)*, *Deraeocoris* spp. *(Heteroptera: Miridae)*, *Geocoris* spp. *(Hemiptera: Geocoridae)*, *Campylomma* divesicornis Reut. *(Heteroptera: Miridae)*, and Aelothrips collaris (Priesner) *(Thysanoptera: Aeolothripidae)* in cotton production areas [9-12]. Studies carried out in Diyarbakır province have identified species such as *Nabis pseudoferus* Rem. *(Hemiptera: Nabidae)*, *Nabis rugosus* L. *(Hemiptera: Nabidae)*, Geocoris pallidipennis (C.) *(Hemiptera: Geocoridae)*, and *Chrysoperla* carnea (Steph.). In another study, *Nabis pseudoferus* orientarius (Remane, 1962), *Nabis punctatus*, and *Nabis ferus (Hemiptera: Nabidae)* were detected in cotton fields in Şanlıurfa, Diyarbakır, and Mardin provinces [13]. Additionally, some researchers have identified *Geocoris* spp. in their studies [14,15].

Predatory insects are important natural enemies that feed on adults, larvae, and eggs of soft-bodied pests such as leafworms, aphids, mites, and moths commonly found in cotton fields. These predators serve as key agents in biological control programs. For instance, *Chrysoperla carnea* larvae can consume 50-60 aphids per day, effectively suppressing pest populations [16]. Similarly, *Geocoris punctipes* (Say, 1832) (Hemiptera: *Geocoridae*) has demonstrated significant efficacy with predation rates reaching up to 70% on bollworm eggs [17]. However, the effectiveness of predatory insects shows regional variations depending on factors such as species diversity, habitat suitability, and agricultural practices. For example, while Coccinellid species dominate in Indian cotton fields [18], hemipteran predators like *Orius insidiosus* (Say, 1832) *(Hemiptera: Anthocoridae)* are more prominent in U.S. cotton production systems [19]. This study was conducted in cotton production areas of Diyarbakır, Şanlıurfa, and Mardin provinces in Turkey's Southeastern Anatolia Region between 2021 and 2024. The research aimed to determine the density and prevalence of natural enemies that are significant for biological control. The findings obtained from this study are expected to contribute to future biological control efforts.

Materials and Methods

Determination of Predatory Species Prevalence and Density

Study Area and Sampling Methodology: This study was conducted in cotton production areas of Diyarbakır, Şanlıurfa, and Mardin provinces between 2021 and 2024. Sampling was designed to represent each area, ensuring coverage of at least 1% of the total cotton cultivation area in each district. Sampling was carried out at two-week intervals from cotton planting (April-May) until harvest.

Field Collection Protocol: Predator species were sampled using a D-Vac suction device to determine their prevalence and density. Collections were made: At 20-25 m inside field borders, along diagonal transects, from three different points per field, and with 2-minute suction periods per row. Specimens were collected using a 30 cm × 45 cm mesh bag with a rubber rim, labeled in the field, and transported to the laboratory [13-20].

Laboratory Procedures: Samples were examined under a stereomicroscope for the identification of predators. Taxonomic verification was performed by: Hemiptera: Doc. Dr. Gülten YAZICI (Ankara Plant Protection Research Institute), *Coccinellidae*: Dr. Derya ŞENAL (Şeyh Edebali University, Bilecik), and Neuroptera: Prof. Dr. Ali SATAR (Dicle University, Diyarbakır).

Data Analysis: Individual counts from surveys in Şanlıurfa, Diyarbakır, and Mardin were recorded. Identified predator species were analyzed for their prevalence, density, and correlations with dominant pest species.

Results

As a result of this four-year study (2021-2024) conducted in cotton fields in the provinces of Diyarbakır, Şanlıurfa, and Mardin in the Southeastern Anatolia Region, the identified predatory insects and their species are presented in (Table 1). Accordingly, 9 species from the family *Coccinellidae* (Order: Coleoptera), 7 species from the family *Geocoridae* (Order: Hemiptera), 4 species from the family *Miridae*, 3 species from the family *Nabidae*, 2 species from the family *Anthocoridae*, and 1 species, *Chrysoperla carnea* (Stephens), from the family *Chrysopidae* (Order: Neuroptera), were identified. Other predatory insects identified at the family level included species from Thysanoptera *(Aeolothripidae: Aeolothrips)* and *Reduviidae*. Overall, a total of 28 predatory insect species belonging to 8 families across 4 different insect orders were identified in the surveyed cotton production areas. As a result of the survey studies conducted in cotton fields, the predatory insect species identified in the provinces of Diyarbakır, Şanlıurfa, and Mardin between 2021 and 2024 were evaluated based on their families, prevalence, total individual counts, and their proportions relative to the total number of predators collected, with annual variations determined by province. Accordingly, the data obtained from the survey studies carried out in Diyarbakır between 2021 and 2024 are presented in (Table 2). Throughout the four-year study period, the most frequently observed species belonged to the family *Chrysopidae*, followed by *Anthocoridae* and *Geocoridae*. When examining the proportion of each identified species within the total predators: In 2021, the highest value was recorded for the *Anthocoridae* family (33.94%), In 2022, for *Miridae* (Campylomma) (23.81%), In 2023, for *Chrysopidae* (C. carnea) (23.04%), In 2024, again for *Chrysopidae* (C. carnea) (22.43%).

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Table 1: Predatory insect species detected in cotton fields in Diyarbakır, Şanlıurfa, and Mardin provinces between 2021 and 2024.

Order	Family	Species
Coleoptera	*Coccinellidae*	*Hippodamia variegata* (Goeze),
		Stethorus gilvifrons (Mulsant)
		Coccinella septempunctata (L.)
		Coccinella undecimpunctata (L.)
		Nephus nigricans Weise
		Hippodamia variegata (Goeze)
		Scymnus rubromaculatus (Goeze)
		Propylaea quatuordecimpunctata (Linnaeus)
		Oenopia conglobata (Linnaeus)
Hemiptera	*Geocoridae*	*Geocoris* (*Geocoris*) *megacephalus* (Rossi, 1790)
		Geocoris (*Geocoris*) *pubescens* (Jakovlev, 1871)
		Geocoris (*Geocoris*) *punctipes* (Say, 1831)
		Geocoris (*Piocoris*) *putonianus* (Bergroth, 1892)
		Geocoris (*Geocoris*) *pallidipennis* (Costa, 1843)
		Geocoris (*Piocoris*) *erythrocephalus* (Lepeletier & Serville, 1825)
		Geocoris (*Geocoris*) *arenarius* (Jakovlev, 1867)
	Miridae	*Deraeocoris* (*Camptobrochis*) *serenus* (Douglas & Scott, 1868)
		Deraeocoris pallens Reut.
		Macrolophus costalis Fieber
		Campylomma diversicornis Reuter
	Nabidae	*Nabis* (*Nabis*) *pseudoferus orientarius* Remane, 1962
		Nabis (*Nabis*) *punctatus* A. Costa, 1847
		Nabis (*Nabis*) *ferus* (L., 1758)
	Anthocoridae	*Orius niger* Wolff
		Orius (Heterorius) *laticollis laticollis* (Reuter)
	Reduviidae	Unknown species
Neuroptera	*Chrysopidae*	*Chrysoperla carnea* (Stephens)
Thysanoptera	*Aeolothripidae*	*Aeolothrips* spp.

Table 2: Prevalence rates of predator species detected in cotton fields in Diyarbakır province between 2021 and 2024.

Study Period	2021 (n=75)			2022 (n=46)			2023 (n=62)			2024 (n=64)		
Predators	Total Abundance	Prevalence	Percentage of Total Predators (%)	Total Abundance	Prevalence	Percentage of Total Predators (%)	Total Abundance	Prevalence	Percentage of Total Predators (%)	Total Abundance	Prevalence	Percentage of Total Predators (%)
Chrysoperla carnea (Chrysopidae)	318	78,67	26,13	0195	80,43	20,19	235	75,81	23,04	214	71,88	22,43
Coccinellidae species	7	6,67	0,58	68	43,48	7,04	98	29,03	9,61	160	37,50	16,77
Orius spp. *(Anthocoridae)*	413	74,67	33,94	177	69,57	18,32	230	66,13	22,55	166	59,38	17,40
Geocoris spp. *(Geocoridae)*	155	40,00	12,74	128	41,30	13,25	164	54,84	16,08	187	68,75	19,60

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Deraeocoris spp. *(Miridae)*	87	33,33	7,15	67	41,30	6,94	57	29,03	5,59	38	20,31	3,98
Nabis spp. *(Nabidae)*	25	14,67	2,05	79	21,74	8,18	38	16,13	3,73	24	14,06	2,52
Scymnus spp. *(Coccinellidae)*	39	13,33	3,20	12	15,22	1,24	22	16,13	2,16	19	17,19	1,99
Aeolothrips (Thysanoptera)	32	16,00	2,63	8	4,35	0,83	31	11,29	3,04	43	10,94	4,51
Campylomma spp. *(Miridae)*	141	36,00	11,59	230	50,00	23,81	141	40,32	13,82	98	39,06	10,27
Reduviidae species	0	0,00	0,00	2	4,35	0,21	3	3,23	0,29	4	4,69	0,42
Macrolophus spp. *(Miridae)*	0	0,00	0,00	0	0,00	0,00	1	1,61	0,10	1	1,56	0,10
Total	1217			966			1020			954		

Table 3: Prevalence rates of predatory insects in cotton fields of Şanlıurfa province between 2021 and 2024.

Study Period	**2021 (n=60)**			**2022 (n=50)**			**2023 (n=51)**			**2024 (n=47)**		
Predators	**Total Abundance**	**Prevalence**	**Percentage of Total Predators (%)**	**Total Abundance**	**Prevalence**	**Percentage of Total Predators (%)**	**Total Abundance**	**Prevalence**	**Percentage of Total Predators (%)**	**Total Abundance**	**Prevalence**	**Percentage of Total Predators (%)**
Chrysoperla carnea (Chrysopidae)	456	85,00	48,31	242	68,00	24,06	280	74,51	37,18	212	72,34	39,33
Coccinellidae species	9	10,00	0,95	242	34,00	24,06	128	23,53	17,00	131	27,66	24,30
Orius spp. *(Anthocoridae)*	190	66,67	20,13	101	50,00	10,04	86	41,18	11,42	28	19,15	5,19
Geocoris spp. *(Geocoridae)*	129	58,33	13,67	309	72,00	30,72	178	60,78	23,64	138	55,32	25,60
Deraeocoris spp. *(Miridae)*	125	21,67	13,24	67	28,00	6,66	50	15,69	6,64	5	4,26	0,93
Nabis spp. *(Nabidae)*	10	15,00	1,06	27	18,00	2,68	17	13,73	2,26	17	10,64	3,15
Scymnus spp. (Coccinellidae)	3	3,33	0,32	0	0,00	0,00	3	3,92	0,40	5	6,38	0,93
Aeolothrips (Thysanoptera)	0	0,00	0,00	0	0,00	0,00	0	0,00	0,00	0	0,00	0,00
Campylomma spp. *(Miridae)*	22	18,33	2,33	18	16,00	1,79	11	11,76	1,46	2	4,26	0,37
Reduviidae species		0,00			0,00		0	0,00	0,00		0,00	
Macrolophus spp. *(Miridae)*	0	0,00	0,00	0	0,00	0,00	0	1,96	0,00	1	2,13	0,19
Toplam				1006			753			539		

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Table 4: Prevalence rates of predatory insects in cotton fields of Mardin province between 2021 and 2024.

Study Period	2021 (n=39)			2022 (n=36)			2023 (n=24)			2024 (n=13)		
Predators	Total Abundance	Prevalence	Percentage of Total Predators (%)	Total Abundance	Prevalence	Percentage of Total Predators (%)	Total Abundance	Prevalence	Percentage of Total Predators (%)	Total Abundance	Prevalence	Percentage of Total Predators (%)
Chrysoperla carnea (Chrysopidae)	293	92,31	43,73	170	69,44	25,60	138	79,17	29,05	46	61,54	15,97
Coccinellidae species	14	23,08	2,09	116	33,33	17,47	40	29,17	8,42	15	23,08	5,21
Orius spp. *(Anthocoridae)*	35	30,77	5,22	41	44,44	6,17	66	41,67	13,89	95	46,15	32,99
Geocoris spp. *(Geocoridae)*	203	71,79	30,30	252	63,89	37,95	141	75,00	29,68	56	76,92	19,44
Deraeocoris spp. *(Miridae)*	103	33,33	15,37	57	19,44	8,58	41	25,00	8,63	2	15,38	0,69
Nabis spp. *(Nabidae)*	3	7,69	0,45	2	5,56	0,30	1	4,17	0,21	0	0,00	0,00
Scymnus spp. *(Coccinellidae)*	7	12,82	1,04	6	13,89	0,90	3	12,50	0,63	0	0,00	0,00
Aeolothrips (Thysanoptera)	7	10,26	1,04	10	2,78	1,51	12	12,50	2,53	15	15,38	5,21
Campylomma spp. *(Miridae)*	5	10,26	0,75	10	13,89	1,51	33	20,83	6,95	59	46,15	20,49
Reduviidae species	0	0,00	0	0	0,00	0	0	0	0	0	0,00	0
Macrolophus spp. *(Miridae)*	0	0,00	0	0	0,00	0	0	0	0	0	0,00	0
Toplam	670			664			475			288		

Table 5: Predator insect species and their densities determined in Diyarbakır, Şanlıurfa, and Mardin provinces in 2021-2024.

Predators Species	2021		2022		2023		2024	
	N	Mean±Std.Er.	N	Mean±Std.Er.	N	Mean±Std.Er.	N	Mean±Std.Er.
Chrysoperla carnea (Chrysopidae)	75	4,24±0,58	46	4,24±0,59	62	3,79±0,43	64	3,34±0,53
Coccinellidae species	75	0,90±0,05	46	1,48±0,44	62	1,58±0,55	64	2,50±0,88
Orius spp. *(Anthocoridae)*	75	5,51±0,69	46	3,85±0,57	62	3,71±0,60	64	2,59±0,43
Geocoris spp. *(Geocoridae)*	75	2,07±0,47	46	2,78±0,73	62	2,65±0,50	64	2,92±0,56
Deraeocoris spp. *(Miridae)*	75	1,16±0,33	46	1,46±0,36	62	0,92±0,25	64	0,59±0,22
Nabis spp. *(Nabidae)*	75	0,33±0,14	46	1,72±0,97	62	0,61±0,24	64	0,38±0,18
Scymnus spp. *(Coccinellidae)*	75	0,52±0,25	46	0,26±0,10	62	0,35±0,15	64	0,30±0,11
Aeolothrips (Thysanoptera)	75	0,43±0,16	46	0,17±0,15	62	0,50±0,20	64	0,67±0,29
Campylomma spp. *(Miridae)*	75	1,88±0,38	46	5,00±1,25	62	0,00±0,00	64	1,53±0,35
Reduviidae	75	0,00±0,00	46	0,04±0,03	62	0,00±0,00	64	0,06±0,04
Macrolophus spp. *(Miridae)*	75	0,00±0,00	46	0,00±0,00	62	0,00±0,00	64	0,02±0,02
Intense pest species								
Cicadellidae species	75	157,32±20,58	46	124,74±34,29	62	139,23±18,56	64	147,36±23,62

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Bemisia tabaci (Aleyrodoidae)	75	0,00±0,00	46	0,00±0,00	62	4,35±3,07	64	5,47±4,74
Chrysoperla carnea (Chrysopidae)	60	7,60±1,23	50	4,84±0,71	51	5,49±0,81	47	4,51±0,94
Coccinellidae species	60	0,15±0,07	50	1,78±0,63	51	2,51±0,93	47	2,79±1,19
Orius spp. *(Anthocoridae)*	60	3,17±0,53	50	2,02±0,45	51	1,69±0,39	47	0,60±0,21
Geocoris spp. *(Geocoridae)*	60	2,15±0,44	50	6,18±1,11	51	3,49±0,66	47	2,94±0,83
Deraeocoris spp. *(Miridae)*	60	2,08±0,90	50	1,34±0,58	51	0,98±0,40	47	0,11±0,09
Nabis spp. *(Nabidae)*	60	0,17±0,05	50	0,54±0,24	51	0,33±0,14	47	0,36±0,22
Scymnus spp. *(Coccinellidae)*	60	0,05±0,04	50	0,00±0,00	51	0,06±0,04	47	0,11±0,06
Aeolothrips (Thysanoptera)	60	0,00±0,00	50	0,00±0,00	51	0,00±0,00	47	0,00±0,00
Campylomma spp. *(Miridae)*	60	0,37±0,16	50	0,36±0,19	51	0,22±0,10	47	0,04±0,03
Reduviidae	60	0,00±0,00	50	0,00±0,00	51	0,00±0,00	47	0,00±0,00
Macrolophus spp. *(Miridae)*	60	0,00±0,00	50	0,00±0,00	51	0,00±0,00	47	0,02±0,02
Intense pest species								
Cicadellidae species	60	104,77±14,63	50	114,78±23,37	51	92,98±15,31	47	71,04±15,19
Bemisia tabaci (Aleyrodoidae)	60	48,00±22,46	50	17,56±7,87	51	118,04±39,88	47	196,06±75,84
Chrysoperla carnea (Chrysopidae)	39	7,51±1,15	36	4,72±1,17	24	5,75±1,14	13	3,54±1,20
Coccinellidae species	39	0,36±0,11	36	3,22±0,97	24	1,67±0,72	13	1,15±0,92
Orius spp. *(Anthocoridae)*	39	0,90±0,40	36	1,14±0,26	24	2,75±1,32	13	7,31±4,97
Geocoris spp. *(Geocoridae)*	39	5,21±1,22	36	7,00±1,60	24	5,88±1,15	13	4,31±1,62
Deraeocoris spp. *(Miridae)*	39	2,64±0,92	36	1,58±0,93	24	1,71±0,66	13	0,15±0,10
Nabis spp. *(Nabidae)*	39	0,08±0,04	36	0,06±0,04	24	0,04±0,04	13	0,00±0,00
Scymnus spp. *(Coccinellidae)*	39	0,18±0,08	36	0,17±0,07	24	0,13±0,07	13	0,00±0,00
Aeolothrips (Thysanoptera)	39	0,18±0,09	36	0,28±0,28	24	0,50±0,40	13	1,15±0,83
Campylomma spp. *(Miridae)*	39	0,00±0,00	36	0,00±0,00	24	1,38±0,62	13	0,00±0,00
Reduviidae	39	0,00±0,00	36	0,00±0,00	24	0,00±0,00	13	0,00±0,00
Macrolophus spp. *(Miridae)*	39	0,00±0,00	36	0,00±0,00	24	0,00±0,00	13	0,00±0,00
Intense pest species								
Cicadellidae species	39	68,79±15,96	36	65,33±15,55	24	109,77±37,14	13	269,69±119,68
Bemisia tabaci (Aleyrodoidae)	39	0,00±0,00	36	0,14±0,14	24	10	13	184,62±85,37

Table 6: Co-occurrence rates of predatory insects in Diyarbakır, Şanlıurfa, and Mardin provinces.

Co-occurrence Rate of Predator Species (%)	2021			2022			2023			2024		
	Diyarbakır	Şanlıurfa	Mardin	Diyarbakır	Şanlıurfa	Mardin	Diyarbakır	Şanlıurfa	Mardin	Diyarbakır	Şanlıurfa	Mardin
0	-	-	-	-	2	5,56	-	5,88	-	3,13	2,13	7,69
1	9,33	20,00	-	2,17	12	11,11	8,06	17,65	8,33	1,56	29,79	23,08
2	26,67	23,33	48,72	17,39	26	33,33	24,19	29,41	25,00	18,75	46,81	23,08
3	25,33	38,33	33,33	28,26	34	25,00	38,71	25,49	41,67	28,13	8,51	15,38
4	17,33	3,33	7,69	21,74	18	11,11	22,58	15,69	12,50	31,25	10,64	7,69
5	17,33	11,67	2,56	19,57	6	13,89	3,23	5,88	8,33	9,38	2,13	7,69
6	4,00	3,33	5,13	10,87	2	-	3,23	-	4,17	6,25	-	15,38
7	-	-	2,56	-	-	-	-	-	-	1,56	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-

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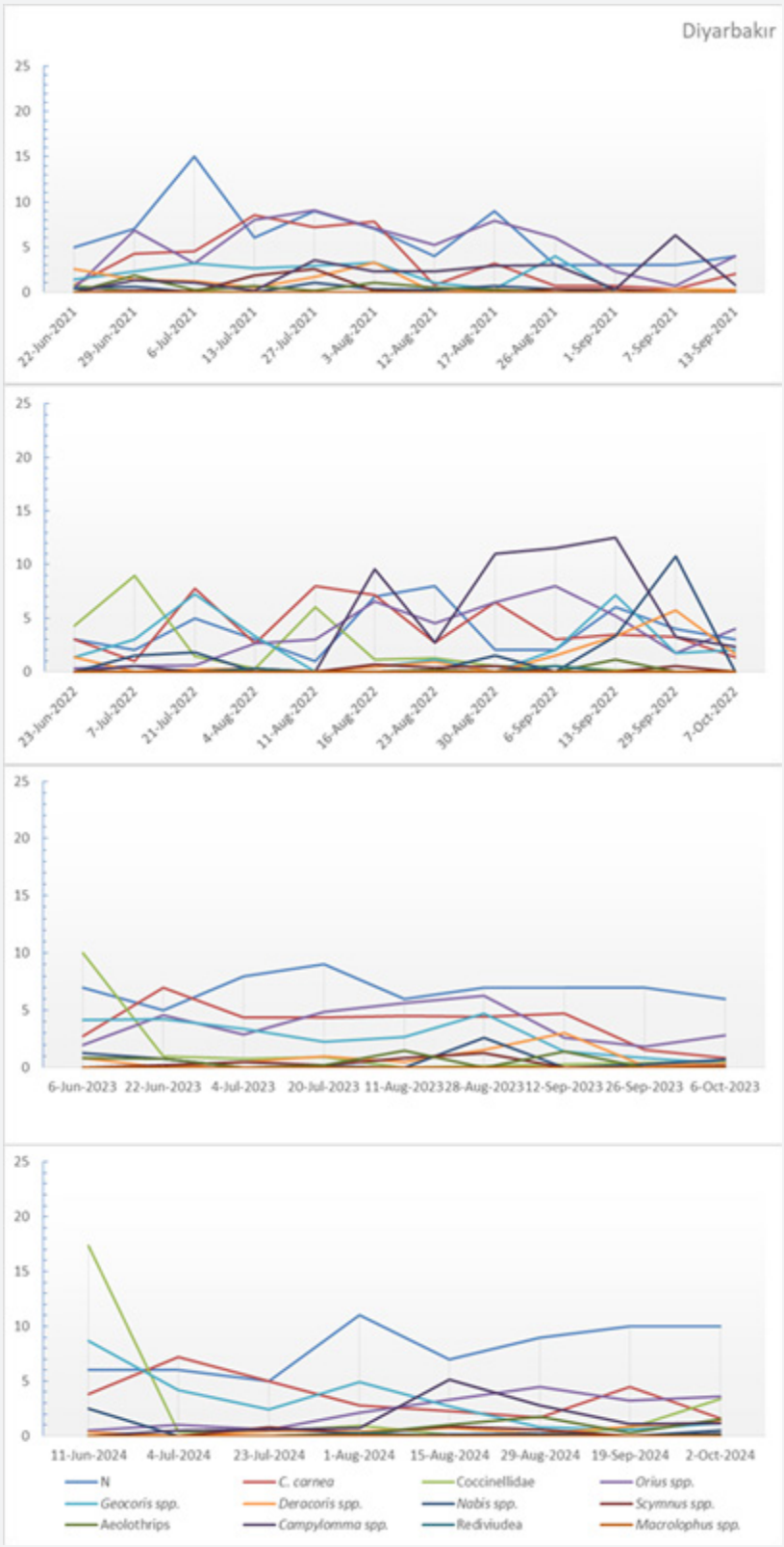

Figure 1: Population density of predators in the cotton fields of Diyarbakır province between 2021 and 2024.

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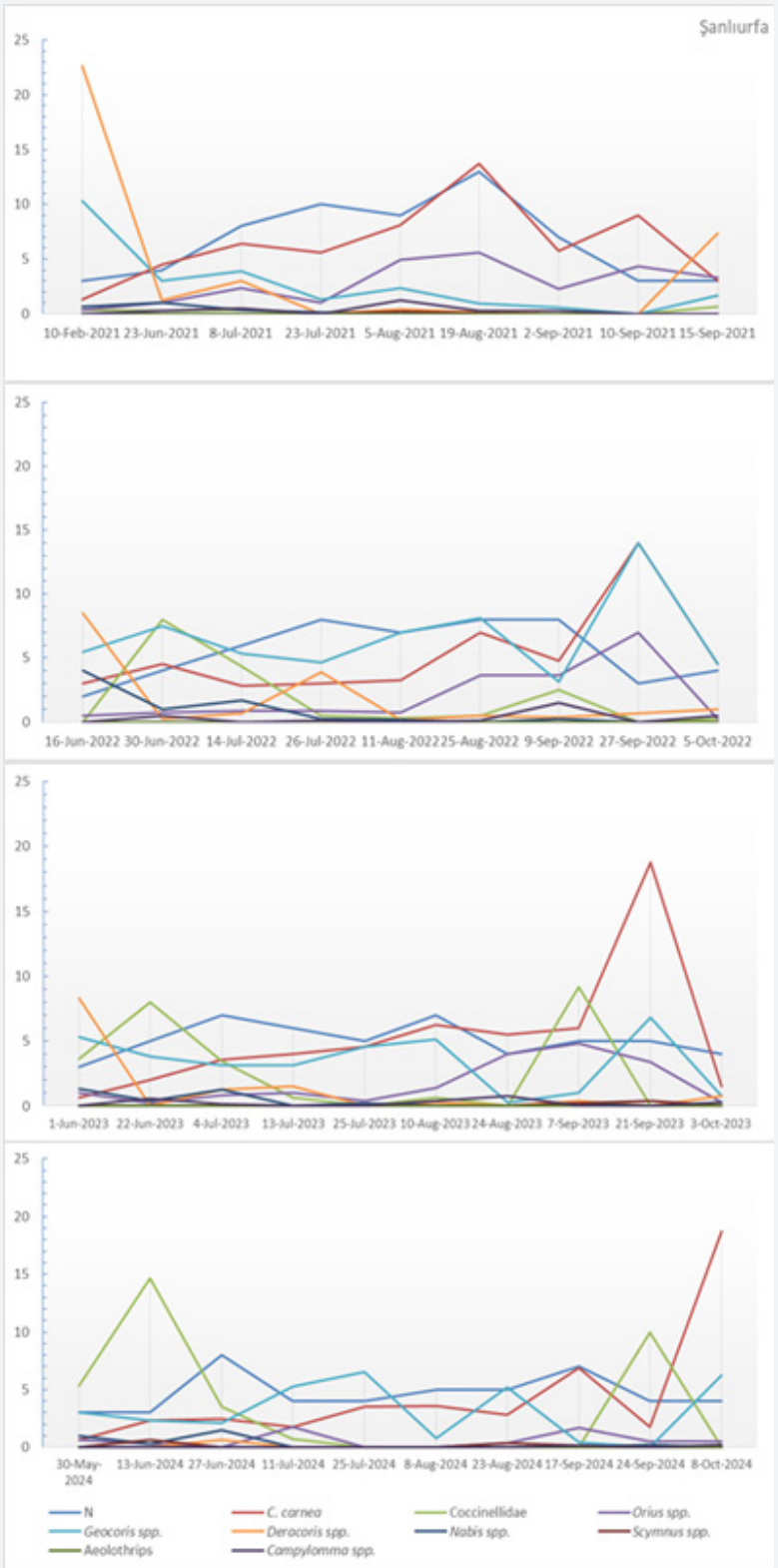

Figure 2: Population density of predators in the cotton fields of Şanlıurfa province between 2021 and 2024.

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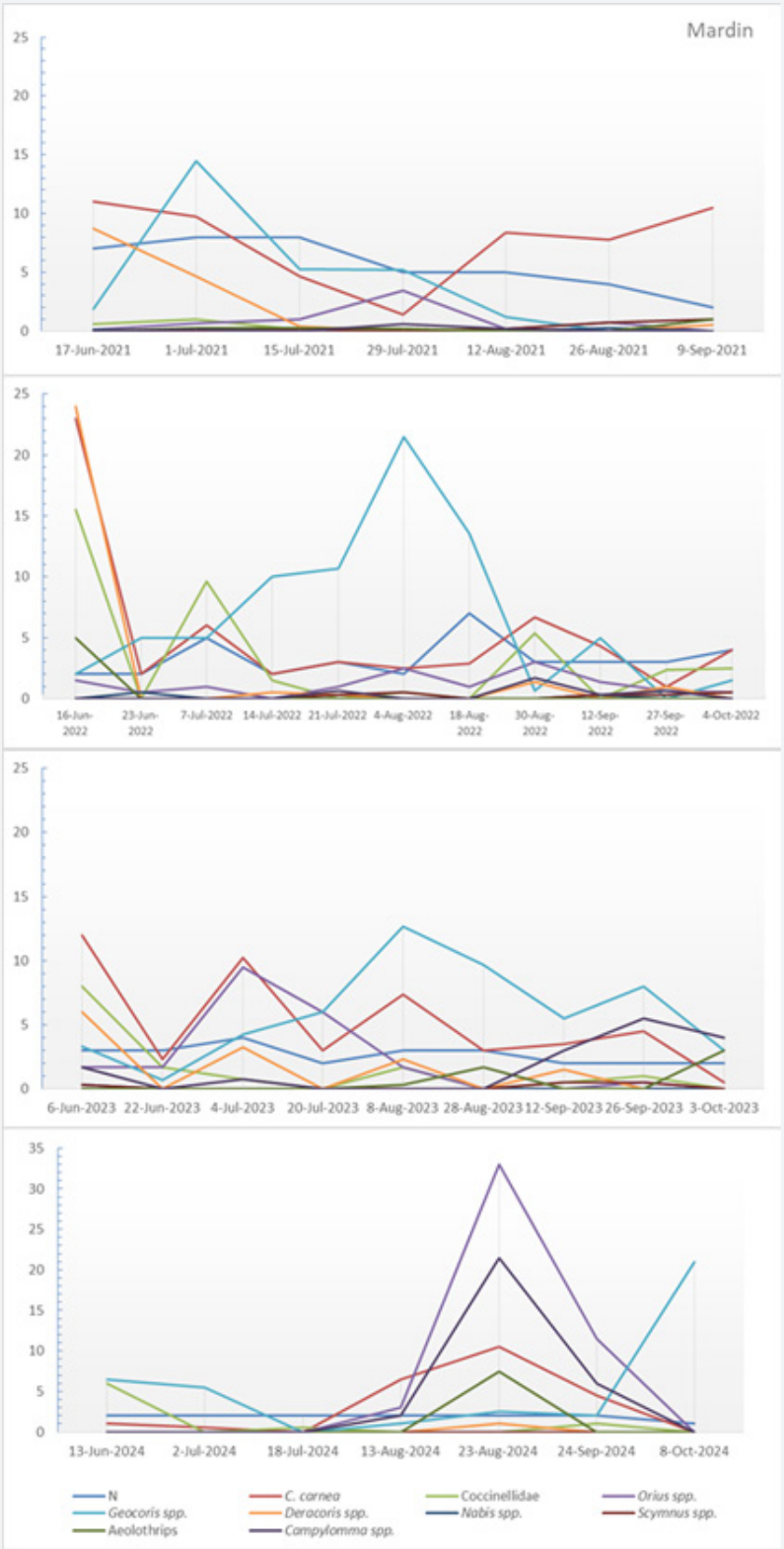

Figure 3: Population density of predators in cotton fields of Mardin province between 2021 and 2024.

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The data on the average numbers of predators collected during surveys in Diyarbakır province are presented graphically in (Figure 1). Accordingly, in Diyarbakır province in 2021, the highest mean values were recorded for Orius spp. (9.119) and C. carnea (8.50) in July. In 2022, the highest mean values were observed for Campylomma spp. (12.50) and Nabis spp. (10.75) in September. In 2023, the highest mean values were recorded for Coccinella (10.00) and C. carnea (7.00) in June. In 2024, the highest mean values were observed for Coccinella (17.33) and Geocoris spp. (8.67) in June; however, Coccinella showed a significant decline in subsequent months (Figure 1). The data on prevalence, individual counts, and proportions obtained from surveys conducted in Şanlıurfa province between 2021-2024 are presented in (Table 3). According to the results, in 2021, the most common species belonged to the *Chrysopidae* family, followed by *Anthocoridae* and *Geocoridae* species. In 2022, the most common species were from *Geocoridae*, followed by *Chrysopidae* and *Anthocoridae*. In both 2023 and 2024, the most common species were from the *Chrysopidae* family, followed by the *Geocoridae* family. When examining the proportion of beneficial species identified in Şanlıurfa province within the total predators, the *Chrysopidae* family showed the highest ratio at 48.31% in 2021, *Geocoridae* at 30.72% in 2022, *Chrysopidae* again at 37.18% in 2023, and *Chrysopidae* maintained the highest ratio at 39.33% in 2024.

The data on the average numbers of predators collected during field surveys in Şanlıurfa province are presented graphically in (Figure 2). The results show that in 2021, Deraeocoris spp. (22.67) and Geocoris spp. (10.33) reached their highest mean values in June. In 2022, Chrysoperla carnea and Geocoris spp. were the dominant predators with mean values of 14.00 in September. During 2023, Chrysoperla carnea (18.80) and Coccinellids (9.20) showed their peak mean values in September. In 2024, the highest mean values were recorded for Coccinella (14.67) in June and Chrysoperla carnea (18.75) in October (Figure 2). The data on prevalence, individual counts, and ratios obtained from surveys conducted in Mardin province between 2021 and 2024 are presented in (Table 4). During the first three years of the study, the most frequently observed species belonged to the *Chrysopidae* family, followed by species from the *Miridae* family in 2024. When examining the proportion of beneficial species identified in the study within the total predator population, the *Chrysopidae* family showed the highest percentage at 43.73% in 2021, followed by *Geocoridae* at 37.95% in 2022 and 29.68% in 2023, while in 2024, the *Anthocoridae* family again had the highest ratio at 32.99%.

The data on the average numbers of predators obtained from surveys in Mardin province are presented graphically in (Figure 3). Accordingly, in Mardin province in 2021, Geocoris spp. (14.50) In July and C. carnea (11.00) in June were the predatory insects with the highest mean values. In 2022, Deraeocoris spp. (24.00) and C. carnea (23.00) in June, and Geocoris spp. (21.50) In August were the predators with the highest mean values. In 2023, Geocoris spp. (12.67) In August and C. carnea (12.00) in June had the highest mean values. In 2024, Orius spp. (33.00) and C. carnea (10.50) in August were the predators with the highest mean values (Figure 3).

The analytical data on the relative densities of predatory insects identified during survey studies conducted in cotton production areas of Diyarbakır, Şanlıurfa, and Mardin provinces between 2021-2024, categorized by family across different sampling sites, are presented in (Table 5). According to (Table 5), in 2021, the most abundant beneficial insect species in Diyarbakır province was *Anthocoridae*, with a mean value of 5.51. In contrast, in Şanlıurfa and Mardin provinces, C. carnea *(Chrysopidae)* exhibited the highest densities, with mean values of 7.60 and 7.51, respectively. The most prevalent pest species in 2021 was *Cicadellidae*, with values of 157.32, 104.77, and 68.79 in Diyarbakır, Şanlıurfa, and Mardin provinces, respectively (Table 5). In 2022, the most abundant beneficial insects were Campylomma spp. *(Miridae)* with a mean of 5.00 in Diyarbakır, and Geocoris spp. *(Geocoridae)* with means of 6.18 and 7.00 in Şanlıurfa and Mardin, respectively. The dominant pest species remained *Cicadellidae*, with values of 124.74, 114.78, and 65.33 across the three provinces (Table 5). In 2023, C. carnea *(Chrysopidae)* was the most abundant in Diyarbakır (3.34) and Şanlıurfa (4.51), while Geocoris spp. *(Geocoridae)* dominated in Mardin (5.88). In 2024, *Coccinellidae* species were most prevalent in Diyarbakır (3.34) and Şanlıurfa (4.51), and *Anthocoridae* species showed the highest density in Mardin (7.31). The major pest species included *Cicadellidae* in Diyarbakır (147.36) and Mardin (269.69), and Whiteflies *(Aleyrodoidae)* in Şanlıurfa (196.06) (Table 5).

The percentage values for the co-occurrence rates of predatory insects identified during surveys conducted in the provinces of Diyarbakır, Şanlıurfa, and Mardin between 2021 and 2024 are presented in Table 6. According to the results, in 2021, the highest simultaneous co-occurrence rates were observed at 26.67% (2 predators) in Diyarbakır, 38.33% (3 predators) in Şanlıurfa, and 48.72% (2 predators) in Mardin. In 2022, Diyarbakır exhibited a co-occurrence rate of 28.26%, while Şanlıurfa had 34.00% (3 predators), and Mardin recorded 33.33% (2 predators). For 2023, the co-occurrence rates were 38.71% (3 predators) in Diyarbakır, 29.41% (2 predators) in Şanlıurfa, and 41.67% (3 predators) in Mardin. In 2024, the co-occurrence rates were 31.25% (4 predators) in Diyarbakır, 46.81% (2 predators) in Şanlıurfa, while Mardin recorded equal values of 23.00% for both single and two-predator co-occurrences (Table 6).

According to the evaluation of the simultaneous occurrence rates of predatory insects by province (Table 6), it was observed that Diyarbakır, particularly in the years 2021 and 2023, had higher simultaneous occurrence rates of high predatory insect counts (e.g., 2-4 predators) compared to other provinces (for example, in 2021, 26.67% for 2 predators and 25.33% for 3 predators; in 2023, 38.71% for 3 predators). However, in 2024, these rates showed a significant decline, especially with lower rates recorded

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for higher predator counts. This situation may indicate a decrease in predator populations due to environmental factors, pesticide applications, or changes in agricultural practices in the region. Şanlıurfa exhibited a generally stable distribution in terms of predatory insect diversity throughout the four years. Notably, in 2024, the simultaneous occurrence rate of the two predatory insects reached 46.81%, the highest value among all other provinces and years. This may suggest that Şanlıurfa provides suitable living conditions for predator populations, possibly due to factors such as more intensive irrigated farmland, plant diversity, and second-crop cultivation. Additionally, the high rate of 20.00% for 1 predator in 2021 was also noteworthy. Mardin generally had lower and less diverse simultaneous occurrence rates of predatory insects compared to the other two provinces. In 2021, significant rates were observed only for 2 and 3 predators, while in other years and predator counts, the distribution was sparser. The rates of 5.56% for 0 predators in 2022 and 7.69% for 0 predators in 2024 indicate periods of very low predatory activity. However, in 2024, notable rates such as 23.08% for 1 predator and 15.38% for 6 predators were recorded, suggesting localized increases in certain periods. This text provides an overall assessment of predatory insect occurrences across Diyarbakır, Şanlıurfa, and Mardin, highlighting temporal and regional variations in predator populations.

An analysis of the year-by-year variations in the data obtained from the study reveals distinct patterns in predator distribution across the provinces. In 2021, Diyarbakır and Şanlıurfa exhibited relatively high and diverse occurrence rates for 1-4 predator species, while Mardin showed a more restricted distribution. The following year (2022) witnessed a general upward trend in predator numbers across all provinces, with particularly notable occurrence rates for 2-4 predators in Diyarbakır and Şanlıurfa. By 2023, Diyarbakır and Mardin experienced significant increases in 3-4 predator counts, whereas Şanlıurfa maintained a more balanced distribution pattern. The year 2024 presented a divergent scenario: while Şanlıurfa continued to demonstrate rising predator activity, Diyarbakır saw declines, particularly in higher predator counts. Meanwhile, Mardin showed increased occurrences of lower predator numbers while higher predator counts became increasingly rare. These data clearly demonstrate that predator insect populations in cotton ecosystems exhibit variations between provinces and across years. The declining trends observed in Diyarbakır necessitate a detailed examination of regional factors. The relatively stable and high rates in Şanlıurfa suggest that agroecological practices or environmental conditions in this province may be more favorable for predator populations. These findings are of great importance for the development and implementation of Integrated Pest Management (IPM) strategies. To protect and enhance natural enemy populations in cotton fields, steps such as promoting the use of less harmful pesticides, expanding biological control methods, creating suitable habitats for predator insects (for example, flowering plants, weed control), and developing specific strategies considering inter-regional ecological differences could be taken.

Discussion

The study identified a total of 28 predator species belonging to 8 families across 4 orders. The *Coccinellidae* family (Hippodamia variegata (Goeze, 1777), Coccinella septempunctata (Linnaeus, 1758), etc.) from the Coleoptera order, along with the *Geocoridae* (G. megacephalus, G. pallidipennis) and *Nabidae* (N. pseudoferus orientarius) families from the Hemiptera order, emerged as the dominant predator groups in the region. Chrysoperla carnea from the Neuroptera order showed high prevalence across all provinces (Tables 2-4). This diversity is particularly noteworthy when compared to 19 species reported in India [18] and 22 species in the USA [19]. The presence of 7 species from the *Geocoridae* family especially reflects this family's ecological adaptation in the Mediterranean basin [14]. In contrast, Geocoris species in the USA exhibit less diversity but occur in higher densities [17]. In Diyarbakır, the *Anthocoridae* family (33.94%) showed the highest proportion in 2021, followed by *Miridae* (23.81%) in 2022, *Chrysopidae* (23.04%) in 2023, and *Chrysopidae* again (22.43%) in 2024. In Şanlıurfa, *Chrysopidae* dominated in 2021 (48.31%), 2023 (37.18%), and 2024 (39.33%), while *Geocoridae* (30.72%) was predominant in 2022. In Mardin, *Chrysopidae* (43.73%) led in 2021, *Geocoridae* in both 2022 (37.95%) and 2023 (29.68%), and *Anthocoridae* (32.99%) became prominent in 2024 (Tables 2-4). These results demonstrate that predator dynamics in the region vary both geographically and temporally. Similarly, [15] reported that Geocoris species are abundant in the Mediterranean region. However, in this study, the dominance of *Geocoridae* in Şanlıurfa in 2022 may be interpreted as a result of climatic factors and increasing pest populations.

The *Chrysopidae* family emerged as the most prevalent predator group across all provinces (reaching 48.31% in Şanlıurfa). These findings align with observations from Spanish cotton fields where Chrysoperla carnea showed 35-40% dominance [21]. However, in Brazil, *Chrysopidae*'s prevalence remains below 15%, with *Anthocoridae* species being more prominent instead [16]. These variations demonstrate how climate and agricultural practices shape predator distribution patterns.

A negative correlation was observed between pest density and predator populations. For instance, despite higher Aleyrodoidae (whitefly) populations in Şanlıurfa during 2023-2024, *Coccinellidae* species remained limited in density (Table 5). This suggests an imbalance between whiteflies' rapid reproductive capacity and predators' adaptation period. Conversely, in Mardin during 2022, a significant relationship emerged between *Geocoridae* density and declining *Cicadellidae* pests. This finding aligns with previous studies demonstrating Geocoris species' effectiveness against sap-sucking pests [14]. A similar pattern was observed in Pakistan, where Geocoris species proved inadequate against increasing Bemisia tabaci populations [22]. The negative correlation between *Geocoridae* density and *Cicadellidae* pest decline in Mardin (2022) further confirms Geocoris species' efficacy against leaf-sucking pests.

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The study revealed that predator species co-occurred in combinations of 2-3 species at a rate approaching 50% (Table 6). In Diyarbakır, the high frequency of 4 or more species coexisting (29-52%) suggests this province's habitat diversity is particularly favorable for predators. However, the lower rates observed in Şanlıurfa and Mardin may be associated with factors such as monoculture farming or pesticide use. These findings align with Australian cotton field studies demonstrating that multiple predator presence enhances pest control by 40% [23]. The prevalence of monoculture in Şanlıurfa appears to have limited predator diversity. In this context, Diyarbakır's high biodiversity shows promising potential for integrated pest management.

Conclusion

This study comprehensively presents the prevalence, density, and co-occurrence dynamics of the predator insect complex in three key cotton-producing provinces of Turkey's Southeastern Anatolia Region Diyarbakır, Şanlıurfa, and Mardin-between 2021 and 2024. The findings provide critical insights into the role of natural enemies in cotton ecosystems, their population fluctuations, and the future of integrated pest management (IPM) strategies in the region. Throughout the study, Chrysoperla carnea *(Chrysopidae)*, Orius spp. *(Anthocoridae)*, and Geocoris spp. *(Geocoridae)* were identified as the most prevalent and abundant species forming the core of the predator complex in cotton fields. These species play a crucial role in the natural control of cotton pests. While Diyarbakır initially exhibited relatively high predator prevalence, density, and co-occurrence rates, a decline in the abundance and co-occurrence of certain key predator species (e.g., Orius spp.) was observed, particularly toward 2024. In contrast, *Coccinellidae* populations increased. In Şanlıurfa, despite an overall downward trend in total predator abundance, *Coccinellidae* species showed a significant rise in prevalence and density. However, the sharp decline in Orius spp. density correlated with an increase in Bemisia tabaci populations, suggesting a weakening of natural control mechanisms. Mardin experienced the most pronounced decline in total predator abundance among the three provinces, with a dramatic reduction in C. carnea density. Conversely, increases were recorded in Orius spp. and Campylomma spp. densities, indicating a notable shift in the predator complex structure. The highest surges in pest populations (particularly *Cicadellidae* and Bemisia tabaci) in Mardin were associated with the overall decline in predator populations.

When examining the relationship between the most abundant pest insects and the identified predators, the observed yearly increases in key pest population densities, such as Bemisia tabaci and *Cicadellidae*, coincided with declines in essential predators (e.g., Orius spp. in Diyarbakır and Şanlıurfa, and C. carnea in Mardin). This suggests that reductions or shifts in natural enemy populations may lead to pest outbreaks. The regional disparities highlight the influence of environmental factors, such as localized farming practices, climatic conditions, and pesticide usage patterns, on predator populations. In conclusion, this study reaffirms the intricate structure of natural enemies in cotton ecosystems and their indispensable role in pest control. The acquired knowledge will form the foundation for a more balanced, ecological, and sustainable pest management approach in the region's cotton production.

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For predator identification, the specimens were examined under a stereomicroscope. Taxonomic verification was conducted by: Hemiptera: Dr. Gülten YAZICI (Ankara Plant Protection Research Institute), *Coccinellidae*: Dr. Derya ŞENAL (Şeyh Edebali University, Bilecik), and Neuroptera: Prof. Dr. Ali SATAR (Dicle University, Diyarbakır). This study utilized the facilities of the Diyarbakır Plant Protection Research Institute, which is affiliated with the General Directorate of Agricultural Research and Policies of the Ministry of Agriculture and Forestry of the Republic of Turkey. We would like to thank them.

References

1. FAO (2023). FAOSTAT: Cotton production statistics.
2. Cevheri Cİ, Şahin M (2020) The Importance of Cotton Production in the World and Turkey for the Textile Sector, Harran University Engineering Journal 5(2): 71-81.
3. Özüdoğru T (2023) Cotton Status and Forecast Report 2023-380 TEPGE.
4. Dhawan AK, Peshin R (2021) Integrated pest management in cotton.
5. Bayhan E, Ölmez Bayhan S (2022) Entomological Problems in Cotton Fields of Southeastern Anatolia Region", Invasive Pest Species and New Approaches in Their Control. Eds. Gülay KAÇAR, Paradigma Academy Publishing House 1: 1.
6. Akat O, Akat Z, Sezgin M, Ölmez Bayhan S, Bayhan E, (2024a) Safety assessment for humans and biodiversity: Side effects of agrochemicals. In Proceedings of the 2nd International Canadian Scientific Research Congress, pp. 286-295.
7. Akat O, Akat Z, Emir Çoban Ö (2024b) Effects of Agricultural Chemicals on Fish Species. In Proceedings of the 2nd International Canadian Scientific Research Congress, pp. 296-307.
8. Brevault T, Bikay S, Maldes J M, Naudin K (2013) Impact of climate change on cotton pest management in West Africa. Agricultural Systems 118: 1-12.
9. Büyük M, Eren S, Baran B, Demir A (2002) Current agricultural pest control problems and solution suggestions in cotton production in the GAP Region. Proceedings of the 5th Turkish Cotton, Textile and Clothing Symposium Diyarbakır pp: 177-185.
10. Özpınar A, Yücel A (2002) Determination of harmful and predatory insects on cotton in the Southeastern Anatolia Project (GAP) area. 5th Turkish Biological Control Congress Erzurum pp :247-255.
11. Bayhan E, Ölmez Bayhan S (2018) Güneydoğu Anadolu Bölgesi Pamuk Alanlarındaki Faydalı Böcekler. Mas International European Congress on Mathematics, Engineering, Natural and Medical Sciences-II. 21-23 Mardin, pp: 79-84.
12. Bayhan E, Ölmez Bayhan S (2021) Biological Control Methods Against Agricultural Pests" Nutrition in Childhood Chronic Diseases 4 Nutrition in Childhood Neurology and Psychiatric Diseases Public Health and Nutrition. Editor: Yusuf Kenan HASPOLAT, Coşkun ÇELTİK, Kürşat Bora ÇARMAN, Ulaş, Emre AKBULUT, Taşkın TAŞ, Publication Place Orient pp: 658.

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DOI: 10.19080/ARTOAJ.2025.29.556457

13. Sezgin M, Ölmez Bayhan S (2023) Nabis Species *(Hemiptera: Nabidae)* Identified in Cotton Production Areas of Şanlıurfa, Diyarbakır, and Mardin Provinces. Journal of Dicle University Institute of Science and Technology 12(1) :139-146.

14. Akyıldız M, Bayhan E (2023) Determination of Geocoris Species *(Hemiptera: Geocoridae)* in Cotton Production Areas of Diyarbakır, Mardin, and Şanlıurfa Provinces. Dicle University Journal of the Institute of Natural and Applied Sciences 12(2): 285-293.

15. Akyıldız G (2023) The Role of Geocoris Species in Biological Control Entomology Bulletin 45(2): 112-125.

16. Silva RJ, Bueno VHP, Sampaio MV (2020) Chrysoperla carnea in Brazilian cotton fields. Biological Control 144: 104232.

17. Hagler JR, Naranjo SE (2004) Sampling and conservation of Geocoris spp. in cotton. Environmental Entomology 33(2): 414-422.

18. Khan MA, Sattar M, Iqbal Z (2019) Predator diversity in Indian cotton agroecosystems. Journal of Asia-Pacific Entomology 22(1): 189-195.

19. Tillman PG, Cottrell TE, Mizell RF (2020) Predator communities in US cotton. Insects 11(12): 850.

20. Akat O, Ölmez Bayhan S (2024) Determination of predators and parasitoids of Tuta absoluta *(Lepidoptera: Gelechiidae)* in different tomato varieties cultivated in open fields in Diyarbakır Province. Research in Agricultural Sciences 55(1): 36-40.

21. Albajes R, Lumbierres B, Pons X (2020) Aphidophagous predators in Spanish cotton fields. Bio Control 65(3): 301-315.

22. Ali H, Afzal M, Iqbal J (2021) Predator-prey dynamics in but cotton fields of Punjab, Pakistan. Crop Protection 143: 105543.

23. Grundy P, Leven T (2022) Multi-predator interactions enhance pest suppression in Australian cotton. Agriculture, Ecosystems & Environment 324: 107712.

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