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Seasonal abundance of *Cassida vittata* (Coleoptera: Chrysomelidae) and associated insect predators in three sugar beet plantations

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Abstract

Cassida vittata Vill. (Coleoptera: Chrysomelidae) is a major pest of sugar beet, causing significant losses in root yield and sugar content. This work was done at the experimental farm of Sakha Agricultural Research Station during the 2022/2023 and 2023/2024 seasons. In the first season, the population density of *C. vittata* was lowest (10.69 larvae /5 plants) in the first plantation, followed by the second plantation (13.20), while the highest insect density (28.06) was recorded in the third plantation. The corresponding values of the second season were 10.06, 12.86, and 32.26 for the three plantations, respectively. Population densities of the predators; *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae), formicids, *Coccinella undecimpunctata* (L.) (Coleoptera: Coccinellidae) and *Paederus alfierii* Koch (Coleoptera: Staphylinidae), were also highest in the third plantation compared to the first or second one. Correlations between *C. vittata* larval populations and its associated insect predators were highly significant positive in both study seasons. Thus, these predators play an important role in the integrated management of insect pests in sugar beet fields.

Introduction

Sugar beet *Beta vulgaris* L. (Family: Chenopodiaceae) is one of the most important sugar crops worldwide. In Egypt, it has become the first source of sugar supply, followed by sugar cane, since 2013 (El-Shafey, 2014). The policy of Ministry of Agriculture in Egypt aims to minimizing the gap between sugar production and consumption by encouraging the growers to expand the cultivated area of sugar beet and maximize productivity (Afifi, 2001). Unfortunately, sugar beet plants are liable to infestation by numerous damaging insect pests throughout all growing stages. These pests result in significant reductions in roots and sugar production (El-Dessouki, 2014 and Refaei *et al.*, 2023). The tortoise beetle, *Cassida vittata* Vill. (Coleoptera: Chrysomelidae) is an important economic pest to the sugar beet crop (Abou-El kassem, 2010 and El-Rawy and Shalaby, 2011). It causes significant economic losses and reduces the commercial value of the crop (Ahmadi *et al.*, 2017). The larvae feed upon leaves, causing significant defoliation (Maareg *et al*., 2005 and Hawila, 2021). In case of severe infestation, reductions in root weight and sucrose content may reach 40.10 and 56.20%, respectively (Bazazo and Besheit, 2019). Shalaby (2001) indicated that *C. vittata* appears in December,

and peaks during March and April, and detected higher numbers of larvae in late plantation than in early one. Abo El-Naga (2004) reported that the larval population started to appear in the third week of February, forming peaks in the third week of March, and the first and the fourth week of May.

Fortunately, the sugar beet fields have several insect predators that should be conserved to keep the natural balance in the sugar beet ecosystem (Hendawy, 2009). El-Khouly (2006) detected adults of *Coccinella undecimpunctata* (L.) (Coleoptera: Coccinellidae) by the third week of March, which peaked by the first week of May. High populations of *C. undecimpunctata* and *Paederus alfierii* Koch (Coleoptera: Staphylinidae) synchronized with the populations of *C. vittata*. However, the coccinellid numbers were usually more than the staphylinid ones. Also, Zawrah (2000) studied the relationship between the predaceous insects and different stages of insect prey species and found that the highest occurrence of the predacious insects coincided with the second peak of the immature stages of *C. vittata*. Moreover, Talha (2001) found that the October plantation harbored the highest number of predators; *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae), *P. alfierii*, and *C. undecimpunctata* compared to the August or September plantation (Hegazy, 2018). Pointed out that *Scymnus interruptus* Goeze (Coleoptera: Coccinellidae), the green lacewing *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), and some species of predatory ants (Hymenoptera: Formicidae) are important generalist predators of insect pests in sugar beet fields, particularly because they have diverse feeding habits.

The objectives of this study were to monitor *C. vittata* population fluctuation in three sugar beet cultivations, and to find out the correlation between these insects and related predators.

Materials and methods

1. Population density of *Cassida vittata* larvae and associated predators:

This trial was carried out at the experimental farm of Sakha Agricultural Research Station, Kafr EI Sheikh, Egypt, during the 2022/2023 and 2023/2024 seasons. The experimental area measured about one-half feddan for each cultivation. This area was divided into three replicates/ plantations, planted with "Karam" variety on three dates: 16th August, 16th September and 17th October. All recommended practices were followed without insecticidal applications. Biweekly, numbers of *Cassida vittata* larvae, *C. carnea* (Larvae), *P. alfierii* (Adults), formicid species (adults) and *C. undecimpunctata* (larvae + adults) were counted visually in the field on 5 plants/replicate.

2. Statistical analysis:

All statistical analysis was performed using analysis of variance (ANOVA) by means of the "SPSS" computer software package. The treatment means were compared using Duncan's multiple- range test (Duncan, 1955). *and** symbols were used in all tables to indicate the significance at 5% and 1% levels of probability, respectively. Also, the simple correlation coefficient values between *C. vittata* and predators were calculated according to Snedecor and Cochran (1989).

Results and discussion

1. Seasonal abundance of *Cassida vittata* larvae and its insect predators:

1.1. 2022/2023 season:

1.1.1. *Cassida vittata* larvae:

Data in Table (1) shows the seasonal average number of *C. vittata* larvae in the three plantations during the 2022/2023 season. Mean numbers of larvae were 10.59 ± 0.10, 13.19 ± 0.20, and 28.19 ± 0.33 for the three plantations, respectively. Generally, the numbers of larvae increased progressively from 15th December towards the harvest of sugar beet crops. For the first plantation, the highest average number (11.66 larvae/5 plants) was detected on 15th February, while the highest average numbers of the second (15.33 individuals) and third (43.33 per 5 plants) plantations were recorded on 15th March and 30th April, respectively.

Table (1): Seasonal average number of *Cassida vittata* larvae in sugar beet plantations in the 2022/2023 season.

Date of inspection	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 15th	10.00	———	———
Dec. 30th	10.66	———	———
Jan. 15th	11.00	11.33	———
Jan. 30th	9.66	12.00	———
Feb. 15th	11.66	13.00	———
Feb. 28th	———	14.33	17.33
March 15th	———	15.33	21.00
March 30th	———	———	25.00
April 15th	———	———	33.66
April 30th	———	———	43.33
Mean ± SE	10.60 ± 0.10 a	13.20 ± 0.20 b	28.06 ± 0.33 c

1.1.2. Predators:

Concerning the insect predators, data in Tables (2, 3, 4, and 5) clarify that the highest population of *C. carnea* (27.92 ± 6.21) was detected in the third plantation, followed by the second one (20.66 ± 4.31), whereas the lowest population (14.53 ± 3.21) was recorded in the first one. The corresponding values of formicids were 17.19 ± 6.21, 19.79 ± 7.12, and 21.46 ± 8.01, respectively. Averages of *C. undecimpunctata* were 9.66 ± 3.41, 13.39 ± 4.21, and 18.19 ± 6.32 and those of *P. alfierii* were 10.26 ± 3.01, 12.86 ± 3.22, and 13.86 ± 3.31 for the first, second and third plantations, respectively.

Table (2): Seasonal average number of *Chrysoperla carnea* larvae in sugar beet plantations in the 2022/2023 season.

Date of inspection	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 15th	8.33	———	———
Dec. 30th	13.00	———	———
Jan. 15th	14.33	13.66	———
Jan. 30th	17.00	18.66	———
Feb. 15th	20.00	20.66	———
Feb. 28th	———	23.66	20.33
March 15th	———	26.66	26.33
March 30th	———	———	27.66
April 15th	———	———	31.66
April 30th	———	———	33.66
Mean ± SE	14.53 ± 3.21 a	20.66 ± 4.31 b	27.92 ± 6.21 c

Table (3): Seasonal average population of formicid species in sugar beet plantations in the 2022/2023 season.

Date of examination	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 15th	10.33	———	———
Dec. 30th	14.00	———	———
Jan. 15th	17.00	11.00	———
Jan. 30th	21.00	16.66	———
Feb. 15th	23.66	20.33	———
Feb. 28th	———	24.00	13.33
March 15th	———	27.00	17.66
March 30th	———	———	20.66
April 15th	———	———	25.66
April 30th	———	———	30.00
Mean ± SE	17.19 ± 6.21 a	19.79 ± 7.12 b	21.46 ± 8.01 c

Table (4): Seasonal average individuals of *Coccinella undecimpunctata* in sugar beet plantations in the 2022/2023 season.

Date of examination	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 15th	7.00	———	———
Dec. 30th	8.66	———	———
Jan. 15th	10.00	8.66	———
Jan. 30th	10.66	10.66	———
Feb. 15th	12.00	13.66	———
Feb. 28th	———	16.33	10.00
March 15th	———	17.66	15.33
March 30th	———	———	17.33
April 15th	———	———	20.66
April 30th	———	———	27.66
Mean ± SE	9.66 ± 3.41 a	13.39 ± 4.21 b	18.19 ± 6.32 c

Table (5): Seasonal average number of *Paederus alfierii* in sugar beet plantations in the 2022/2023 season.

Date of examination	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 15th	6.33	———	———
Dec. 30th	8.33	———	———
Jan. 15th	11.00	7.33	———
Jan. 30th	12.00	9.33	———
Feb. 15th	13.66	14.00	———
Feb. 28th	———	16.33	10.00
March 15th	———	17.33	12.00
March 30th	———	———	14.33
April 15th	———	———	15.33
April 30th	———	———	17.66
Mean ± SE	10.26 ± 3.01 a	12.86 ± 3.22 b	13.86 ± 3.31 b

1.2. 2023/2024 season:

1.2.1. *Cassida vittata* larvae:

Table (6) elucidates that the means populations of larvae during the whole season were 10.06 ± 0.10, 12.86 ± 0.21, and 32.26 ± 2.10 larvae/5 plants in the three plantations, respectively. In general, the number of larvae increased progressively from 16th December to the end of the season. The highest average number was found on 14th February for the first plantation, with 12.33 larvae/5 plants, 14.33 in the second one that was recorded on 16th March, and 53.33 individuals on 29th April in the third one.

Table (6): Seasonal average population of *Cassida vittata* larvae in sugar beet plantation in 2023/2024 season.

Date of examination	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 16th	6.66	———	———
Dec. 31st	10.33	———	———
Jan. 16th	10.33	11.66	———
Jan. 31st	10.66	12.00	———
Feb. 14th	12.33	12.66	———
Feb. 28th	———	13.66	20.00
March 16th	———	14.33	21.66
March 31st	———	———	26.00
April 14th	———	———	40.33
April 29th	———	———	53.33
Mean ± SE	10.06 ± 0.10 a	12.86 ± 0.21 b	32.26 ± 2.10 c

The findings of both seasons agree with those of Talha (2001), who mentioned that the third cultivation of the sugar beet crop was highly infested with *C. vittata*. Mousa (2005) found that the third plantation harbored the highest number of *C. vittata* larvae. In such a concern, El-Khouly (2006) revealed that the populations of *C. vittata* larvae increased to their peak in April. Also, Amin *et al.* (2008) showed that the relative abundance of *C. vittata* larvae increased with the delay of the planting date and revealed that August and September plantations are better for sowing sugar beet at Kafr Elsheikh Governorate. Attia (2009) reported that the first sowing date harbored the least infestation with *C. vittata*, while the third sowing date harbored the highest population of this insect. The population densities increased successively as the plants grew older towards the end of the season. Also, Mohammed (2018) mentioned that the October plantations exhibited the highest *C. vittata* population density.

1.2.2. Predators:

Regarding certain insect predators, findings in Tables (7, 8, 9, and 10) clarify that the highest numbers were found in the third plantation, then the second one. while the lowest population was recorded in the first one. Means ± SE of *C. carnea* were 15.66 ± 3.21, 23.06 ± 6.11, and 29.93 ± 7.21; 17.79 ± 3.41, 20.53 ± 4.20, and those of formicid species were 17.79 ± 3.41, 20.53 ± 4.20, and 23.46 ± 6.34 for the three plantations, respectively. Averages of *C. undecimpunctata* were 10.39 ± 3.21, 16.19 ± 5.11, and 18.8 ± 6.00, and those of *P. alfierii* were 10.93 ± 3.34, 13.79 ± 4.01, and 16.19 ± 5.72 for the three plantations, respectively.

Table (7): Seasonal average number of *Chrysoperla carnea* larvae in sugar beet cultivations in the 2023/2024 season.

Date of record	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 16th	8.00	———	———
Dec. 31st	13.33	———	———
Jan. 16th	15.33	14.00	———
Jan. 31st	18.66	20.00	———
Feb. 14th	23.00	23.66	———
Feb. 28th	———	27.33	21.00
March 16th	———	30.00	27.33
March 31st	———	———	31.00
April 14th	———	———	34.00
April 29th	———	———	36.33
Mean ± SE	**15.66 ± 3.21 a**	**23.06 ± 6.11 b**	**29.93 ± 7.21 c**

Table (8) Annual average population of formicid species in sugar beet cultivations in the 2023/2024 season.

Date of examination	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 16th	10.00	———	———
Dec. 31st	13.33	———	———
Jan. 16th	17.66	10.66	———
Jan. 31st	22.00	17.00	———
Feb. 14th	26.00	20.66	———
Feb. 28th	———	24.33	14.33
March 16th	———	30.00	19.66
March 31st	———	———	23.33
April 14th	———	———	26.66
April 29th	———	———	33.33
Mean ± SE	17.79 ± 3.41 a	20.53 ± 4.20 b	23.46 ± 6.34 c

Table (9): Annual average number of *Coccinella undecimpunctata* in sugar beet cultivations in the 2023/2024 season.

Date of inspection	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 16th	6.66	———	———
Dec. 31st	8.33	———	———
Jan. 16th	11.00	10.00	———
Jan. 31st	12.33	14.00	———
Feb. 14th	13.66	17.00	———
Feb. 28th	———	19.66	11.00
March 16th	———	20.33	15.00
March 31st	———	———	17.00
April 14th	———	———	21.00
April 29th	———	———	30.00
Mean ± SE	10.39 ± 3.21 a	16.19 ± 5.11 b	18.8 ± 6.00 c

Table (10) Seasonal average number of *Paederus alfierii* for three cultivations in the 2023/2024 season.

Date of inspection	Mean No. of larvae /5 plants		
	1st plantation	2nd plantation	3rd plantation
Dec. 16th	6.00	———	———
Dec. 31st	8.00	———	———
Jan. 16th	10.00	7.66	———
Jan. 31st	14.00	9.00	———
Feb. 14th	16.66	15.00	———
Feb. 28th	———	17.33	9.66
March 16th	———	20.00	10.33
March 31st	———	———	17.00
April 14th	———	———	20.33
April 29th	———	———	23.66
Mean ± SE	10.93 ± 3.34 a	13.79 ± 4.01 b	16.19 ± 5.72 c

2. Simple correlation coefficient values between the populations of *Cassida vittata* larvae and certain associated insect predators:

The simple correlation coefficient values were calculated (Table 11) according to Snedecor and Cochran (1989), considering the populations of *C. vittata* larvae (Tables 1 and 6) and its insect predators (Tables 2, 3, 4, 5, 7, 8, 9, and 10) during the two seasons over the three cultivations. Data revealed that highly positive significant correlations between *C. vittata* larvae and all insect predators were found.

Table (11): Simple correlation coefficient values between *Cassdia vittata* and insect predators in the three cultivations.

Relationship	2022/2023			2023/2024		
	First	Second	Third	First	Second	Third
Cassida vittata* x *Chrysoperla carnea	0.561**	0.621**	0.711**	0.572**	0.591**	0.743**
***Caasia vittata* x formicid species**	0.632**	0.511**	0.601**	0.602**	0.630**	0.701**
Cassida vittata* x *Coccinella undecimpunctata	0.521**	0.530**	0.714**	0.536**	0.732**	0.781**
Cassida vittata* x *paederus alfierii	0.540**	0.564**	0.801**	0.536**	0.521**	0.813**

The correlations between *C. Vittata* larvae and all insect predators were usually highly significant in both seasons. Numerous authors demonstrated the important role of insect predators in controlling *C. vittata* in the Egyptian sugar beet fields, such as

Youssef and Abou-Attia (2001), who concluded that *C. carnea* plays an important role in managing major sugar beet insects, as the predator fed upon eggs and larvae of *C. vittata*. These findings explain that insect predators may play a vital role in suppressing *C. vittata* larvae. There was a synchronization and highly positive significant correlation between *C. vittata* larvae and its predators. Also, the third cultivation that has the highest population of C. *vittata* also had the highest insect predators during both seasons of study.

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