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Role of predatory ground beetles (Coleoptera : Carabidae) in managing sugar beet pests

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Abstract:

Carabidae are represent about 40000 species throughout the world. They feed on a diversity of prey such as, snails, larvae and pupae of Lepidoptera, Collembola, Cicadellidae, aphids, larvae and pupae of Coleoptera, larvae of Diptera and eggs of insects. Carabids had little attention to be studied in Egyptian sugar beet fields. Therefore, this work was undertaken for understanding the role of Carabidae in controlling sugar beet pests at Sakha Agricultural Research Station. The results showed that the dominant carabid species were, *Bembidion* spp., *Calosoma chlorostictum* Degen. *Pterostichus pharao* L. Highly significant positive correlations between carabids and cotton leafworms, *Agrotis ipsilon* (Hufnagel) (Lepidoptera: Noctuidae) larvae, aphids, Cicadellidae, Collembola, *Scrobipalpa ocellatella* Boyd.(Lepidoptera: Gelechiidae), snails and *Cassida vittata* Vill. (Coleoptera: Chrysomelidae) during the three cultivations in 2017/2018 and 2018/2019 seasons. The major trapped pests by carabids were *S.ocellatella*, cotton leaf worms, *C.vittata, Pegomyia mixta* Vill. (Diptera: Anthomyiidae), Collembola, Cicadellidae, aphids, *Nezara viridula* L. (Hemiptera : Pentatomidae) , *A. ipsilon* and snails with 20, 13.84, 12.30, 10.76, 9.23, 7.69, 6.15, 4.61 and 4.61%, respectively in 2017/2018 seasons. 23.94, 15.49, 16.90, 12.67, 4.22, 5.63, 4.22, 7.04, 2.81 and 7.04%, respectively in 2018/2019. Also, raner 24% Sc was reduced carabid number with 10.49 and 17.17% in two seasons, respectively as, the conventional insecticides; Tac 48% Ec and Diracomel 90% Sp were reduced carabid number with 99.44 and 98.28% in 2017/2018, 100 and 99.34% in 2018/2019. In conclusion, these results proved that the importance of carabid species in managing sugar beet pests. In addition to, ecdysone agonists (IGRs) conserve the population of these carabid species in comparison with conventional insecticides. Thus, it is preferred to control sugar beet pests by spraying ecdysone agonists for maintaining the population of these predators.

Introduction

Sugar beet *Beta vulgaris* L. (Family : Chenopodiaceae) is cultivated in about 40 countries of the world and accounts for 40 – 45% of the world total sugar production. It

provides about a third of all sugar consumed worldwide (Biancardi *et al.*, 2010). It is highly sensitive crop to pests (Kos *et al.*, 2013). Sugar beet is liable to infestation by numerous pests such as, aphids, leafhoppers, *Spodoptera littoralis* Boisd. and *S. exigua* (Hubner), *Pegomyia mixta* Vill. (Diptera: Anthomyiidae), *Cassida vittata* Vill. (Coleoptera:Chrysomelidae), *Scrobipalpa ocellatella* (Boyd.) (Lepidoptera: Gelechiidae), *Nezara viridula* L. (Hemiptera : Pentatomidae) and snails, *Monacha* spp. (Gastropoda: Hygromiidae) (Iskander, 1982; Abd El-Ghany, 1995; Shalaby, 2001; Bazazo, 2010; Khalifa, 2017 and Khalifa, 2018). Sugar beet fields have enormous insect predators which can manage these pests under the economic threshold levels (Mesbah, 1991; El-Zoghby, 1999; Shalaby and Hendawy, 2007; Khalifa, 2017; Khalifa, 2018 and El-Dessouki, 2019). From these major insect predators in Egyptian sugar beet fields are ground beetles (Coleoptera : Carabidae). Carabidae are known as important predatory organisms of the soil living pests (Sunderland, 2002). They are representing approximately 40.000 described species found throughout the world. Many carabids are easily recognized at the family level. Adults are well- proportioned beetles with pronounced mandibles, and palps, long slender legs, striate elytra, and sets of punctures with tactile setae.

They have undergone morphological adaptations to suit the habitat in which they are found. Such modifications have permitted running, burrowing in soil and sand, living under tree bark, climbing plants and swimming in water (Losey and Denno, 1998). They are known to search actively for food by means of random search vision, or chemical cues. They feed on a diversity of prey such as, snails, slugs, larvae of Lepidoptera, Collembola, Cicadellidae, aphids, pupae of beetles, eggs of insects, gall midge (Cecidomyiidae) larvae, cabbage root fly, *Delia radicum* L. (Diptera: Anthomyiidae) eggs and larvae, pupae and eggs of onion maggot, *Delia antiqua* (Meigen) (Diptera: Anthomyiidae), eggs and larvae of colorado potato beetle, *Leptinotarsa decemlineata* Say (Coleoptera: Chrysomelidae) eggs and larvae of weevils (Curculionidae) and dipteran eggs (Riddick, 2005). Kromp (1999) reported that carabid beetles are usually beneficial to agriculture crops, preying on aphids, slugs and other pests. Holland and Luff (2000) showed that Carabidae occurs in all temperate agroecosystems and have been implicated as predators of many pests; aphids, lepidopterous larvae and slugs. Also, they indicated that Carabidae are an important component of integrated pest management (IPM). Rajagopal and Kumar (1992) clarified that carabids are known to prey upon caterpillars, pupae, larvae, aphids, termites etc. They are found in almost all habitats like agricultural fields, orchards, plantations, forest ect. Many species of carabids were recorded earlier as predators of crop pests. They are commonly associated with several crop pests under field conditions, but information on their distribution, seasonal abundance and feeding potential is lacking. Fournier and Loreau (1999) reported that carabids are generalist predators in crops and in natural habitats. They are cited as being predators of aphids, lepidopteran larvae, slugs, and herbaceous plant seeds. Also, many species of these beetles have a role in the natural biological control for several lepidopteran pests in different crops. Awad *et al*. (2014) investigated that intensive use of conventional insecticides led to numerous dangerous drastic problems, i.e. Environment

pollution, destruction of the natural enemies and incidence insect resistance to these insecticides. Ecdysone agonists (Methoxyfenozide) are novel and promising insecticides with high efficacy against various insects, at the same time almost non-toxic to predators and environment. The status of insect predators in Egyptian sugar beet fields was investigated by numerous authors (Talha, 2001; Bazazo, 2005; Hendawy, 2009; Bazazo, 2010 and El Dessouki, 2019), but carabids had little attention to be cited.

Thus, this study was done for investigating the seasonal abundance of some sugar beet pests and their associated carabid predators. Calculating the correlation coefficient values between them. Surveying certain prey of carabids by (Visual record and fine brush methods). Also, evaluating the efficiency of mexthoxyfenozide (Ecdysone agonists) as novel, ecofriendly insecticides in controlling sugar beet insects as well as carabids maintaining in comparison with conventional insecticides.

Materials and Methods

1. Seasonal abundance of carabids and certain sugar beet pests:

After thinning, biweekly samples were taken till harvest for two successive seasons, 2017/2018 and 2018/2019. During every sample (5 plants), a plastic bag was converted on a sugar beet plant to harbor the whole plant which cut at the soil surface. The bag was tightly tied at the bottom and transferred to the laboratory for further procedures. In the laboratory, a piece of cotton saturated with chloroform was introduced into the bag for 20 minutes to anesthetize the confirmed pests. The bag size varied during the season according to the growth of plants. The area of this experiment was 1/2 feddan planted with farida cultivar / each cultivation. The specimens were identified using stereoscopy (4.8 – 56.0 x magnification) the carabid species Figure (1) were identified by (Plant Protection Research Institute, Egypt).

***Bembidion* spp.** ***Calosoma chlorostictum* Degen** ***Pterostichus pharao* (Lutshnik)**

Figure (1): The specimens of the carabid species.

2. Effect of certain methoxyfenozide (Ecdysone agonists) and conventional insecticides on carabids:

Another field about 1/2 feddan was performed to this experiment during 2017/2018 and 2018/2019 seasons. Three insecticides in Table (1) were applied and recommended against cotton leaf worms , each insecticide was replicated four times (3x4 = 12 plots), each plot measured 42m2, in addition to four plots as check. Knapsack sprayer

(20 L volume) was used for spraying. Number of carabids was counted by visual record one, three, seven and 10 days post spraying.

Reduction in carabids was calculated by Henderson and Tilton (1955) formula:

$$1-\left(\frac{\text{No. in check before spray}}{\text{No. in check after spray}} \times \frac{\text{No. in treated after spray}}{\text{No. in treated before spray}}\right) \times 100$$

Also, differences between the mean numbers of carabids were analyzed using Duncan test (1955). Date of spraying was 20 and 25 September in two seasons, respectively, Completely randomized block design was applied.

Table (1): The insecticides used against cotton leaf worms during 2017/2018 and 2018/2019 seasons.

Insecticide		Category	Rate / feddan
Common	**Trade name**		
Methoxyfenozide	Raner 26% sc	Ecdysone agonists	75 cm^3
Chlorpyrifes	Tac 48% Ec	Conventional	1000 cm^3
Methomyl	Diracomel	Conventional	300 gm

3. Identification the prey of carabid species:

Using visual record and a fine brush method were used to monitor carabids and their prey. Four hours for each sample 9.00 a.m to 13.00 p.m during third cultivation.

70% ethyl – alcohol was put into glass tubes, after that, the specimens were identified using stereoscopy (4.8 – 56.0 x magnification). 20 sample (4 hours / sample) were collected beginning from 15 November up to 30 March and 14 November up to 29 March during 2017/2018 and 2018/2019, respectively.

Results and discussion

1. Seasonal abundance of carabids and certain sugar beet pests:

In general, data in Tables (2,3,4,5,6 and 7) showed that the population density carabids were low on September and January, and then exhibited high numbers on October, November and December for the first cultivation during the two seasons. Low populations were showed on October and January, and then occurred high populations on November, December and February to the second cultivation during the two seasons.

Low numbers were found on November, January and February in 2017/2018, whereas on January in 2018/2019. High numbers were detected on December and March during 2017/2018, while on November, December, February and March during 2018/2019.

Also, general carabid – prey ratio ranging between 1: 0.06 to 1: 0.21 and 1: 0.02 to 1: 0.15 and 1: 0.02 to 1: 0.28 for three cultivations, respectively during 2017/2018 seasons.

1: 0.03 to 1: 0.30 and 1: 0.01 to 1: 0.36 and 1: 0.05 to 1:0.57 for three plantations, respectively throughout 2018/2019 seasons.

Concerning the correlation coefficient values between certain sugar beet pests and their associated carabid were calculated according to Snedecor and Cochran (1989) considering population fluctuations of carabid species and pests during the two seasons 2017/2018 and 2018/2019. Data in Tables (8 and 9) showed that highly significant positive correlations were attained between carabids and cotton leaf worms, *A.ipsilon*, aphids, leafhoppers, Collembola, *S.ocellatella*, snails and *C. vittata* during the three cultivations. Significant positive correlations were calculated among carabids and *P. mixta* during the three cultivations. The raise of general carabid – prey ratio and the highly positive significant correlation

coefficient values between carabids and sugar beet pests during the two seasons, these carabids demonstrate that play a vital role in managing sugar beet pests. Ghoneim (2014) indicated that Carabidae is a large, cosmopolitan family of beetles (Coleoptera). Many species of these carabids have a role in the natural biological control for several pests. Holland and Luff (2000) showed that carabidae are an important component of an integrated pest management. Riddick (2005) reported that carabids were capable of reducing aphids population densities. Carabids, even when at relatively low - densities, were able to locate low density populations of aphids in sugar beet fields. Rajagopal and Kumar (1992) demonstrated that the management and conservation of Carabidae is are necessary for effective utilization in the integrated pest management program. Weseloh *et al.* (1995) investigated that carabids are one of the most important mortality agents of the larvae and pupae of Lepidoptera. Thus, it should be used intensively in the biological control of lepidopterous insects.

Data presented in Table (10) clarify that the major trapped pests by carabids were *S. ocellatella*, cotton leaf worms, *C.vittata, P.mixta,* Collembola, Cicadellidae, aphids, *N.viridula*, *A.ipsilon* and snails with 20, 13.84, 12.30, 10.76, 9.23, 7.69, 6.15, 4.61 and 4.61%, respectively in 2017/2018 seasons. 23.94, 15.49, 16.90, 12.67, 4.22, 5.63, 4.22, 7.04, 2.81 and 7.04%, respectively in 2018/2019.

Table (2): Seasonal abundance of major pests attacking sugar beet plants and their associated carabid species during 2017/2018 season, using bag and cut method, first cultivation.

Date	Carabids	Pests					
		Cotton leaf worms	*Agrotis ipsilon*	Aphids	Leafhoppers	Collembola	*Pegomyia mixta*
15/9/2017	4	3	1	0	0	0	0
30/9	13	4	2	0	0	2	0
15/10	13	6	3	0	1	3	0
30/10	17	5	4	0	1	5	0
15/11	18	5	6	0	0	4	0
30/11	19	4	3	2	1	0	0
15/12	23	2	4	3	3	2	1
30/12	28	1	4	5	4	2	2
15/1/2018	9	1	2	6	7	1	3
30/1	9	1	2	6	7	1	3
Total	153	32	31	22	24	20	9
General Predator – prey ratio	--	1: 0.21	1: 0.20	1: 0.14	1:0.16	1: 0.13	1: 0.06

Table (3): Seasonal abundance of major pests attacking sugar beet plants and their associated carabids species during 2017/2018season, using bag and cut method, second cultivation.

Date	Carabids	Pests							
		Cotton leaf worms	*Agrotis ipsilon*	Aphids	Leaf-Hoppers	Collem-bola	*Pegomyia mixta*	*Scrobipalpa ocellatella*	Snails
15/10	5	2	1	0	0	1	0	0	0
30/10	10	3	1	0	0	1	0	0	0
15/11	16	3	2	0	2	1	0	0	0
30/11	21	5	3	0	3	2	0	0	0
15/12	22	1	0	0	3	1	1	0	0
30/12	24	1	0	0	0	0	2	0	0
15/1	8	1	0	0	0	0	3	0	0
30/1	7	1	0	1	0	0	3	0	1
15/2	12	0	0	2	2	0	4	1	2
28/2	6	1	0	2	1	2	6	2	3
Total	131	18	7	5	11	8	19	3	6
General Predator – prey ratio	--	1 : 0.14	1 : 0.05	1 : 0.04	1 : 0.08	1 : 0.06	1 : 0.15	1 : 0.02	1 : 0.05

Table (4): seasonal abundance of major pests attacking sugar beet plants and their associated carabid species during 2017/2018 season, using bag and cut method, third cultivation.

Date	Carabids	Pests								
		Cotton leaf worms	*Agrotis ipsilon*	Aphids	Leaf-hoppers	Collembola	*Pegomyia mixta*	*Scrobipalpa ocellatella*	Snails	*Cassida vittata*
15/11	3	2	0	0	0	0	0	0	0	0
30/11	11	2	1	0	2	0	1	0	0	0
15/12	18	1	1	1	0	1	1	0	0	0
30/12	22	0	0	0	1	1	3	0	0	0
15/1	7	0	0	0	0	1	4	0	0	0
30/1	6	0	0	0	0	1	4	0	0	0
15/2	5	0	0	0	0	1	5	2	2	2
28/2	9	0	0	1	0	0	6	2	3	3
15/3	23	2	1	0	2	2	6	6	4	9
30/3	26	1	0	2	3	3	7	7	5	11
Total	130	8	3	4	8	10	37	17	14	25
General Predator – Prey ratio	--	1 : 0.06	1 : 0.02	1:0.03	1:0.06	1:0.07	1:0.28	1:0.13	1:0.11	1:0.20

Table (5): Seasonal abundance of major pests attacking sugar beet plants and their associated carabid species during 2018/2019 season, using bag and cut method, first cultivation.

Date	Carabids	Pests					
		Cotton leaf worms	*Agrotis ipsilon*	Aphids	Leafhoppers	Collembola	*Pegomyia mixta*
14/9	2	2	1	0	0	1	0
29/9	6	3	2	0	0	1	0
14/10	11	5	2	0	1	1	0
29/10	13	5	4	0	2	0	0
14/11	19	6	4	0	3	0	0
29/11	22	8	5	0	3	0	2
14/12	15	0	0	0	4	0	3
29/12	8	0	0	1	4	0	4
14/1	6	0	0	1	0	0	6
29/1	6	0	0	1	0	0	8
Total	108	29	18	3	17	3	23
General Predator – prey ratio	--	1 : 0.30	1 : 0.20	1 : 0.03	1 : 0.20	1 : 0.03	1 : 0.21

Table (6): Seasonal abundance of major pests attacking sugar beet plants and their associated carabid species during 2018/2019 season, using bag and cut method, second cultivation.

Date	Carabids	Pests								
		Cotton leaf worms	*Agrotis ipsilon*	Aphids	Collem-bola	*Pegomyia mixta*	*Scrobipal-pa ocellatella*	Snails	*Cassida vittata*	Leafhoppe-rs
14/10	3	4	1	0	0	0	0	0	0	0
29/10	9	6	1	0	1	0	0	0	0	0
14/11	16	7	2	0	2	0	0	0	0	0
29/11	21	9	3	1	1	0	0	0	0	2
14/12	23	2	0	1	1	3	0	0	0	3
29/12	9	0	0	0	1	4	0	0	0	3
14/1	9	0	0	0	0	6	0	0	0	0
29/1	8	0	0	0	0	9	0	0	0	0
14/2	13	1	0	0	0	12	2	1	1	0
28/2	18	0	1	0	0	13	3	3	1	0
Total	129	29	8	2	6	47	5	4	2	8
General Predator – prey ratio	--	1: 0.22	1: 0.06	1: 0.01	1: 0.04	1: 0.36	1 : 0.03	1 : 0.03	1 : 0.01	1 : 0.06

Table (7): Seasonal abundance of major pests attacking sugar beet plants and their associated carabid species during 2018/2019 season, using bag and cut method, third cultivation.

Date	Carabids	Pests								
		Cotton leaf worms	*Agrotis ipsilon*	Aphids	Leaf-hoppers	Collembola	*Pegomyia mixta*	*Scrobipalpa ocellatella*	Snails	*Cassida vittata*
14/11	11	6	2	0	1	0	1	0	0	0
29/11	13	8	2	0	1	1	1	0	0	0
14/12	16	3	0	0	1	1	3	0	0	0
29/12	8	0	0	0	1	1	5	0	0	0
14/1	8	0	0	0	0	0	7	0	0	0
29/1	9	0	0	0	0	1	8	0	0	0
14/2	10	0	0	0	0	1	9	1	2	2
28/2	17	0	0	1	0	0	13	3	3	3
14/3	23	1	1	3	3	0	17	5	6	9
29/3	29	1	3	4	3	3	19	9	8	13
Total	144	19	8	8	10	8	83	18	19	27
General Predator – prey ratio	--	1 : 0.13	1 : 0.05	1 : 0.05	1 : 0.06	1 : 0.05	1 : 0.57	1 : 0.12	1 : 0.13	1 : 0.18

Table (8): Correlation coefficient values between some sugar beet pests and their carabids during 2017/2018 season.

Relationship	"r" value			Status of significance		
	1st cultivation	2nd cultivation	3rd cultivation	1st cultivation	2nd cultivation	3rd cultivation
Carabids x cotton leaf worm	0.611**	0.610**	0.602**	Highly	Highly	Highly
Carabids x *Agrotis ipsilon*	0.701**	0.703**	0.712**	Highly	Highly	Highly
Carabids x aphids	0.811**	0.810**	0.813**	Highly	Highly	Highly
Carabids x leaf- hoppers	0.721**	0.722**	0.713**	Highly	Highly	Highly
Carabids x Collembola	0.801**	0.802**	0.811**	Highly	Highly	Highly
Carabids x *Pegomyia mixta*	0.550**	0.551**	0.541**	Significant	Significant	Significant
Carabids x *Scrobipalpa ocellatella*	--	0.813**	0.816**	--	Highly	Highly
Carabids x snails	--	0.822**	0.826**	--	Highly	Highly
Carabids x *Cassida vittata*	--	--	0.823**	--	--	Highly

Table (9): Correlation coefficient values between certain sugar pests and carabids during 2018/2019.

Relationship	"r" value			Status of significance		
	1st cultivation	2nd cultivation	3rd cultivation	1st cultivation	2nd cultivation	3rd cultivation
Carabids x cotton leaf worm	0.621**	0.623**	0.631**	Highly	Highly	Highly
Carabids x *Agrotis ipsilon*	0.651**	0.653**	0.656**	Highly	Highly	Highly
Carabids x Aphids	0.826**	0.838**	0.840**	Highly	Highly	Highly
Carabids x leafhoppers	0.712**	0.734**	0.719**	Highly	Highly	Highly
Carabids x Collembola	0.801**	0.812**	0.813**	Highly	Highly	Highly
Carabids x *Pegomyia mixta*	0.501**	0.511**	0.512**	Significant	Significant	Significant
Carabids x *Scrobipalpa ocellatella*	--	0.841**	0.861**	--	Highly	Highly
Carabids x snails	--	0.911**	0.922**	--	Highly	Highly
Carabids x *Cassida vittata*	--	0.913**	0.910**	--	Highly	Highly

Table (10): Prey of carabids in sugar beet fields during 2017/2018 and 2018/2019 seasons, using visual record method.

Taxa	Stage	2017/2018		2018/2019	
		No.*	%	No.*	%
Scrobipalpa ocellatella	Larvae	13	20.00	17	23.94
Cotton leaf worm	Eggs + larvae	9	13.84	11	15.49
Cassida vittata	Larvae + pupae+ adults	8	12.30	12	16.90
Pegomyia mixta	Larvae + eggs	7	10.76	9	12.67
Collembola	Adult	7	10.76	3	4.22
Cicadellidae	Nymph + Adult	6	9.23	4	5.63
Aphids	Nymph + adults	5	7.69	3	4.22
Nezara viridula	Eggs+Nymph	4	6.15	5	7.04
Agrotis ipsilon	Larvae	3	4.61	2	2.81
Snails	Adult	3	4.61	5	7.04
Total	__	65	__	71	__

*** 10 samples (4 hours for each sample)**

2. Effect of certain methoxyfenozide (Ecdysone agonists) and conventional insecticides on carabids:

Table (11) elucidate that raner 24% Sc was reduced carabid number with 10.49 and 17.17% in two seasons, respectively as, the conventional insecticides; Tac 48% Ec and Diracomel 90% Sp were reduced carabid number with 99.44 and 98.28% in 2017/2018, 100 and 99.34% in 2018/2019. These results are agreement with those of several authors, Ishaaya (2005), Pineda *et al.* (2009) and Rani *et al*. (2018). They concluded that ecdysone agonists are promising insecticides with high efficacy against various insects, at the same time almost non-toxic to predators and have a minimum on the environment. It would be an ideal agent for IPM.

Table (11): Side effect of certain conventional and ecdysome agonists insecticides on carabids during 2017/2018 and 2018/2019 seasons.

Compound	Before spray	After one day		After 3 day		After 7 day		After 10 day		Overall mean of reduction
	Mean	M.	Red.%	M.	Red.%	M.	Red.%	M.*	Red.%	
Tac	9.75	0.00	100	0.00	100	0.00	100	0.25[a]	97.77	99.44
Diracomel	9.50	0.00	100	0.00	100	0.00	100	0.75[a]	93.15	98.28
Raner	9.75	9.25	7.50	9.50	7.31	9.50	11.62	9.50[b]	15.55	10.49
Check	9.75	10.00	--	10.25	--	10.75	--	11.25	--	--
Tac	7.00	0.00	100	0.00	100	0.00	100	0.00a	100	100
Diracomel	7.00	0.00	100	0.00	100	0.00	100	0.25a	97.39	99.34
Raner	7.50	7.00	13.10	7.50	10.00	7.50	18.18	7.50b	27.02	17.07
Check	6.75	7.25	--	7.50	--	8.25	--	9.29	--	--

*** The Duncan test at level of 5% probability was applied, the main followed by the same letter do not differ significantly.**

3. Identification the prey of carabid species:

The survey showed the occurrence of 3 carabid species (Table 12). Most surveyed carabid species were; *Bembidion* spp (67.32, 91.60 and 86.15) followed by *Calosoma chlorostictum* Degen (18.95, 1.52 and 2.30), and *Pterostichus pharao* (13.72, 6.87 and 11.53) during three cultivations, respectively in 2017/2018. As, *Bembidion* spp (90.74, 77.51 and 97.22), *Calosoma chlorostictum* Degen. (7.40, 11.62 and 1.38) and *Pterostichus pharao* (1.85, 10.85 and 1.38) during three cultivations, respectively in 2018/2019.

Table (12): Survey of carabid Species during 2017/2018 and 2018/2019

Taxa	1st Cultivation		2nd Cultivation		3rd Cultivation	
	No.	%	No	%	No.	%
2017/2018						
***Bembidion* spp.**	103	67.32	120	91.60	112	86.15
Pterostichus pharaoh	21	13.72	9	6.87	15	11.53
***Calosoma chlorostictum* Degen.**	29	18.95	2	1.52	3	2.30
Total	153	———	131	———	130	———
2018/2019						
***Bembidion* spp.**	98	90.74	100	77.51	140	97.22
Pterostichus pharaoh	2	1.85	14	10.85	2	1.38
***Calosoma chlorostictum* Degen.**	8	7.40	15	11.62	2	1.38
Total	108	———	129	———	144	———

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