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HYMENOPTEROUS PARASITOIDS ASSOCIATED WITH CEREAL APHIDS IN WHEAT FIELDS AT ASSIUT

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ABSTRACT:

The present study was carried out in Assiut area to investigate the relationship between cereal aphids and their associated parasitoids on wheat plants during two successive seasons, 2011 and 2012. The results indicated that, of 48,000 mummified aphids collected from wheat plants in two seasons, 89.69% adult parasitoids were emerged. Ten parasitoid species belonging to five families of order hymenoptera were identified. The primary parasitoid species were recorded, *Aphidius colemani* Vereck, *A. matricariae* Haliday, *Diaeretiella rapae* (McIntosh), *Ephedrus plagiator* (Ness), *Praon necans* Mackauer and *Trioxys* sp., in addition the secondary parasitoids were, *Alloxysta australiae* (Ashmead), *Dendrocerus carpenteri* (Curtis), *Chalcids* sp.,and *Aphidencyrtus* sp. Data show that, *Diaeretiella rapae* was the most dominant and abundant primary parasitoid species represented 87.99% and 64.35% during 2011 and 2012 seasons, respectively. In spite of aphids, five aphid species namely, *Schizaphis graminum* (Rondani), *Rhopalosiphum padi* L., *R. maidis* (Fitch.), *Sitobion avenae* (Fab.) and *Metopolophium dirhodum* (Walker) were found attacking wheat plants in Assiut region. *Rhopalosiphum padi* and *Schizaphis graminum* were the most dominant and abundant cereal aphids on wheat plants represented (55.55 and 54.41%) and (40.68 and 43.11%) in both two species during 2011 and 2012 seasons, respectively. The maximum population level of cereal aphids was recorded during the 1st wk of March (529.0 and 729.0) during the two seasons, respectively. The parasitoids appeared early in the season in relatively low population density but its population fluctuated in high density during the 2nd wk of March (408.0 and 335.6) in 2011 and 2012 seasons, respectively, coincided with the collapse of aphids from wheat field. This work indicated that wheat fields are rich in aphid parasitoid species which of course play a significant role in suppressing aphid infestations.

INTRODUCTION:

In Egypt, the major insect pests attacking wheat plants are the greenbug, *Schizaphis graminum* (Rondani), the bird cherry-oat aphid, *Rhopalosiphum padi* L. and to lesser extent the corn leaf aphid, *R. maidis* (Fitch.) and the English grain aphid, *Sitobion avenae* (Fab.) (El-Heneidy *et al.*, 2001; Abdel-Samad and Gomaa, 2004; Mahmoud, 2005; Salem, 2007 and Salem and Mahmoud, 2012).

The damage caused by cereal aphids in both direct through feeding injury and indirect through the effects of honeydew in combination with fungi, which reduce rate photosynthesis and the available leaf area (Martin and Johnston, 1982; Ryan *et al.*, 1987 and Royer *et al.*, 1997).

The hymenopterous parasitoids attacking cereal aphids are considered to be of importance in natural control of their host populations. The reported parasitoid species attacking cereal aphids are *Diaeretiella rapae* (McIntosh), *Praon* spp., *Aphidius* spp. and *Ephedrus* spp. (Stary, 1976; Ibrahim, 1990; Elliot *et al.*, 1995; Ali *et al.*, 2001; Adly, 2002 and Salem, 2007).

The present study focused on survey and population densities of major cereal aphid species and their associated parasitoid species particularly *D.rapae* on wheat plants at Assiut Governorate.

MATERIALS AND METHODS:

The present study was carried out in Assiut province (Assiut district) located beside El-Azhar University at Assiut, during two successive seasons (2011 and 2012). An area of about 1/4 feddan was divided into 4 plots of equal size (approximately 250 m^2) and cultivated with wheat seeds (Seds 1). Common cultural practices were applied and no chemical pesticides were used during the study and weeds were removed by hand.

1-Mummies collected from wheat plants:

Available mummified aphids were collected weekly from wheat plants (depending on aphid density). After collection, mummies transferred to the laboratory and put individually in small plastic vials (1.5 cm in diameter and 5.5 cm in high), then kept under the laboratory conditions. The mummies were inspected daily, and the emerging adult parasitoids were identified and counted. Aphid parasitoids emerged were identified according to Pike *et al.* (1997) and confirmed by aid Dr. Peter Stary, Academy of Science, Institute of Entomology, Republic of Czechoslovakia.

2-Sweep-net method:

Sweep-net method was used to study the population of cercal aphids and the major parasitoid, *D. rapae*. Samples of cereal aphids and the associated parasitoid inhabiting wheat plants were taken regularly at weekly intervals from the beginning of January to the end of March. Twenty five net strokes were taken 4 times (100 net strokes) as the standard sample at weeks intervals. Each collected sample was empted carefully into labeled collected bag. Samples were transferred to the laboratory and the insects were killed by chloroform. The number of cereal aphids and parasitoid species were count and recorded.

Dominance (D) and abundance (A) degrees of cereal aphids and parasitoid species were calculated according to Facylate, (1971).

$$D = t/T \times 100$$

where:

t =Total number of each species during the collecting period.

T = Total number of all species collected during the collecting period.

$$A = n/N \times 100$$

where:

n = Total number of samples in which each species appeared.

N = Total number of samples taken allover the season.

RESULTS AND DISCUSSIONS:

1-Survey and relative abundance of cereal aphid parasitoid species by using mummies collection method:

Figure (1) show the numbers of mummies collected from wheat plants and the percentage of emerged parasitoids during 2011 and 2012 seasons. In 2011 season, from about 21200 mummified aphids collected from wheat fields there were 18760 adult parasitoid emerged from mummies represented 88.49% of the total collected mummies. On the other side, data also showed that of 26800 mummies collected from wheat fields in 2012 season, there were 24390 adult parasitoid emerged from mummified aphids represented 91.01% of the total collected mummies. Also, Figure (1) show that the percentage of emerged adult parasitoid in 2012 season was higher than that recorded in 2011 season with an overall average of 89.69%.

In this approach, Gilstrap *et al.*, (1984) reported that from 7.700 greenbug and 2.200 from corn leaf aphid mummies which collected from sorghum, adult parasitoid emerged were 5.635 of the collected greenbug mummies and 1.468 of the collected corn leaf aphid mummies represented 73.18% and 66.72%, respectively.

A-Primary parasitoid recorded:

Family: Aphidiidae; *Aphidius colemani* Vereck, *A. matricariae* Haliday, *Diaeretiella rapae* (McIntosh), *Ephedrus plagiator* (Ness), *Praon necans* Mackauer and *Trioxys* sp.

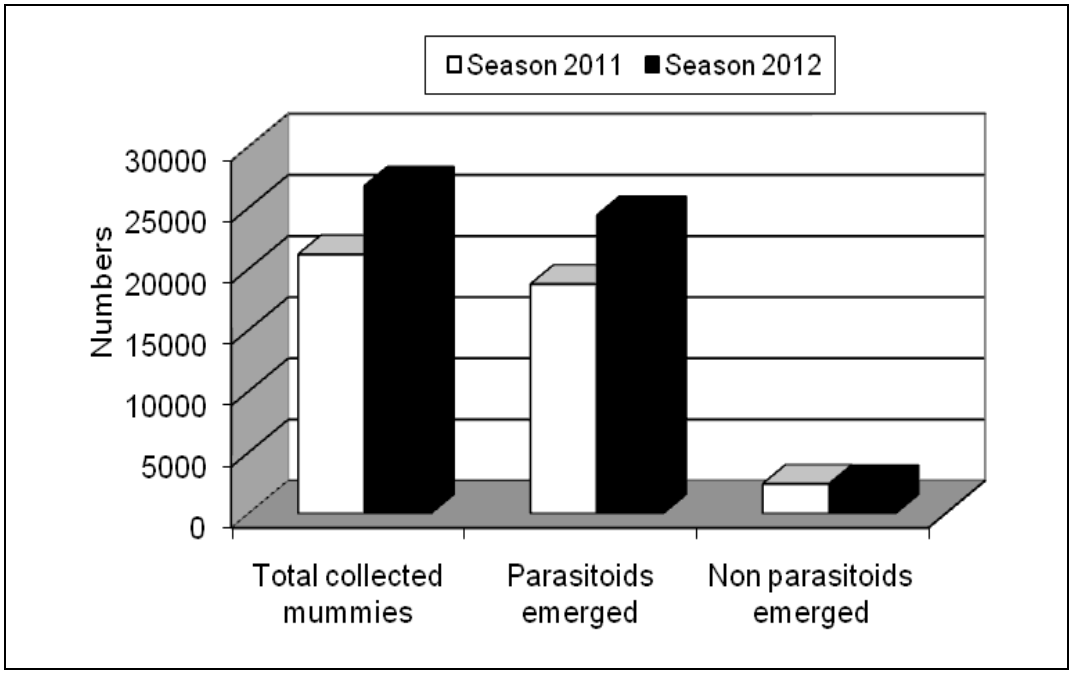

Fig. 1: Total cereal aphid mummies parasitoids emerged and non parasitoid emerged collected from wheat plants, Assiut, 2011 and 2012 seasons

B-Secondary parasitoid recorded:

Family: Cynipidae, *Alloxysta australiae* (Ashmead)

Family: Megaspilidae, *Dendrocerus carpenter* (Curtis)

Family: Chalcididae, *Chalcids* sp.

Family: Encyrtidae, *Aphidencyrtus* sp.

The same results were obtained by Ali *et al.*, 2001; El-Heneidy *et al.*, 2001; El-Heneidy *et al.*, 2002; El-Hussieni *et al.*, 2003; Sobhy *et al.*, 2003; Abdel-Rahman, 2005 and Salem and Mahmoud, 2012.

C-Relative abundance of parasitoid species:

Data in Table (1) show the percentage of each primary and secondary parasitoid species emerged from mummified aphids collected from wheat fields during 2011 and 2012 seasons. Among the recorded cereal aphid primary parasitoids, the highest percentage (87.92%) was recorded for *D. rapae* followed by *P. necans* (4.04%), *A. colemani* (3.01%), *E. plagiator* (2.45%), *A. matricariae* (1.85%) and *Trioxys* sp. (0.74) during 2011 season. Highest percentages during 2012 season reached 64.28, 15.50, 7.08, 6.08, 4.78 and 2.27% for *D. raae, P. necans, A. matricariae, E. plagiator, Trioxys* sp. *and A. colemani,* respectively. The highest percentage (94.01%) of total parasitoid species among the surveyed parasitoids was recorded in 2011 season and it was relatively higher than that of season 2012 (65.56%). This results agrees with the findings of Elliot *et al*., (1995) and pike *et al*., (1997) reported that the parasitoid *D. rapae* was recorded in high numbers on cereal aphids than other species. Salem and Mahmoud (2012) reported that *D. rapae* seem to be the most important primary parasitoid species as biological control agents due to their highest value of dominance and abundance degrees followed by *A. colemani* and *P. necans*.

Table 1: Relative abundance of the primary and secondary parasitoid species emerged from cereal aphid mummies collected from wheat plants, Assiut, 2011 and 2012 seasons

Parasitoid species	Seasons				Total	
	2011		2012			
	No.	(%)	No.	(%)	No.	(%)
1-Primary parasitoids:	-	94.01	-	65.56	-	77.93
A . colimani	532	3.01	364	2.27	896	2.66
A . matricariae	327	1.85	1134	7.08	1461	4.34
D . rapae	15535	87.92	10290	64.38	25825	76.68
E . plagiator	433	2.45	973	6.08	1406	4.17
P . necans	713	4.04	2482	15.50	3195	9.49
Ttioxys sp.	130	0.74	765	4.78	895	2.66
Total	17670	-	16008	-	33678	-
2-Secondary parasitoids:	-	5.99	-	34.44	-	22.07
A . australiae	234	20.80	5143	61.15	5377	58.69
D . carpenteri	741	65.87	2481	29.50	3222	35.19
Chalcids sp.	86	7.64	623	7.41	709	7.36
Aphidencyrtus sp.	64	5.69	163	1.94	227	2.40
Total	1125	11.80	8410	88.20	9535	-
Grand total	18795	-	24390	-	43213	-

Concerning the secondary parasitoid species, the highest percentage of hyperparasitism (65.87%) was recorded for *D. carpenteri* followed by *A. australiae* (20.80%), *Chalcids* sp. (7.64%) and *Aphidencertus* sp. (5.69%) during 2011 season. Meanwhile, in 2012 season the highest percentages of hyperparasitism were 61.15, 29.50, 7.41 and 1.94% for *A. australiae, D. carpenteri, Chalcids* sp. and *Aphidencyrtus* sp. respectively. On the other hand, the highest percentage (34.44%) of the total parasitoids was observed in 2012 season and it was relatively higher than that of 2011 season (5.99%). Al-Dobi *et al.*, (1999) stated that the secondary parasitoid, *Dendrocerus* sp. was the most abundant species on cereal aphid primary parasitoids in wheat fields.

2-Population of cereal aphids and the associated parasitoids by using sweep-net method:

Wheat plants in Upper Egypt were susceptible to damaging infestations mainly by three cereal aphid species, *S. graminum, R. padi* and *R. maids*. Seasonal occurrence periods of different species were recorded as follows; from the beginning of January to the end of March for *R. padi* and *S. graminum* and from the 1st wk of January to the 1st wk of March for *R. maids*. The fourth and fifth species, *S. avenae* and, *Metopolophium dirhodum* (Walker) which occurs late in the season were found in very low numbers during course of this study. Available literatures in Egypt confirmed that most of the surveyed cereal aphid species were, *R. maidis, R. padi, S. graminum and S. avenae* as recorded by El-Hariry, 1979; Abou-Elhagag and Abdel-Hafez, 1998; El-Serafy, 1999; Ali and Abdel-Rahman, 2000; Ali *et al.*, 2001; Abdel-Rahman, 2005; Mahmoud, 2005 and Salem, 2007. In addition, El-Fatih, 2000; Salem, 2007 and Salem and Mahmoud, 2012, they recorded *M. dirhodum* on wheat plants at Giza, Beni-Suef and Assiut regions.

A-Dominance and abundance degrees of cereal aphids and associated primary and secondary parasitoid species:

* Cereal aphid species:

Data in Table (2) show that, *R. padi* and *S.gramimim* seems to be the most important economic cereal aphids as indicated by the highest value of dominance (88.91 and 90.73%) as well as abundance degrees (100%) in 2011 and 2012, respectively, followed by *R.maidis* which had low dominance (3.77 & 2.48%) and abundance (69.23 & 76.92%) during 2011 and 2012 season respectively. Similar results were reported by Ali and Abdel-Rahman (2000) reported that *R. padi* and *S. graminum* were the most important economic pests by the highest value of dominance and abundance degrees followed by *R. maidis*. Salem (2007) reported that *S. graminum* was the most abundant cereal aphids species followed by *R. padi* .The corn leaf aphid was less abundant.

*Primary parasitoid species:

Data in Table (2) show that *D. rapae* seems to be the most important primary parasitoid species as indicated by the highest values of dominance (48.43 & 47.15%) and abundance

(100.00%) during 2011 and 2012 seasons, respectively. However, the high abundance degrees (100.00%) of the parasitoid *A. colemani* and *P. necans* indicate that these species could be of economic importance if the environmental conditions charged in their favor. Meanwhile, the primary parasitoid species which had low values of dominance and abundance were *A. matricaiae, E. plagiator* and *Trioxys* sp. represented (12.12 & 19.99%), (11.90 & 9.23%) and (3.42 & 3.53%) for the dominance degrees and (61.54 & 69.23%), (46.15 & 69.23%) and (30.77 & 53.85%) for the abundance degrees during 2011 and 2012 seasons, respectively. Salem and Mohmoud (2012) reported that *D. rapae* was considered the most dominate and abundance primary parasitoid species and may play an important role in controlling the cereal aphids in wheat fields.

*Secondary parasitoid species:

Data in the same Table (2) show that highest percentage of the secondary parasitoid species (34.00%) was recorded to *D. carpenteri* in the first season, while it was (47.43%) to *A. australiae* during the second season. Lowest dominance degrees were recoded to *Chalcids* sp. (19.95 & 16.42%) and *Aphidencyrtus* sp. (13.24 & 1.99%) during 2011 and 2012 seasons, respectively. Salem (2007) reported that *Alloxysta* sp. was the most common and abundant species among the secondary parasitoid species collected.

Table 2: Dominance and abundance degrees of cereal aphids and their parasitoid species collected by sweep-net technique inhabiting wheat plants, Assiut, 2011 and 2012 seasons

Species	Dominance (%)		Abundance (%)	
	2011	2012	2011	2012
1-Pests:	25.89	26.83	-	-
R. maidis.	3.77	2.48	69.23	76.92
R. padi.	55.55	54.41	100.00	100.00
S. graminum.	40.68	43.11	100.00	100.00
2-Parasitoids:				
A-Primaryparasitoids:	53.12	40.80	-	-
A. colimani	15.57	12.97	100.00	100.00
A . matricariae	12.12	19.99	61.54	69.23
D . rapae	48.43	47.15	100.00	100.00
E . plagiator	11.90	9.23	46.15	69.23
P . necans	8.55	7.11	100.00	92.31
Ttioxys sp.	3.42	3.53	30.77	53.85
B-Secondary parasitoids:	20.99	32.37	-	-
A . australiae.	26.54	47.93	69.23	76.92
D . carpenteri.	34.00	33.65	69.23	69.23
Chalcids sp.	19.95	16.42	53.85	46.15
Aphidencyrtus sp.	13.24	1.99	46.15	30.77

B-Population of cereal aphids and the associated primary parasitoid, *D. rapae*:

Data in Table (3) show that, in 2011 season, *S. graminum* was appeared on the plants during the 1st wk of January (6.8 aphids/25 net strokes). The greenbug showed its peak of activity during the 4th wk of January (230.2 aphids/25 net strokes). In spit of the bird cherry-oat aphid

was first observed in the field in the 1st wk of January (1.2 aphids/25 net strokes) and reached its peak (368.0 aphids/25 net strokes) during the 1st wk of March. As regards, *R. maidis* was recovered in wheat plant during the 1st wk of January (3.2 aphids/25 net strokes) and continued on wheat plant until the 1st wk of March given the population peak during the 4th wk of January (25.4 aphids/25 net strokes). On the other side, in 2012 season, the greenbug population followed nearly the same trend of the first season. Its population increased from 3.4 aphids/25 net strokes in the 1st wk of January to reach a peak of 318.6 aphids/25 net strokes during the 1st wk of March. Concerning the aphid, *R. padi* was recorded two weeks later than *S. graminum* (1.2 aphid/25 net strokes) and reached its peak during the 1st wk of March (410.2 aphids/25 net strokes). On the other hand, *R. maidis* was noticed during the 1st wk of January (5.2 aphids/25 net strokes) and reached a peak (16.2 aphids/25 net strokes) during the 4th wk of January and decline from the wheat fields during the 3rd wk of March. On the other side, the main peak of total aphid species was recorded during the 1st wk of March (529.0 and 729.0/25 net strokes) during 2011 and 2012 seasons, respectively. Generally, cereal aphids were encountered on wheat plants during the 1st wk of January and left wheat plants on the end of March throughout the study period. El-Heneidy *et al.*, (2003) reported that the active period of cereal aphids in wheat fields in Egypt usually starts from the late tillering growth stage (during January) and continued through the stem elongation, booting, heading and ends during the ripening stage (during April).

Table 3: Population densities of cereal aphid species and associated parasitoid species collected by sweep-net inhabiting wheat plants, Assiut, 2011 and 2012 seasons

Date	Av. No. individuals/ 25 sweeps					Date	Av. No. individuals/25 sweeps				
	2011 season				*D. rapae*		2011 season				*D. rapae*
	Cereal aphids						Cereal aphids				
	SG	RP	RM	Total			SG	RP	RM	Total	
Jan. 5	6.8	1.2	3.2	11.2	3.6	Jan. 3	3.4	0.0	5.2	8.6	2.2
12	28.2	3.8	8.8	40.8	5.2	10	19.4	0.0	3.6	23.0	11.4
19	23.4	15.4	17.6	56.4	10.8	17	11.8	1.2	12.8	25.8	8.2
26	35.8	7.8	25.4	69.0	6.2	24	25.2	5.4	16.2	46.8	10.4
Feb. 2	26.2	18.0	7.2	51.4	13.0	Feb. 1	33.6	12.8	4.2	50.6	39.2
9	68.0	35.4	7.4	110.8	35.2	8	79.2	43.6	9.8	132.6	102.2
16	116.4	72.8	3.2	192.4	163.2	15	98.8	196.4	4.2	299.4	81.6
23	230.2	248.2	1.2	479.6	193.6	22	216.2	245.0	0.4	461.6	146.2
Mar. 2	160.8	368.0	0.2	529.0	252.2	Mar. 1	318.6	410.2	0.2	729.0	134.8
9	78.0	217.2	0.0	295.2	408.0	8	138.0	217.2	0.1	355.3	335.6
16	21.2	79.4	0.0	100.6	294.6	15	37.8	93.0	0.0	130.8	118.2
23	4.6	22.6	0.0	27.2	111.2	22	2.2	12.4	0.0	14.6	49.6
30	0.2	2.2	0.0	2.4	66.4	29	1.2	6.6	0.0	7.8	19.2
Total	799.8	1092	74.2	1966.0	1563.2	Total	985.4	1243.8	56.6	2285.9	1058.8
Mean	61.52	84.0	5.71	151.2	120.25	Mean	75.8	95.62	4.04	175.8	81.45

***S. graminum** ** R. padi** ***R. maidis**

Concerning the primary parasitoid, *D. rapae* (Table 3) was more common throughout the season. In 2011 season, two peaks of *D. rapae* were observed, the first peak recorded at the 3rd wk of January (10.8 parasitoids/25 net strokes) and the second which was higher than the former, was observed in the 2nd wk of March (408.0 parasitoids/25 net strokes) coincided with the peak decline of the aphid populations. Similar results was recorded in 2012 season except for the first peak was recorded during the 2nd wk of February (102.0 parasitoids/25 net strokes). Generally, *D. rapae* was appeared on wheat plants during the 1st wk of January and increased gradually until reached the maximum peak during the 2nd wk of March throughout the two seasons coincided with aphid populations decline. Alichi *et al*. (2008) found that peak populations of the aphid parasitoids occurred after the peak of aphid populations by 1-3 weeks. Cai *et al.* (2009) stated that the density peak of parasitoid populations was 9-12 days behind the density peak of the aphid populations. On the other side, El-Heneidy (1994) found that highest population of the primary parasitoids was counted during February and March synchronizes the peak population of cereal aphids on wheat plants

Finally, the present work and the aforementioned literatures indicated that wheat fields are rich with aphid parasitoid species which of course play a significant role in suppressing aphid infestation. Thus, spraying insecticides particularly early in wheat growing season should be avoided to conserve parasitoids that are more efficient when aphid populations are low.

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الطفيليات من رتبة غشائية الأجنحة المصاحبة لحشرات من النجيليات فى حقول القمح فى أسيوط

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أجريت هذه الدراسة بمحافظة أسيوط (مركز أسيوط) بجوار جامعة الأزهر بأسيوط خلال موسمى ٢٠١١م ، ٢٠١٢م لدراسة العلاقة بين الطفيليات وحشرات من النجيليات التى تصيب القمح.

أظهرت نتائج الدراسة أنه من بين ٤٨٠٠٠ مومياء جمعت من على نباتات القمح خلال موسمى الدراسة, كانت نسبة الخروج للطفيليات الكاملة ٨٩,٦٩% من المجموع الكلى للمومياوات المجموعة من الحقل. تم تعريف ١٠ أنواع من الطفيليات التابعة لرتبة غشائية الأجنحة قسمت إلى مجموعتين رئيسيتين:

* **المجموعة الأولى تضم الطفيليات الأولية، وهى:**

-***Aphidius colemani*** **Vereck.**	-***A. matricariae*** **Haliday,**	-***Diaeretiella rapae*** **(McIntosh).**
-***Ephedrus plagiator*** **(Ness).**	-***Praon necans*** **Mackauer**	-***Trioxys*** **sp.**

* **المجموعة الثانية فتضم الطفيليات الثانوية، هى:**

−***Alloxysta australiae*** **(Ashmead).**	- ***Dendrocerus carpenteri*** **(Curtis).**
- ***Chalcids*** **sp.**	- ***Aphidencyrtus*** **sp.**

كما وجد أيضا أن الطفيل *Diaeretiella rapae* (McIntosh) هو أهم أنواع الطفيليات التى تهاجم حشرات من النجيليات من حيث درجة السيادة والوفرة العددية حيث كون (٦٤,٣٥%، ٨٧,٩٩%) من المجموع الكلى للطفيليات الأولية خلال موسمى ٢٠١١م، ٢٠١٢م ، على التوالى.

بينت الدراسة أن نباتات القمح يتواجد عليها خمسة أنواع من حشرات من النجيليات هى: من النجيليات *Schisaphis Graminum* (Rondani)، من الشوفان *Rhopalosiphum padi* L. ، من أوراق الذرة *R. maidis* (Fitch.) من الغلال الإنجليزى *Sitobion avenae* (Fab.) ، وأخيراً من الحبوب القرمزى *Metopolophium dirhodum* (Walker) ، وقد وجد أن حشرات من الشوفان ومن النجيليات هي أهم الأنواع التي تصيب نباتات القمح من حيث درجة السيادة والوفرة العددية حيث كونت (٥٥,٥٥%، ٥٤,٤١%)، (٤٣,١١%، ٤٠,٦٨%) من المجموع الكلى لحشرات المن خلال موسمى الدراسة على الترتيب.

كذلك وجد أن أعلى تعداد لحشرات المن تم تسجيله فى الأسبوع الأول من شهر مارس (٥٢٩، ٧٢٩) فى حين وصل الطفيل، *Diaeretiella rapae* إلى أقصى تعداد له فى الأسبوع الثانى من مارس (٣٣٥,٦، ٤٠٨) خلال موسمي الدراسة متزامناً مع تناقص أعداد حشرات المن من على نباتات القمح ثم يقل تدريجياً حتى يختفى كل من حشرات المن والطفيل من حقول القمح فى نهاية شهر مارس تقريباً.

من خلال هذه الدراسة يمكن القول بأن حقول القمح غنية بأعداد كثيرة من أنواع الطفيليات، والتى بالطبع يمكن أن يكون لها دوراً معنوياً كبيراً فى خفض الإصابة بحشرات المن فى هذه الحقول.