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THE ROLE OF PARASITOIDS IN CONTROLLING SAN JOSE SCALE, *Qudaraspidiotus perniciosus* (Comstock) (HEMIPTERA: DIASPIDIDAE) POPULATIONS AS A NEW INTRODUCED PEST TO Egypt.

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ABSTRACT

The experiments were conducted in a plum (*Prunus salicina* (Lind) orchard located at the Experimental Research Station of the Faculty of Agriculture, Mansoura University during 2001/2002 and 2002/2003 seasons. The diaspidid, *Quadraspidiotus perniciosus* (Comstock) was recorded for the first time in Egypt. Two aphelinid parasitoids were founded associated with the pest populations nemaly, *Aphytis diaspidis* DeBach and *Encarsia citrina* Craw. during both years of study. The ectoparasitoid, *A. diaspidis* was the most dominant parasitoid and represented the majority of the total numbers of emerging parasitoids.

The total numbers of *A. diaspidis* immature stages showed three peaks during the 1st week of May, 3rd week of October and 2nd week of December, 2001. While, four slight peaks of seasonal abundance were recorded in the second year occurred at the 4th week of March, 1st week of September (2002), 1st week of January, and 1st week of March (2003).

The average percentages of mortality caused by parasitoids throughout the whole year represented by 17.05 and 18.19 %, while mortality caused by predators represented by 9.45 and 12.91 % and unknown mortality represented by 9.398 and 5.38 % during the first and second year, respectively.

INTRODUCTION

Armored scale insects (Hemiptera: Diaspididae) are one of the most important groups of agriculture pests. Many species are highly destructive to fruit trees and ornamental plants (Rosen, 1986). The San Jose scale (SJS), *Ouadraspiditous perniciosus* (Comstock) one of the most dangerous diaspidid pests in European and several countries of the world (Kozàr *et al.*, 1982; Alexsidze, 1996; and Jahn & Polesny, (2002). The SJS attacks at least 34 families of hosts (over 700 species), and it has become a cosmopolitan pest in deciduous fruit and nut orchards (Gentile and Summers, 1958; Kyparissoudas, 1990). It sucks plant cell contents and injects a toxin, resulting in loss of tree vigour and productivity at low infestation levels (Zalom *et al.*, 2001). At high densities, infestation may kill limbs or even entire trees within 1-3 years (Gulmahamed and DeBach, 1978).

It is thought to be native to northern China, eastern Siberia and North Korea (Rosen and DeBach, 1978). According to Kozar (1990), its native land the Far East, it has been introduced all over the world in the last 100 years.

Many of our most serious insect pest are species that have been accidentally introduced from another area of the world. These pests often arrive without natural enemies that may have important regulatory affects in the homeland. The invading species often increases rapidly to injurious population densities on its new host and courses widespread destruction to previously healthy stands (McClure, 1983). Parasitoids as specific natural enemies, including Aphelinidae is able to remarkably reduce population levels of scale insects. Pathogens and predators are rather non-specific and often depend on high prey densities (Rosen, 1990).

So, the present work is aimed to study the relation between the parasitoid and the host populations in addition to evaluate the seasonal abundance and activity of the parasitoids. Also, assessment the quantitave changes in diaspidid population.

MATERIALS AND METHODS

Sampling technique:-

Five adjacent plum trees homogenous in age and size infested with San Jose scales located at the experimental farm of the Faculty of Agriculture, Mansoura University were selected and marked for the present study. Samples were collected biweekly during the two successive seasons 2001/2002 and 2002/2003. Each sample consisted of 25 infested twigs (5 twigs / tree) collected from different sides (north, south, east, west and middle) of the tree. The collected twigs (each twig, 20 cm in length) were cut and taken to the laboratory in polyethylene bags for investigation.

The collected twigs of each tree were investigated by using a binocular microscope. Scales were recorded as living, dead (unknown mortality), predator- damaged and parasitized with living parasitoids (immature stages) or emerged holes.

The number of parasitoids (immature stages) were counted and recorded. To determine the parasitoid species, each samples was maintained in Petri dishes (10 cm in diameter), containing a piece of moisture cotton wool. The emerged parasitoids were collected and identified.

Estimate the role of the different mortality factors:-

The percentages of parasitism (Par. %), predation (Pre. %) and unknown mortality (UM %) were calculated according the formulation modified from the formulation of **Orphanides (1982)**:-

$$\text{Par. or Pre. or UM \%} = \frac{\text{Par. or Pre. or UM}}{L + D} \times 100$$

Where Par., Pre. and UM are the number of parasitized, predeceased and unknown dead scales, respectively. While, L and D are the number of living and all dead scales, respectively.

RESULTS

1. Survey:-

San Jose scale (SJS), *Quadraspidiotus perniciosus* (Comstock) was observed and recorded during the course of study as first record in Egypt (Mansoura district), Dakhlia Governorate on plum trees. Two aphelinid parasitoids, namely, *Encarsia citrina* Craw. and *Aphytis diaspidis* DeBach were associated with *Q. perniciosus* population on the infested plum trees during both years of study. The endoparasitoids, *E. citrina* prefers parasitizing on the second instar female and third instar male. It occurred in relatively few numbers especially during the 2nd year of study. The numbers and ratios were 37 (= 28.68 %) and 14 individuals (= 8.69 %). While, the total numbers and ratios of *A. diaspidis* were 92 (= 71.32 %) and 147 individuals (= 91.3 %) for the first and second year (Table, 1).

Table (1): Relationship between the *Q. perniciosus* (SJS) and the parasitoid (*E. citrina* and *A. diaspidis*) populations and parasitism percentages during season 2001/2002 at Mansoura district.

Sampling dates	No. of host / sample	No. of *E. citrina* / sample	No. of *A. diaspidis* / sample	Parasitism %
25/3/2001	13	0	3	23.08
8/4	18	0	5	27.78
22/4	60	0	0	0
6/5	115	0	8	6.96
19/5	101	0	4	3.96
2/6	89	0	2	2.25
15/6	5	1	2	60
29/6	126	2	3	3.97
13/7	124	2	3	4.03
27/7	127	5	4	7.09
10/8	11	6	3	81.82
24/8	88	1	3	4.55
6/9	42	0	0	0
20/9	47	8	1	19.15
4/10	45	5	5	22.222
18/10	74	4	14	24.32
1/11	37	2	2	10.81
15/11	52	1	4	9.82
29/11	10	0	0	0
10/12	20	0	9	45
24/12	7	0	11	14.29
8/1/2002	22	0	3	13.64
23/1	34	0	4	11.76
18/2	31	0	5	16.13

2. Seasonal abundance of SJS and its parasitoids:-

As shown in Tables (1 , 2), the diaspidid scale, *Q. peniciosus* recorded in three periods of seasonal abundance during Spring (ranged between 13-115), Summer (ranged between 5-127) and Autumn (ranged between10-74 individuals/sample) in the first year (Table 1). While in the second year (Table 2), four periods of abundance were recorded during spring, summer, autumn and winter seasons ranged between (28-274, 10-189, 5-104 and 11-91/ individual/ sample, respectively). The highest occurrence was observed during late July and April in the first and second years of study.

Table (2): Relationship between the *Q. perniciosus* (SJS) and the parasitoid (*E. citrina* and *A. diaspidis*) populations and parasitism percentages during season 2002/2003 at Mansoura district.

Sampling dates	No. of host / sample	No. of *E. citrina* / sample	No. of *A. diaspidis* / sample	Parasitism %
16/3/2002	28	1	4	17.86
30/3	160	0	20	12.5
13/4	274	0	5	1.82
26/4	135	0	7	5.19
9/5	57	0	1	1.75
23/5	176	1	1	1.14
7/6	180	0	2	1.11
21/6	16	0	0	0
5/7	10	4	1	50
19/7	87	0	1	1.15
3/8	44	0	5	11.36
17/8	63	0	5	7.94
1/9	104	0	9	8.65
15/9	65	0	5	7.69
29/9	25	1	1	8
12/10	32	2	3	15.63
26/10	23	0	1	4.35
9/11	5	0	1	20
23/11	59	0	3	5.08
7/12	21	0	9	42.86
21/12	18	2	12	77.78
4/1/2003	91	2	17	20.88
18/1	46	0	9	19.57
15/2	11	0	6	54.55

In respect to, the endoparasitoid *E. citrina*, it was recorded with very few numbers during both years of study, especially in the second year. The parasitoid was rarely observed with very few numbers during the first year (ranged between 0 - 8 individuals) and ranged between (0 - 4 individuals /

Sample) during the second year and no parasitoid was observed during spring and winter seasons (Table 1, 2).

Generally, changes in the host population density not coincide with the changes of parasitoid seasonal abundance. Therefore, the relationship between the host population and parasitoid activity was weak in the first and second year.

With respect to the ectoparasitoid *A. diaspidis*, it could be noticed that in the first year, the total numbers of *A. diaspidis* immature stages showed three peaks during the 1st week of May, 3rd week of October and 2nd week of December, 2001, respectively (Table 1). The highest numbers occurred during October, represented by 14 individuals/ 25 twigs. Four slight peaks of seasonal abundance were recorded in the second year (Table 2). The first (20 individuals), second (9 individuals), third (17 individuals) and the fourth peak (49 individuals / 25 twigs) occurred at the 4th week of March, 1st week of September (2002), 1st week of January, and 1st week of March (2003), respectively (Table 1).

3. Efficiency of the different mortality factors on SJS populations:-

The efficiency of the mortality factors (parasitoids, predators and unknown mortality factors) on *Q. perniciosus* populations were summarized as shown in Table (3).

Table (3): Efficiency of the mortality factors (parasitoids, predators and unknown factors) affecting *Q. perniciosus* populations during 2001/2002 (A) and 2002/2003 (B) seasons.

Mortality factors / Seasons	Unknown mortality %	Predation %	Parasitism %	Total mortality %
Spring				
(A)	16.55	2.85	12.36	31.76
(B)	4.68	13.38	9.73	27.07
Summer				
(A)	10.08	10.05	23.38	43.51
(B)	6.24	13.67	10.39	31.84
Autumn				
(A)	4.35	4.59	12.3	21.2
(B)	5.4	14.1	9.91	27.31
Winter				
(A)	6.61	20.29	20.16	44.58
(B)	5.14	10.48	42.74	46.95
Mean (All over the year)				
(A)	9.40	9.45	17.05	35.89
(B)	5.38	12.91	18.19	36.47

It could be concluded that, parasitoids recorded the highest activity during Summer and Winter in the first and second year of study. The average percentages of mortality caused by parasitoids throughout the whole year represented by 17.05 and 18.19 % during the first and second year. The role of predators in population regulations of *Q. perniciosus* was relatively weak

and came in the second class. The highest activity of predation was recorded during winter in both years of study. The average percentages of mortality caused by predators all over the year represented by 9.45 and 12.91 % during the first and second year. In respect to unknown mortality factors, it contributed with the low percentages of the average mortality during both years of study (9.40 and 5.38 %).

DISCUSSION

The San Jose scale, *Q. perniciosus* was found on plum trees at Mansoura district, Dakhlia Governorate as first record in Egypt. It recorded 3-4 periods of seasonal abundance during both years of study. Similar results were recorded by Navrozidis *et al.* (1996). The highest abundance was recorded during July and April in the first and second years of study. Also, studies carried out on the SJS biology in Central Macedonia (Paloukis, 1984; Katsoyanndas and Argyriou, 1985), have shown that during mid June to July there are high populations of mature scales.

In the present study, *A. diaspidis* was the most common parasitoid on *Q. perniciosus* and represented the majority of the total number of emerging parasitoids at Mansoura district. Similar results were recorded in Georgian (USSR) by Popva (1976), in California (Gulmahamed and DeBach, 1978) and in Chile Gonzalez (1982). It recorded 3-4 peaks of seasonal abundance during both years. These results approximately are come in the same line of Jahn and Polesny (2002).

The parasitoids, *A. diaspidis* and *E. citrina* were exhibited low efficiency on *Q. Perniciosus* populations. In addition the synchronization between the host and both parasitoids was obviously weak during the period of study. According to Abdel- Kareim and Kozar (1987), *Epidiaspis leprii* Sign. which introduced to Hungary and there was no effective parasitoid or predator. The synchronization of the parasitoid with the host population is pad. The native scale insect species have effective specialized parasites with good synchronization, therefore, the role of insect parasitoids was very low and the synchronization between the parasitoid and host population was not good. Also, the armored scale *Fiorina externa* Ferris and *Tsugaspidiotus tsugae* (Marlatt) (Hemiptera: Diaspididae) of hemlock are a good example. Clearly, *E. citrina* plays a major role in the regulation of native population of both scales in Japan. Even though *E. citrina* is already well established in the northeastern United States, *F. externa* populations increase to such high densities that frequently injure and kill their new hosts, yet is ineffective in regulation exotic populations of these same scales (McClure, 1978, 1985 and 1988). The author hypothesize that these differences are due to a lack of synchrony in the life cycles of parasitoid and host in the United States.

Generally, it can be concluded that, there was no specific and effective parasitoid for *Q. perniciosus* which introduced to Egypt for the first time. So, many studies must be carried out in the future on the relationship between the insect and parasitoid populations, mass rearing and release techniques to improvement efficiency of above parasitoids under field conditions.

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دور الطفيليات فى تنظيم تعدادت حشرة سان جوزية القشرية (رتبة نصفية الأجنحة: دياسبيديدى) *Quadraspidiotus perniciosus* (Comstock) كافة دخيلة جديدة إلى مصر.

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أجريت الدراسة على أشجار البرقوق الموجودة في المزرعة البحثية الخاصة بكلية الزراعة- جامعة المنصورة خلال موسمي الدراسة ٢٠٠١/٢٠٠٢ و ٢٠٠٢/٢٠٠٣. تم تسجيل حشرة سان جوزيه القشرية *Quadraspidiotus perniciosus* (Comstock) لأول مرة في مصر. كما وجد اثنين من طفيليات عائلة افليينيدى مرتبطة بتعداد هذه الحشرة هي *Aphytis diaspidis* DeBach و *Encarsia citrina* (Craw.) خلال موسمي الدراسة. ولوحظ ان طفيل الـ *A. diaspidis* كان أكثر الطفيليات تواجدا على تعداد الحشرة وكان تعداده يمثل الغالبية العظمى من مجموع الطفيليات الخارجة خلال موسمي الدراسة. ويتضح من النتائج المتحصل عليها ان الطفيل الداخلى *E. citrina* سجل باعداد قليلة جدا خلال موسمين الدراسة بينما سجلت الاطوار غير الكاملة لطفيل *A. diaspidis* ثلاث ذروات خلال الاسبوع الاول من مايو والثالث من اكتوبر والثانى من ديسمبر لعام 2001. بينما سجلت اربع ذروات فى السنة الثانية خلال الاسبوع الرابع من مارس والاول من سبتمبر لعام ٢٠٠٢ والاسبوع الاول من يناير والاول من مارس ٢٠٠٣.

ويتضح من النتائج المتحصل عليها ان متوسط نسب الموت التى تحدث بواسطة الطفيليات خلال السنه كلها كانت ١٧,٠٥ و ١٨,١٩ % بينما التى تحدث بواسطة المفترسات كانت ٩,٤٥ و ١٢,٩١ % بينما تلك التى تحدث بواسطة عوامل الموت الغير معروفة كانت ٩,٤٠ و ٥,٣٨ % خلال السنة الاولى والثانية على التوالى.