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Ecological and Biological Studies on the Citrus Flower Moth *Prays citri* (Millière) (Lepidoptera: Hyponomeutidae) in Qalyubia Governorate, Egypt

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ABSTRACT

The investigation was carried out during two years in citrus orchards in Qalyubia Governorate 2015 – 2016, to study ecological and biological aspects of the Citrus Flower Moth *Prays citri* (Millière) (Lepidoptera: Hyponomeutidae). Data illustrated from ecological and biological points of view. Ranjpure lime (*Citrus auranifolia*) was the most preferred variety (highly susceptible) of infested by *P. citri.* While lemon (Citrus *limon*) which is considered as "moderately susceptible" exhibit less preferable to *P. citri*, but not seen any infested flowers in navel orange (Citrus *sinensis*) was the lowest preferred variety, throughout the investigation 2015 – 2016. One peak of infestation of *P. citri* in spring under weather conditions of Qalyubia Governorate. Predatory potential of *Chrysoperla carnea* (Steph) larvae on citrus flower moth *P. citri* larvae, under laboratory conditions was highly significant in mean consumption rate of 2nd and 3rd instars The total consumption by the third instar of *C. carnea* was significantly than the second instar . Biological results indicated that Female laid eggs both individually 54.6 eggs in average per female, Incubation period lasted 1.07 days, hatchability was 67.7 % in average, Larval and pupal stage period was 6.37 and 5.33 days respectively, female and male longevity lasted 4.3 and 3.6 days respectively. Life cycle 12.77 days while Generation lasted 13.79 days under 29.4°C and 62.7 % RH.

INTRODUCTION

Citrus is considered as the major Fruit crops in Egypt, due to cultivated area reached to 204095 Hectare representing about 29% of the total Fruit area 700854 ha (Waleed 2018). The citrus flower moth *Prays citri* Millière (Lepidoptera: Hyponomeutidae) is an important pest found on citrus in the Mediterranean region. Its attack of *Citrus limon* (lemon) is of particular economic importance, because it may result in up to 90% loss in flower production in Spain, (Garrido *et al*., 1984). *P. citri* is considered an economically important pest in Egypt on lime tree (Ibrahim and Shahateh, 1984).The population density of *P. citri* was highest on lime trees in comparison with navel orange and mandarin trees. (Abd El-Kareim, *et al* 2017 and Abo-Sheaesha 1994). The incubation period of *P. citri* ranged between 2–9 days also life cycle of *P. citri* lasted a period from 12 to 51 days according to the time of year. (Abo-Sheaesha 1994). On the other hand, there are many researchers studied the biology, ecology, control and other topics of *P. citri*, such as; Buchelos *et al.* (1963); Perez-Ibanez *et al.* (1973). Shehata (1982); Atria *et al.* (1992); El-Sayed *et al.* (1994); Sinacori and Mineo (1997); Shehata and Feeby (1998); Carimi *et al.* (2000); Abo-Sheaesha and Agamy (2004) and Conti & Fisicaro (2015).

The present study aimed to provide citrus producers and other interesting people with the required information, concerned with the biology, features of infestation, ecological tendency, this research was focused on studying the main following items:

1 – Studying the population fluctuation of *P. citri* under field conditions for different citrus hosts and the natural enemies associated with this pest.

2 – Studying some of biological aspects of *P. citri* under laboratory conditions.

MATERIALS AND METHODS

1. Experimental area:

Experiments were conducted in citrus orchards at the farm of Faculty Agriculture at Moshtohor Tookh district, Qalubya Governorate in two successive seasons 2015 – 2016

2. Ecological studies:

The investigation was carried out during two years in citrus orchards including different species, and cultivars of citrus trees, which are dominant in the farm of Faculty Agriculture at Moshtohor Tookh district. 100 newly flowers were, randomly picked up, weekly from five trees of each tested citrus varieties. They were about three varieties, namely Ranjpure lime (*Citrus auranifolia*), lemon (*Citrus limon*) and navel orange (*Citrus sinensis*) Samples were collected, individually each in a plastic sac, which was, carefully labeled and tightened with a rubber band, and then was transported to the laboratory, where it was examined and both larvae and pupae were counted, with the aid of a binocular microscope. The infestation rate, was calculated according to the following formula:

$$\text{Infestation rate} = \frac{\text{No. of infested flowers}}{\text{Total number of flowers/sample}} \times 100$$

3- Predatory potential of *Chrysoperla carnea* larvae on citrus flower moth *Prays citri* larvae, under laboratory conditions:

This experiment was conducted in the laboratory to find out the predatory potential of *Chrysoperla carnea* (Steph) on citrus flower moth *Prays citri* larvae, under laboratory conditions. The 2nd larvae instars of *C. carnea* were provided with a counted number of 2nd and 3rd larvae instars of *P. citri* inside a Plastic container dimensions 6.5 × 3.5 cm the upper opening was covered by muslin tissue, for feeding *C. carnea*. The predatory potential of *C.* carnea was recorded by counting the number of consumed *P. citri* larvae fed by larvae of *C. carnea* daily inspection continued till the insect pupated under laboratory conditions.

4 - Biological studies:

Studies were carried out in the laboratory of Plant Protection Research Institute, Agricultural Research Center. Newly, flowers of host plant Ranjpure lime contained 2 – 4 of free flowers from injury were put in the small glass bottle which contain water to nourish the flower buds for oviposition daily . They were, individually, put in glass cages, having an upper opening. The citrus flower moth *Prays citri* adult moths of both sexes were obtained by using infested flowers containing larvae and pupae, which were put on the bottom of a glass chimney. The upper opening of the latter was covered by muslin tissue, and fixed around with glue, to allow respiration of the adult moths. The emerged moths were left in the glass chimney, under the room temperature for male-female copulation, and they were fed by a sugar-saturated piece of

sponge, which was put on the surface of the muslin cover of the glass chimney. A glass vacuum tube was used for picking up moths to be transported to each glass cages.

The small glass bottle which contained 2– 4 of free flowers from injury of Ranjpure lime flowers with one female were , daily examined using either a binocular microscope under a glass chimney . The daily numbers, of the laid eggs, the incubation period, the number of succeeded larvae, and the numbers of resulting pupae were, carefully, recorded. All of the different stages were, permanently, mounted for morphological examination. Also, periods of various stages of The citrus flower moth *P. citri*, life cycle, pre-oviposition, oviposition, and post-oviposition and consequently generation period were estimated.

Data was analyses by using ANOVA in SAS (SAS Institute 1998).

RESULTS AND DISCUSSION

1. Ecological results:

Season 2015:

Data illustrated in Table (1) and Fig. (1) showed the varieties, were tested for their susceptibility to such dangerous insect pest , They were Ranjpure lime, lemon and navel orange during the year 2015 from the period of 10 March to 19 May , which or presented in the following . Infestation rate reached about nil or very low levels during winter and early spring for such varieties .The first attacks for hosts flowers occur in the first 4th week of March with low population level . The Population level was high during the second week to third week of May. During this period, Ranjpure lime was the most preferred variety (highly susceptible) of infested by *P. citri* throughout of investigation with general average of infestation and larvae was (17.81 and 19.9) respectively , while lemon which is considered as "moderately susceptible" exhibit less preferable by *P. citri* with general average of infestation rate and larvae was (10.63 and 11.54) respectively , but not seen any infested flowers in navel orange was the lowest preferred variety.

Table 1. Total numbers of larval stage, and rate of infestation/sample by *Prays citri,* during 2015 in Qalyubia Governorate.

Hosts	Ranjpure lime		lemon		navel orange	
Date	Larvae	Infestation rate	Larvae	Infestation rate	Larvae	Infestation rate
10-Mar.	0	0	0	0	0	0
17-Mar.	0	0	0	0	0	0
24-Mar.	1	1	0	0	0	0
31-Mar.	5	4	3	3	0	0
7-Ap.	9	9	8	8	0	0
14-Ap.	25	21	9	8	0	0
21-Ap.	29	27	16	14	0	0
28-Ap.	28	25	22	18	0	0
5-Ma.	34	33	24	22	0	0
12-Ma.	40	36	21	21	0	0
19-Ma.	48	40	24	23	0	0
Total	219	196	127	117	0	0
Mean	19.9	17.81	11.54	10.63	0	0
LSD 5%			6.994			

Season 2016:

According to data in Table (2) and Fig. (2), showed that, the first attacks for hosts flowers occur in the end 4th week of March with low Population level. Also Ranjpure lime was the most preferred variety (highly susceptible) of infested to *P. citri* throughout of investigation with general average of infestation rate and larvae was (17.54 and 19. 36) respectively , while lemon which is considered as " moderately susceptible" to *P. citri* with general average of infestation rate and larvae was (13. and 13.27) respectively , but not seen any infested flowers in navel orange was the lowest preferred .

In the present work, found that, in Citrus flowers samples members of the predator *C. carnea* larvae appeared to attack and feed on larvae of *P. citri*. As generally predators are considered of great importance in the field of biological control of any pest, they have special importance in managing populations of *P. citri*, only immature stages of *C. carnea* feed on the host pest, while adults feed, frequently on flowers nectar.

Table 2. Total numbers of larval stage, and rate of infestation / sample by *Prays citri*, during 2016 in Qalyubia Governorate

Hosts	Ranjpure lime		lemon		navel orange	
Date	Larvae	Infestation rate	Larvae	Infestation rate	Larvae	Infestation rate
12-Mar.	0	0	0	0	0	0
19-Mar.	0	0	0	0	0	0
26-Mar.	1	1	0	0	0	0
2-Ap.	1	1	2	2	0	0
9-Ap.	6	6	9	8	0	0
16-Ap.	13	10	11	9	0	0
23-Ap.	25	22	16	15	0	0
30-Ap.	29	28	25	22	0	0
7-Ma.	38	35	28	27	0	0
14-Ma.	50	48	30	28	0	0
21-Ma.	50	42	25	32	0	0
Total	213	193	146	143	0	0
Mean	19.36	17.54	13.27	13	0	0
LSD 5%			8.341			

According, it can be concluded that, *P. citri* could have one peak of infestation in spring under weather conditions of Qalyubia Governorate. During the winter months, *P. citri* Population decreases significantly with low temperatures, with the emergence of flowers and new shoots in spring, *P. citri* start to appear with low Population, after that it gradual increases to record high Population density in the end of the third week of May. Ranjpure lime was the most preferred variety (highly susceptible) of infested to *P. citri* while lemon was moderately susceptible , but navel orange was nil infested during two seasons 2015 – 2016 under weather conditions of Qalyubia Governorate . The major population peak appeared at the third week of May 2015 and 2016.

These results are agreement with those obtained by (Abd El-Kareim *et al* 2017), reported that the *P. citri* population greatly preferred lime over navel orange and

mandarin. *Prays citri* population showed a single peak of activity on lemon flowers at the end of main flowering period (the first half of April). Also (Ibrahim and Shahateh 1984) reported that sweet lime was the species most susceptible to *P. citri*, followed by lemon, sweet orange, mandarin and grapefruit. Garrido *et al* 1984 reported that, by using traps baited with synthetic pheromone adults were taken throughout the year, though there were two peaks, in May-July and October-November.

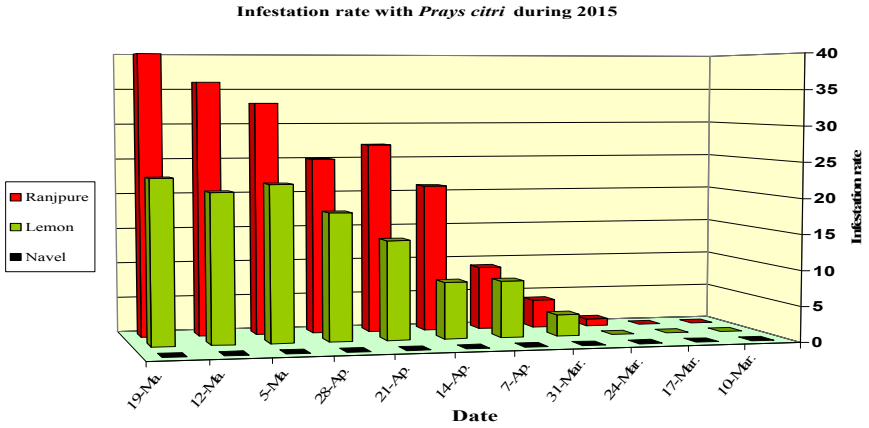

Fig. 1. Infestation rate/sample by *Prays citri*, during 2015 in Qalyubia Governorate.

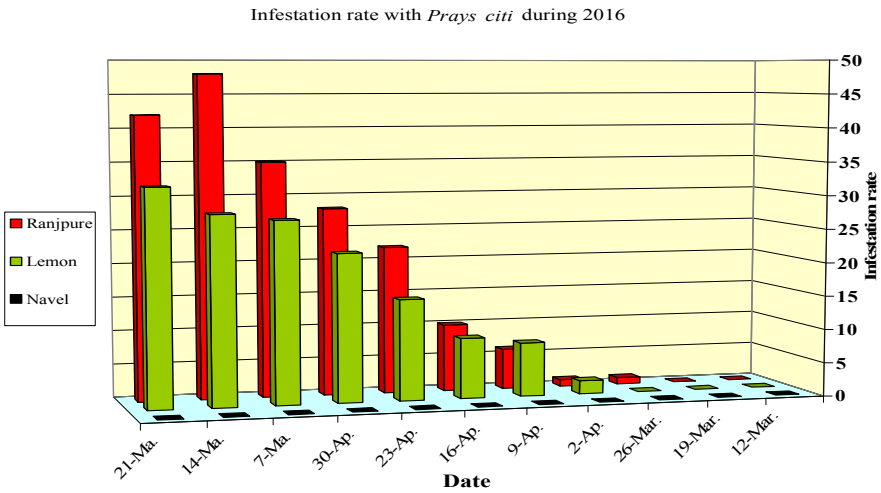

Fig. 2. Infestation rate / sample by *Prays citri*, during 2016 in Qalyubia Governorate.

Predatory potential of *Chrysoperla carnea* larvae on citrus flower moth *Prays citri* larvae, under laboratory conditions:

The consumption rates by each of the two larval instars of *C. carnea* when fed on citrus flower moth *P. citri* larvae under laboratory conditions are given in Table (3). Data illustrated exhibited a highly significant in mean consumption rate of 2nd and 3rd instars the least significant differences at 0.05 level being 0.969. By feeding on citrus flower moth *P. citri* larvae under laboratory conditions individuals, the second instar larva of *C. carnea* during three days consumed 4.2, 6 and 4.9 *P. citri* larvae / day respectively, with the total consumption of *P. citri* throughout the second instar period was 5.03 individuals.

While the third instar larva of *C. carnea* was recorded the mean consumption per day of *P. citri* individuals was 9.3, 11.9 and 14.4 *P. citri* larvae / day respectively, throughout the third instar period which was three successive days with the total consumption 11.86 *P. citri* individuals.

Statistical analysis of data revealed high significantly differences between the 2nd and 3rd instars of *C. carnea* throughout the whole period of the larval stage. The total consumption by the third instar of *C. carnea* was significantly which was 35.6 with an average 11.86 individuals / day, while the total consumption by the second instar was 15.1 with an average 5.03 individuals.

These results are agreement with those obtained by (Atlhan *et al* 2004) , reported that larvae of C. carnea to increasing prey densities with increasing food consumption and older larval stages displayed a higher rate of predation than younger ones. Also (El-Batran, Liala & Fathy 1991) in Egypt reported C. carnea larvae predation efficiency increased as the larvae grew older. Jagaidish & Jayaramaiah (2004) found that, increasing food consumption according to larvae of the 1st , 2nd and 3rd instars of C. carnea consumed 20.20 , 25.40 and 99.93 aphids in their successive stage.

Table 3. Feeding potential of *Chrysoperla carnea* when reveal on larval instars of *Prays citri* under laboratory condition.

Replicates				1	2	3	4	5	6	7	8	9	10	Total	Mean/ Day
C. carnea Larvae	2nd Instar	No. of P. citri individuals consumed /larvae of C. carnea	Total	18	23	12	12	19	13	12	14	13	15	151	15.1
			Mean /Day	6	7.66	4	4	6.33	4.33	4	4.66	4.33	5	50.31	5.031
	3rd Instar		Total	40	36	39	34	33	35	35	37	35	32	356	35.6
			Mean /Day	13.33	12	13	11.33	11	11.66	11.66	12.33	11.66	10.66	118.63	11.86
L S D 5 %									0.9697						

2 – Biological results:

This investigation was conducted during the period from the end of the first week to the end of the forth week of May 2015. This insect reared on Ranjpure lime flowers under laboratory conditions. Such biological results are presented in Table (4) and Fig. (3) & (4) as the following.

Female laid eggs white-creamy color both individually on the Ranjpure lime flowers, total numbers per female ranged from 46 – 65 and average 54.6 eggs. Incubation period lasted 1.07 days under 29.4°C and 62.7 % RH. Rate of hatchability was 67.7 % in average under the same condition. The larval stage feed on the interior petals of flowers causes serious damage on flowers and newly fruit. Larva at first it is light yellow and pale brown color when fully grown, about 6.5 mm long, Period needed to reach pupal stage is about 6.37 days. Pupal stage inside white loose cocoon , light brown in color , duration of pupal stage ranged from 5 – 6 days with average 5.33 days . Adult stage (the moth) small moth, about 3.6 – 4.5 mm in length, about 10 - 12 mm in wing span, the forewings are grey-brown color, darker on the lower edge. Females begin to oviposit after mating male longevity ranged from 3 – 4 and average 3.6 days, and that of female ranged from 4 – 5 and 4.3 days, in average.

Larval stage Egg stage

Fig. (3)

Adult stage Pupal stage

Small glass bottle Glass chimney

Fig. (4)

Table 4. Biological characteristic of *Prays citri* (Millière) reared in the laboratory during May 2015 at Qalyubia Governorate.

Stages		Range	Mean
No. of laid eggs		46 – 65 egg/female	54.6
Hatchability rate		65 – 71 %	67.7 %
Incubation period		1 – 1.2 day	1.07
Larval		6 – 7 days	6.37
Pupal		5 – 6 days	5.33
Longevity	Male	3 – 4 days	3.6
	Female	4 – 5 days	4.3
Pre-oviposititon period		1 – 1.03 days	1.02
Oviposition period		2 – 3 days	2.3
Post-oviposition period		0.4– 0.6days	0.47
Life cycle		12 – 14.2 days	12.77
Generation		13 – 15.23 days	13.79
Life span		16 – 19.2 days	17.5
Maximum Temperature		26 – 33 °C	29.4 °C
Minimum Temperature		25 – 30 °C	27.4 °C
Relative Humidity		60 – 64 %	62.7 %

Pre-oviposition periods as adults emerge, and female being fertiled by male, it was ranged from 1 – 1.03 and average 1.02 days, oviposition period ranged from 2– 3 and average 2.3 days and Post-oviposition period was 0.47 day in average. Total developmental stages (larval & pupal- stage) needed about 11.7 days in average to be completed during the mentioned period, while Life cycle (egg → larvae → pupae → adult), it was completed ranged from 12 – 14.2 and average 12.77 days.

Generation (from egg to egg) the period spent for the egg to hatch and develop to adult stage till the female deposit its first egg needed for the total period was ranged from 13 – 15.23 and average 13.79 days .

Life span (from egg to death) the total period from egg to the death of the developmented and emerged adult stage ranged from 16 – 19.2 and average 17.5 days.

These results are agreement with those obtained by (Abo-Sheaesha 1994) reported that life cycle of *P. citri* lasted a period from 12 to 51 days according to the time of year , incubation period lasted 2 – 9 days , hatchability 66.7 – 92.7 % , pre-oviposition , oviposition and Post-oviposition period was 1 – 7 , 2 – 14 and 0 – 12 days respectively. Also found that larval & pupal- stage was 6 – 23 and 3 – 12 days respectively.

Total numbers eggs per female ranged from 28 – 390 and average 43.6 – 270.8 eggs. Ibrahim and Shahateh 1984 reported that the egg stage lasted 2-6 days, the larval stage 7.25 days, the pupal stage 3-10 days and the adult stage 2-18 days with preoviposition, oviposition and postoviposition periods of 2-6, 4-11 and 1-4 days,

respectively. (Abd El-Kareim *et al* 2017) , reported that the incubation period of *P. citr*i eggs was 4.22±0.67, 4.33±0.71 and 4.56±0.73 days on lime, navel orange and mandarin flowers, respectively., the durations of larval and pupal stages ranged between (8.0 - 8.33 days) and (4.2 - 4.6 days), respectively .

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دراسات بيئية وبيولوجية على حشرة فراشة أزهار الموالح بمحافظة القليوبية ـ مصر

عصام فؤاد جازيه

معهد بحوث وقاية النباتات ـ مركز البحوث الزراعية ـ دقى ـ جيزة – مصر

أجريت هذه التجربة بمحافظة القليوبية – مركز طوخ لعامين متتالين , حيث أوضحت النتائج الايكولوجية أن صنف الليمون الراجنبور كان المفضل لفراشة أزهار الموالح يليه الليمون البنزهير , ولم تشاهد أي أطوار للحشرة على أزهار البرتقال أبو سرة خلال موسمي الدراسة 2015 و 2016 . كما كان للحشرة ذروة واحدة للإصابة خلال فصل الربيع . كما شوهد أفراد للمفترس أسد المن بالعينات قيد الدراسة وتم حساب الكفاءة الافتراسية بداية من العمر الثاني لأسد المن والتي أظهرت أن افتراس العمر الثالث لأسد المن ليرقات فراشة أزهار الموالح أعلى من العمر الثاني . وأوضحت الدراسات البيولوجية للحشرة تحت ظروف المعمل حيث بلغ معدل متوسط وضع البيض 54.6 بيضة / أنثى واستغرقت فترة حضانة البيض 1.07 يوم بنسبة فقس 67.7% . في حين بلغ طور اليرقة في المتوسط 6.37 يوم أما طور العذراء بلغ 5.33 يوم في المتوسط وبلغ فترة حياة الحشرة الكاملة 4.3 يوم للأنثى & 3.6 يوم للذكر . وبلغت دورة حياة الحشرة 12.77 يوم وفترة الجيل استغرقت 13.79 يوم بالمتوسط على درجة حرارة 29.4 ورطوبة نسبية 62.7 % .