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Biocontrol of the pomegranate whitefly, *Siphoninus phillyreae* (Hemiptera: Aleyrodidae) by augmentation, releasing and evaluation of *Eretmocerus parasiphonini* (Hymenoptera: Aphelinidae) in Egypt

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Abstract:

The pomegranate whitefly, *Siphoninus phillyreae* (Haliday) (Hemiptera : Aleyrodidae) is one of the most important pests infested pomegranate in Egypt. The aim of this work was to evaluate the biological control potential of the parasitoid, *Eretmocerus parasiphonini* Evans and Abd-Rabou (Hymenoptera: Aphelinidae) against the pomegranate whitefly, *Siphoninus phillyreae* (Haliday) (Hemiptera: Aleyrodidae) on pomegranate (*Punica granatum* L.) by mass rearing and augmentative releases of this parasitoid during 2011-2014 in Egypt. This parasitoid species were mass reared and monthly releases were made in the fields of pomegranate during each of three consecutive years (2011-2014). About 142578 *E. parasiphonini* individuals were released in fields in Assuit, Daqahylia and Giza governorates in Egypt on pomegranate which were naturally infested by *S. phillyreae.* Populations of the parasitoid and parasitism were much higher in field plots where releases were made as compared with where no releases were made. The maximum rate of parasitism reached 48.9, 42.1 and 46.7 % in Assuit, Daqahylia and Giza governorates, respectively in the field treatment where releases were made, while parasitism peaked at 2.6, 4.6 and 2.5% in Assuit, Daqahylia and Giza governorates, respectively where no releases were made. These observations indicated that *E. parasiphonini* is a promising bioagent in controlling *S. phillyreae* in Egypt.

Introduction

Recently, the pomegranate whitefly. *Siphoninus phillyreae* (Haliday) (Hemiptera : Aleyrodidae) is the most important pest of pomegranate in Egypt. Pomegranate leaves infested with *S. phillyreae* have a demand for fluid transport substantially increased beyond the tree's normal capacity to respond. The loss of phloem fluids certainly represents a loss of potential productivity and heavy infestation caused leaf wilt, early leaf drop

and smaller fruit (Abd-Rabou, 1998 and 2001b). This pest attacking 60 host economic plant species including, apple, pear, citrus and olive. It distributed in Palearctic region (Bellows *et al.,* 1990). *Eretmocerus parasiphonini* Evans and Abd-Rabou (Hymenoptera: Aphelinidae) is recorded associated with *S. phillyreae* in Egypt for the first time, 2002 and corrected to be a valid name, 2004 (Abd-Rabou and Evans, 2002 and 2004). Abd-Rabou and Abou-Setta (1998) recorded seven parasitoids attacking *S. phillyreae* these are *Encarsia davidi* Viggiani and Mazzone, *E. galilea* Rivany, *E. inaron* (Walker), *E.lutea* (Masi), *Eretmocerus corni* Haldeman, *E. diversicilatus* Silvestri and *E. mundus* Mercet. They stated that *E. inaron* is the effective parasitoid attacking this pest with maximum parasitism percent of 78%. Biological control of the pomegranate whitefly has been attracted many scientists of the world ex. McDonald *et al*.(1996), Hackney *et al.* (1997), Abd-Rabou (1998 and 2006) and Abd-Rabou and Simmons (2010).

The present work deals with the biocontrol of *S. phillyreae* by using augmentation, releasing and evaluation of *E. parasiphonini* in different localities in Egypt.

Materials and methods

Mass rearing of the parasitoid: In the laboratory, the parasitoid *E. parasiphonini* was successfully mass reared on the infestation of *S. phillyreae* that were feeding on pomegranate (*Punica granatum*) ((According to the method of Abd-Rabou, 1998). Approximately 142578 adults of this parasitoid were released (Tables 1- 3) in Assuit, Daqahylia and Giza governorates in fields of pomegranate which were naturally infested with *S. phillyreae*. Releases were made during each of 3 consecutive years (2011-2014). From August to July parasitoids were released each year. Within a given year, similar numbers of parasitoids were released each month. The parasitoids were released as adults from containers (vials or cups) which were attached to pomegranate trees about 0.21 hectares. One container of 20-30 parasitoids was released per tree by allowing parasitoids to fly or walk from the containers. Half of the field (0.21 hectares) was used as a control and no release was made in this field plot.

Assessments of released parasitoid were estimate through dissection of recovered samples. Cardboard containers, 0.5-liter with ventilated tops, were used to hold samples for two weeks at 25-29˚C. The samples were 600 pomegranate leaves (4replications) each replicate was 150 leaves. This was achieved by holding 150 pomegranate leaves in each container. All materials found at the bottom of the rearing containers were examined for dead stages of pomegranate whitefly and the parasitoid, *E. parasiphonini*. The parasitoid was identified by comparison with voucher specimens. Leaf samples were collected at the beginning of every month from Sep. to Aug. in 2011-2014. The samples were taken after each monthly release. For each month of sampling, 50 trees were sampled in the parasitoid release plot and 50 trees were sampled in the control plot.

Percent parasitism was defined as: Percent parasitism = [number of prepupae, pupae, and adult parasitoids / (number of *S. phillyreae*, excluding eggs and first larval instars + number of prepupae, pupae, and adult parasitoids)] x 100. Some time was expected to elapse before the maximal level of impact from this parasitoid could be observed on the target pest.

Results and Discussion

The release of approximately 142578 adult *E. parasiphonini* in the fields on pomegranate resulted in elevated parasitism by this species for each year from 2011 to 2014 as compared with the control fields plots wherein no releases were made (Figures 1-9). The maximum rate of parasitism by *E. parasiphonini* (48.9, 42.1 and 46.7%) was attained in September and July 2013-2014 in the release plot in Assuit, Daqahylia and Giza governorates, respectively. Parasitism gradually increased in May and peaked

during September or July of each year, but was also high in June and August of each year. The peak in parasitism was due to higher populations of *E. parasiphonini* in the field **.** Overall seasonal populations of *S. phillyreae* (including parasitized and non-parasitized individuals) were higher in August - September followed by a decrease over the February - April of the study. For example, the percent parasitism during the last year was high the percent parasitism observed during the first year. This trend occurred for both the control plots and the insect release plots. The statistical analysis between the differences of increase after releasing the parasitiod during the three years under consideration SE. and SD were 62.81 and 108.8, respectively, in Assuit, While in Daqahylia and Giza were 25.36, 43.9 and 48.65, 84.3, respectively. These results showed that the incearse of realeasing parasitids individuals followed by increasing of persent parasitism in the three regions under considerations.

Viggiani and Battaglia (1983), Bellows *et al.* (1990) and Gould *et al.* (1992) studied the population dynamics , parasitoids and predators of *S. phillyreae* in California and Italy , respectively. Biological control of pomegranate whitefly, *S. phillyreae* studied by Viggiani and Mazzone (1980), McDonald *et al.* (1996), Hackney *et al.* (1997) and Abd-Rabou and Simmons (2010). Abd-Rabou (1998) studied the indigenous parasitoids of *S. phillyreae*, from different localities in Egypt were manipulated, reared and mass produced for classical biological control in Upper Egypt, more than 82,019 parasitoids were released. Several releases were made between July to October in both 1995 and 1996. Releases of the following indigenous parasitoids of the pomegranate whitefly in Upper Egypt*: Encarsia inaron* (Walker), *Eretmocerus mundus* (Mercet), *Encarsia lutea* Masi, *Eretmocerus corni* (Haldeman), *Encarisa davidi* Viggiani, *Encarsia galilea* Rivnay and Gerling and *Eretmocerus diversicilatus* Silvestri (Hymenoptera: Aphelinidae). Increases of the rate of parasitism from 6 to 67% indicate that En. inaron is the most effective parasitoid in controlling *S. phillyreae* in Egypt. Other parasitoids found associated with *S. phillyreae* in other localities in Egypt were manipulated and released in Upper Egypt. Some of these parasitoids became established in the release areas. Here recorded new parasitoid *E. parasiphonini,* also increased after more releasing and established in new are in Egypt. The host plants, distribution, parasitoids, predators and biological control studies were carried out in Egypt by Abd-Rabou, 1997, 1999, 2001a, 2002 2003, 2006, Abd-Rabou and Abou-Setta, 1998 and Abd-Rabou and Ahmed, 2006 and 2007.

The role of parasitoids in controlling *S. phillyreae* with augmentation releases was conducted in different parts of the world, India and USA (Mani and Krishnamoorthy, 1995; Hackney *et al.* ,1997; Bellows *et al.* ,2007). Pickett and Pitcairn (1999) stated that the released of the parasitiod, *E. inaron* rapidly established populations and spread throughout areas occupied by ash whitefly. The dispersal and overwintering ability could play a role in the extraordinary success of this parasitoid and we measured the impact of released parasitoids using a new method at a single location in northern California. This result agree with the data recorded here which showed that the increase of releasing parasitiods individuals followed by increasing of percent parasitism in the three regions, Assuit, Daqahylia and Giza.

Table (1): Total numbers of the adult parasitoid, *Eretmocerus parasiphonini* released in different fields of pomegranate in Assuit in Egypt during each year from 2011 to 2014.

Year	Number of released *Eretmocerus parasiphonini* individuals by *Siphoninus phillyreae*												
	Months												
	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Total
2011-12	1120	1555	1230	1390	1540	1700	1415	1380	1400	1365	1250	1125	16470
2012-13	1240	1212	1105	1530	1650	1510	1504	1430	1220	1310	1210	1350	16271
2013-14	1324	1025	1005	1690	1555	1620	1320	1510	1410	1565	1310	1210	16544

Table (2): Total numbers of the adult parasitoid, *Eretmocerus parasiphonini* released indifferent fields of pomegranate in Daqahylia in Egypt during each year from 2011 to 2014.

Year	Number of released *Eretmocerus parasiphonini* individuals by *Siphoninus phillyreae*												
	Months												
	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Total
2011-12	1210	1321	1410	1114	1324	1321	1302	1014	1335	1300	1411	1100	15162
2012-13	1150	1001	1113	1320	1441	1422	1116	1212	1078	1240	1310	1321	14724
2013-14	1104	1012	1124	1421	1341	1521	1246	1720	1312	1500	1410	1256	15967

Table (3): Total numbers of the adult parasitoid , *Eretmocerus parasiphonini* released in different fields of pomegranate in Giza in Egypt during each year from 2011 to 2014.

Year	Number of released *Eretmocerus parasiphonini* individuals by *Siphoninus phillyreae*												
	Months												
	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apri	May	June	July	Total
2011-	1115	1500	1120	1240	1340	1501	1324	1240	1365	1300	1242	1360	15647
2012-	1223	1245	1135	1450	1450	1420	1421	1450	1265	1335	1255	1342	15991
2013-	1300	1009	1145	1501	1235	1510	1229	1325	1478	1500	1325	1245	15802

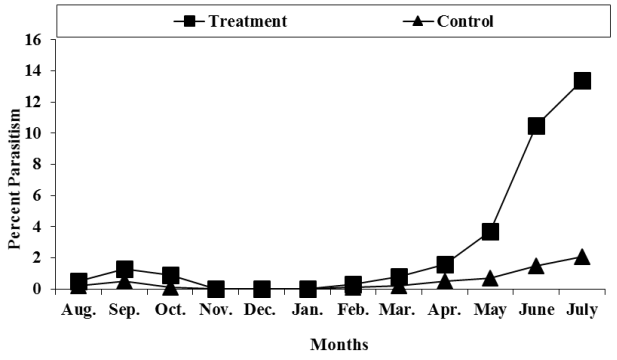

Figure (1): Percent parasitism of *Eretmocerus parasiphonini* associated with *Siphoninus phillyreae* infested pomegranate before and after releasing in Assuit during 2011-2012.

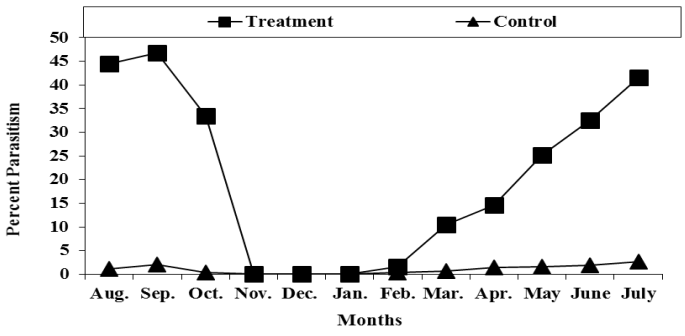

Figure (2): Percent parasitism of *Eretmocerus parasiphonini* associated with *Siphoninus phillyreae* infested pomegranate before and after releasing in Assuit during 2012-2013.

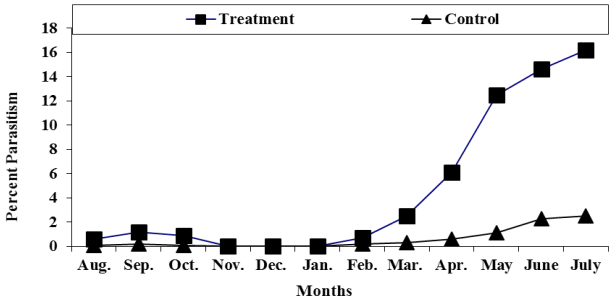

Figure (4): Percent parasitism of *Eretmocerus parasiphonini* associated with *Siphoninus phillyreae* infested pomegranate before and after releasing in Daqahylia during 2011-2012.

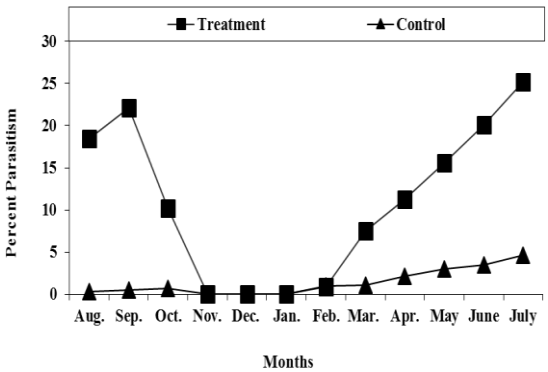

Figure (5): Percent parasitism of *Eretmocerus parasiphonini* associated with *Siphoninus phillyreae* infested pomegranate before and after releasing in Daqahylia during 2012-2013.

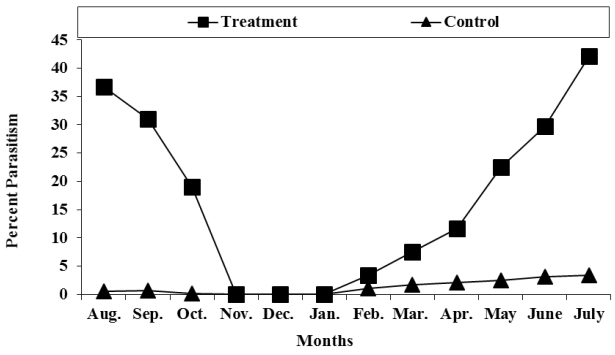

Figure (6): Percent parasitism of *Eretmocerus parasiphonini* associated with *Siphoninus phillyreae* infested pomegranate before and after releasing in Daqahylia during 2013-2014.

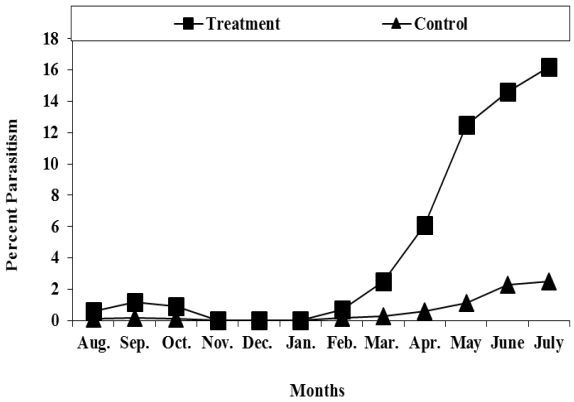

Figure (7): Percent parasitism of *Eretmocerus parasiphonini* associated with *Siphoninus phillyreae* infested pomegranate before and after releasing in Giza during 2011-2012.

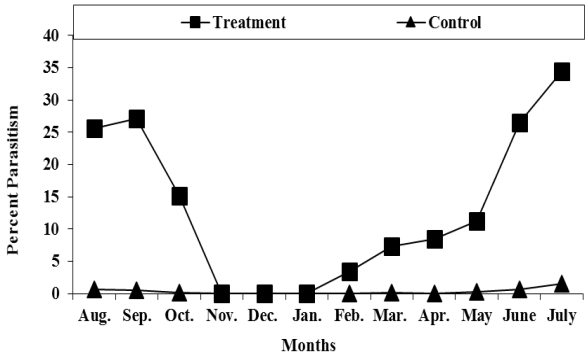

Figure (8): Percent parasitism of *Eretmocerus parasiphonini* associated with *Siphoninus phillyreae* infested pomegranate before and after releasing in Giza during 2012-2013.

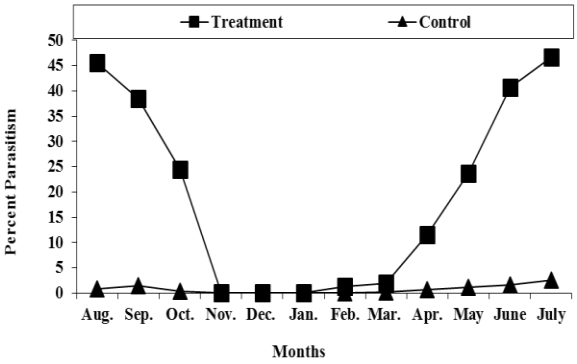

Figure (9): Percent parasitism of *Eretmocerus parasiphonini* associated with *Siphoninus phillyreae* infested pomegranate before and after releasing in Giza during 2013-2014.

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