International Journal of Agriculture, Forestry and Fisheries
2020; 8(2): 68-71
http://www.openscienceonline.com/journal/ijaff
ISSN: 2381-4365 (Print); ISSN: 2381-4373 (Online)

Open Science

Studies on Supper Parasitism of the Larval Ectoparasitiod *Diglyphus isaea* on *Liriomyza bryoniae* and *Liriomyza trifolii* in Alajelat, Libya

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To cite this article

Mohamed Omar Albasha, Alansary Refat Elkhouly. Studies on Supper Parasitism of the Larval Ectoparasitiod *Diglyphus isaea* on *Liriomyza bryoniae* and *Liriomyza trifolii* in Alajelat, Libya. *International Journal of Agriculture, Forestry and Fisheries.* Vol. 8, No. 2, 2020, pp. 68-71.

Received: October 27, 2019; **Accepted**: January 7, 2020; **Published**: March 23, 2020

Abstract

Background: *Diglyphus isaea* (Walker) appears to be one of the major candidates for biological control programs against *Liriomyza spp*. This species is a primary ectoparasitoid capable of developing on at least 18 different Agromyzid species associated with herbaceous plants and rarely with trees. Objectives: The present study aimed to investigate Super parasitism behavior of the larval ectondoparasitoid *D. isaea* in the field on two leaf mining insect hosts *L. trifolii* and *L. bryoniae* in Alojelat region during the winter growing season 2016/2017 using Broad bean (*Vecia faba*), as a host plant. Methods: Broad bean (*Vecia faba*), was targeted as a host plant because it has a heavy infestation by the two leaf mining insects combined with a good population of *D. isaea* 100 parasitized larvae were collected. Larvae were checked and the number of the parasitoid immature stages were counted. Solitary parasitized and supper parasitized larvae were counted and recorded for the two insect hosts *L. trifolii* and *L. bryoniae*. Results: Superparasitism caused by *D. isaea* females on *L. trifolii* recorded high numbers during January and February and reached its peak on February 4th recording (18 superparasitized larvae/100 parasitized ones), while the host population recorded (104 *L. trifolii* larvae/100 leaflets) at the same time. Super parasitism decreased to its lowest number on December 17th recording (1 super parasitized larvae/100 parasitized ones) where the host population recorded (91 larvae/ 100 leaflets) at the same time. While, super parasitism caused by *D. isaea* females on *L. bryoniae* recorded high numbers during January and February and reached its peak on February 18th recording (26 super parasitized larvae/100 parasitized ones), while the host population was (116 larvae/100 leaflets), The lowest number of superparasitism was observed on December 17th (2.0 super parasitized larvae/100 parasitized ones) when the host population was (73 larvae/100 leaflets) at the same time. Conclusion: *D. isaea* females reached its highest numbers on the high population levels of the insect host on either *L. trifolii* or *L. bryoniae* with low preference towards *L. bryoniae,* so, superparasitism by *D. isaea* recorded slightly high numbers on *L. bryoniae* larvae compared with *L. trifolii.*

Keywords

Superparasitism, *D. isaea*, *L. trifolii*, *L. bryoniae*, Alajelat, Libya

1. Introduction

The genus *Diglyphus* (Eulophidae) belong to the sub family Eulophinae. This sub family, includes the genera *hemiptarsenus* and *pengalio,* comprises larval ectoparasites only *Diglyphus* spp. are primary parasites. *Diglyphus isaea* is holarictic [1]. *Diglyphus* are one of the most important parasitoids attacking the leafminers *Liriomyza* spp. A complete sampling of the fauna associated with these pests always showed one or more species of leafminers being parasitized by *Diglyphus* species [2]. *Diglyphus* is an economically important group of parasitic wasps. Species of this genus are primary, solitary or gregarious ectoparasitoids on, mainly, leafmining agromyzids (Diptera: Agromyzidae) [3], *D. isaea* is a primary parasitoid on agromyzid leaf

miners (Diptera: Agromyzidae) [4]. Despite having been described from the United Kingdom more than 160 years, its biology is still poorly known [5, 6]. The parasitoid is used as a biological control agent against *Liriomyza* species in Europe, the United States, and some parts of Asia on a range of crops and ornamental plants [7]. It also has been recorded in parts of Africa and large-scale mass-production programs of *D. isaea* have been developed to support biological control of *Liriomyza* species [8]. The highest success with *D. isaea* has been obtained with augmentative releases [9]. *D. isaea* is an abundant species in Europe, north Africa and Japan and have been reared from a wide variety of leafminers. It is generally associated with hosts on herbaceous plants and scares on trees. Eighteen host species in 5 genera of agromyzide and the lepidopteran *Lyonetiae clerckella* are recorded [3].

D. isaea is known as a solitary ectoparasitoid and few authors have studied supperparasitism behavior. El-Khouly [10] revealed that the highest numbers of superparasitism coincided with the high populations of *L. trifolii* and the reverse is true. This behavior could be explained by the intention of *D. isaea* females to put more than one larva on the third instar host larvae because they are larger in size, at the high larval populations of *L. trifolii* there are a large number of them in the third instar, which encourage *D. isaea* females for supperparasitism. Parrella *et al*. [2] found that super parasitism occurred when *D. begini* is mass reared on *L. trifolii* third instars. Moreover, Heinz and Parrella, [11] mentioned that superparasitism behavior was recorded by *D. begini* females when *L. trifolii* third instar were presented for them. From the available literature a very few authors have studied the super parasitism behavior of *D. isaea* [5, 11, 12].

2. Objective

The present investigation was undertaken to study superparasitism behavior of the larval ectoparasitoid *D. isaea*

3. Materials and Methods

3.1. Seasonal Abundance of the Tomato Leaf Miner *L. bryoniae* and the Serpentine Leaf Miner *L. trifolii*

Broad bean (*Vecia faba*), was targeted as a host plant because it has a heavy infestation by the two leaf mining insects combined with a good population of *D. isaea* Hundred infested leaves with *L. bryonia*e and Hundred infested ones with *L. trifolii* were taken. Some leaves had the two types of infestation, only the targeted leafmining species (*L. bryonia*e or *L. trifolii)* was counted in each group. Samples were kept in plastic bags and transferred to be examined in the laboratory. Number of *L. bryonia*e and *L. trifolii* larvae were counted and recorded.

3.2. Superparasitism of the Parasitoid *D. isaea*

To evaluate superparasitism for the parasitoids *D. isaea*, 100 parasitized larvae were collected. larvae were checked and the number of the parasitoid immature stages were counted. Normal agricultural practices of fertilizing and irrigation were followed and no chemical control measurements were applied. Samples were taken from the appearance of the emergence of the first leaves and continued weekly until harvest.

4. Results

4.1. Super Parasitism on *L. trifolii*

As shown in figure 1, superparasitism caused by *D. isaea* females recorded high numbers during January and February and reached its peak on February 4th recording (18 superparasitized larvae/100 parasitized ones), while the host population recorded (104 *L. trifolii* larvae/100 leaflets) at the same time. Superparasitism decreased to its lowest number on December 17th recording (1 superparasitized larva/100 parasitized ones) where the host population recorded (91 larvae/ 100 leaflets) at the same time.

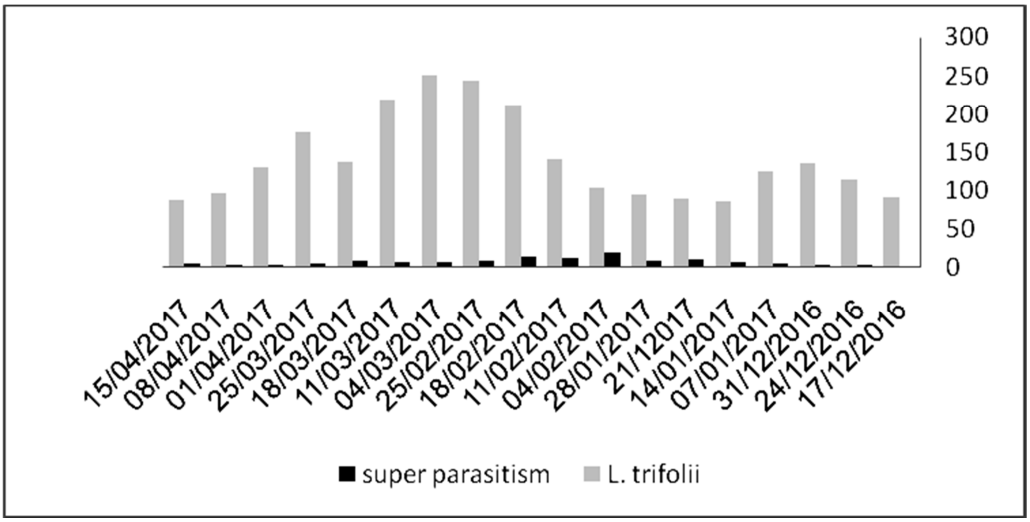

Figure 1. *Superparasitism of D. isaea (superparasitized larvae/100 parasitized ones) as affected by the numbers of L. trifolii.*

4.2. Superparasitism on *L. bryoniae*

As shown in figure 2, superparasitism caused by *D. isaea* females recorded high numbers during January and February and reached its peak on February 18th recording (26 superparasitized larvae/100 parasitized ones), while the host population recorded (116 larvae/100 leaflets), The lowest number of superparasitism was observed on December 17th (2 superparasitized larvae/100 parasitized ones) when the host population was (73 larvae/100 leaflets) at the same time.

As shown in figure 3, superparasitism behavior showed low preference towards *L. trifolii* than *L. bryonia*e.

5. Discussion

The previous results revealed that the, highest numbers of superparasitism coincided with the high populations of the insect host and the reverse is true. This behavior could be explained by the intention of *D. isaea* females to put more than one egg on the third instar host larvae because they are larger in size, at the high larval populations of *L. trifolii* and *L. bryoniae* there are a large number of them are in the third instar, which encourage *D. isaea* females to behave so, Parrella *et al*. [2] found that superparasitism occurred when *D. begini* is mass reared on *L. trifolii* third instars. These results are supported with the findings of Heinz and Parrella, [11] who mentioned that superparasitism behavior was recorded by *D. begini* females when *L. trifolii* third instar were presented for them. These results are also in agreement with those of El-Khouly, 2003 [13] who recorded that superparasitism was significantly higher on third instars of *L. trifolii* than second instars recording 1 superparasitized larva/female on the third instar and 0.1 superparasitized larva/female on the 2nd instar larvae.

Hendrikse *et al.* [14] reported that *D. isaea* is a facultative gregarious parasitoid of the leafmining insects. After paralyzing the host, the female usually lays one egg in exceptions 2-5 eggs on the host. So, *D. isaea* considers a solitary larval ectoparasitoid and in some exceptions this prasitoid behaves as a gregarious one. With regard to the

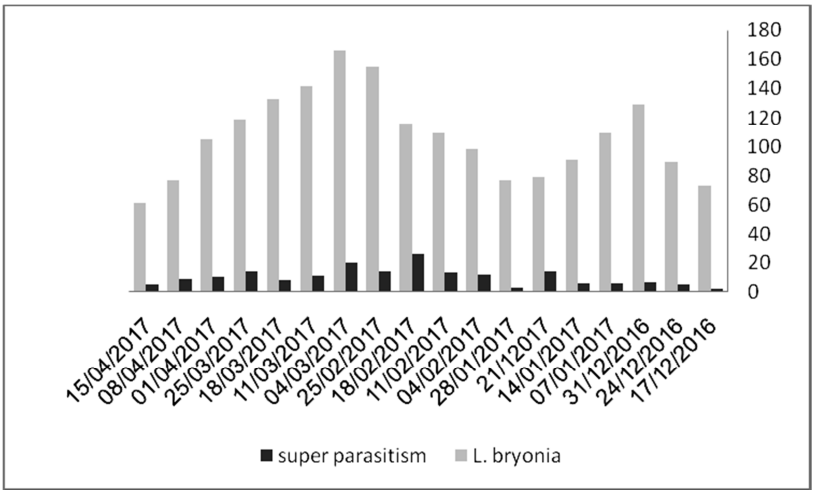

Figure 2. *Superparasitism of D. isaea (superparasitized larvae/100 parasitized ones) as affected by the numbers of L. bryoniae.*

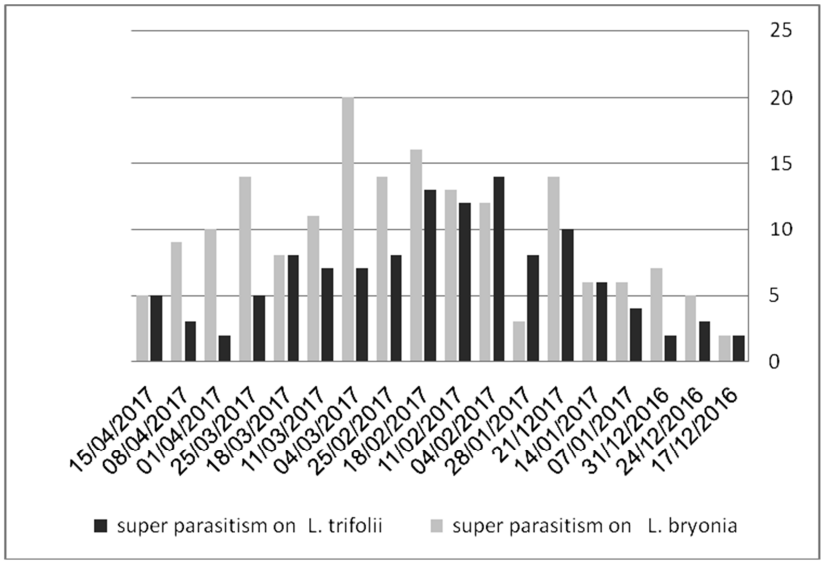

Figure 3. *Superparasitism of D. isaea on Lbryoniae and L. trifolii.*

large size of *L. bryoniae* larvae compared *L. trifolii* that may encourages the parasitoid females to deposit more than one egg on the same host. An explanation by Parrella *et al*. [2] who mentioned that superparasitism occurred when *D. begini* is mass reared on *L. trifolii* third instars may support our finding. On the other hand it should be bear in mind that a further studies on *D. isaea* should be undertaken.

6. Conclusion

It could be concluded that *D. isaea* females reached its highest numbers on the high population levels of the insect host on either *L. trifolii* or *L. bryoniae* with low preference towards *L. bryoniae* so, superparasitism by *Diglyphus isaea* recorded slightly high numbers on *L. bryoniae* larvae compared with *L. trifolii.* Superparasitism by *D. isaea* decreased to it's the lowest number on December and the highest numbers during January and reached its peak on February in both insect host. Further studies are essential in larger population levels of the insect host on other plants and in other regions to confirm these results.

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