Journal of Advances in Biology & Biotechnology
5(3): 1-7, 2016; Article no.JABB.23119
ISSN: 2394-1081

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Natural Abundance and Biocontrol Efficiency of the Ectoparasitoid *Diglyphus isaea* Walker on the Serpentine Leafminer *Liriomyza trifolii* (Burgess) in Tomato Greenhouses in Alzawia Region Libya

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JABB/2016/23119
Editor(s):
(1) Marli Camassola, University of Caxias do Sul, Institute of Biotechnology, Brazil.
Reviewers:
(1) Raul Leonel Grijalva Contreras, Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Mexico.
(2) Ilham Zahir, University Sidi Mohamed Ben Abdellah, Morocco.
Complete Peer review History: http://sciencedomain.org/review-history/12728

Short Research Article

Received 15th November 2015
Accepted 8th December 2015
Published 18th December 2015

ABSTRACT

Aims: The present study aimed to evaluate the role of natural abundance of the ectoparasitoid *D. isaea* as biological control agent.

Place and Duration: Alzawia region, Libya from March to June 2014.

Methodology: Fifty tomato leaflets infested with *L. trifolii* Burgess were taken from each greenhouse. Samples were kept in plastic bags and examined in the laboratory. Number of living *L. trifolii* Burgess larvae, immature stages of the *D. isaea* walker and number of killed larvae according to feeding (no ovipositon) were counted and recorded.

Results: *D. isaea* walker recorded two peaks of abundance in all studied greenhouses, the highest peaks recorded 23, 41, 32 and 33 individuals/ 50 infested leaflets in greenhouses 1,2,3 and 4, respectively. The highest average numbers occurred in April in all greenhouses recording 17.3±4.5, 26.4±11.5, 23.8±6.4 and 21.3±8.8 individuals/ 50 infested leaflets in greenhouses 1,2,3 and 4, respectively. On the other hand the percentage of parasitism ranged between 26.4±8.2 and

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52.4±6.7% recording its highest numbers in June in greenhouses 1,2 and 3 recording (49.4±11.9%, 50.6±5.5, 52.4±6.7) respectively and 40.3±5.2% in green house 4 in May. The percentage of killed larvae according to host-feeding recorded its highest monthly average numbers in May in greenhouses 1 and 2 recording (44.6±18.9 and, 38.2±2.5), in April in greenhouse 3 recording (29.4±3.3) and in may in greenhouse 4 recording 26.6± 20.5%.

Conclusion: The parasitoid showed low populations in March then, developed good populations that kept the populations of the serpentine leaf miner *L. trifolii* Burgess at low densities till the end of the season in all studied greenhouses. So no chemical control measurements against *L. trifolii* Burgess should be applied at the high populations of this parasitoid.

Keywords: Biocontrol efficiency; ectoparasitoid Diglyphus isaea walker; tomato greenhouses; Alzawia region.

1. INTRODUCTION

Genus *Liriomyza* contains more than 300 species, widely distributed in the new and old world but are commonly found in temperate areas [1]. Among them, *L. trifolii* Burgess (Diptera: Agromyzidae), the American serpentine leaf miner is known as one of the most serious pests of many vegetable and horticultural crops worldwide [2]. *Lirimyza trifolii* has a wide range of host plants with more than 400 species reported as hosts [3]. Thirty nine species of parasitoids have been reported to attack *L. trifolii* on a variety of commodities [4]. *Diglyphus isaea* Walker was the most dominant parasitoid species against *L. trifolii* of the parasitoid complex which contained *Opius pallipes* Wesmeal and *Chrysocharis parksi* Crawford (Hymenoptera: Eulophidae) as an endoparasitoid [5]. Sha et al. [6] added that *D. isaea* is a primary parasitoid of agromyzid leaf miners and has been commercialized as a biological control agent. Ozawa et al. [7] found that the dominant parasitoid species emerging from *L. trifolii* larvae in Homaoka tomato greenhouses was *D. isae*. This parasitoid was released in tomato greenhouses to control *L. trifolii* at different release doses, the percentage of parasitism ranged 94.1-100% by the end of the growing season [7,8]. The parasitoid *D. isae* is a primary ectoparasitoid capable of developing on at least 18 different agromyzid species [9]. Goncalves and Almeida [10] reported that through a survey started in 1993 in several protected crops, two ectoparastiods of *Liriomyza* spp, *D. isaea* and *D. poppoe* have been found every year, reaching rate of parasitism of 80-85% with predominance of the first one.Among the parasitoid complex of *Liriomyza* spp. in the Iranian fauna which contained several parasitoid species, the Eulophid *D. saea* was the most common one [11]. Natural abundance of the ectoparasitoid *Diglyphus isaea* walker was studied on the tomato leafminer *L. bryonia* on four winter host plants [broad bean (*Vecia faba*), pea (*Pisum sativum*), mallow (*Malva sylvestris*) and snow thistle *(Sonchus oleraceus*)] in Ojilate region. The parasitoid showed low populations in December on all studied host plants except broad bean. Then developed high populations in February and March, the population decreased till the end of the growing season. *D. isaea* recorded 3-4 peaks of abundance on all studied host plants, the highest peak recorded 64, 198, 70 and 103 individuals/ 100 infested leaflets on broad bean, pea, mallow, and snow thistle respectively [12].

From the available literature, few authors have studied the role of the parasitoid *D. isaea* as biocontrol agent against *L. trifolii* in tomato fields in the Egyptian fauna [12,13,14] but rarely in tomato greenhouses. Therefore the present investigation was undertaken to study the role of the parasitoid *D. isaea* in tomato greenhouses in the Libyan fauna.

2. MATERIALS AND METHODS

The present study was carried out in the Faculty of Education- Zolton – Alzawia university department of biology (Alzawia is a region occurs in north west of Libya nearly 60 km western Tripoli) from March to June 2014, four tomato greenhouses (500 m^2 each) planted with 30-day old tomato nurslings were sampled weekly. Fifty tomato leaflets (Alfarah hybrid 12-16 plant/m^2) infested with *L. trifolii* were taken from each greenhouse (mean temperature inside green houses is 25C). Samples were kept in plastic bags and transferred to be examined in the laboratory. Number of living *L. trifolii* larvae, immature stages of the ectoparasitoid *D. isaea* and number of killed larvae according to feeding (no ovipositon) were counted and recorded. Normal agricultural practices of fertilizing and

irrigation were followed and no chemical control measurements were applied. Samples took place in all greenhouses one weak after nurslings were replanted and continued weekly until harvest.

3. RESULTS AND DISCUSSION

Data presented in Figure 1 shows the numbers of the ectoparasitoid *D. isaea* and the percentage of parasitism in four tomato greenhouses.

In greenhouse (1) the parasitoid *D. isaea* recorded low numbers in the beginning of the season in late march and early April , then the population increased recording two peaks of abundance (23 and 20 individuals/ 50 infested leaflets) occurred in 4th of April and the 20th of June respectively. On the other hand the percentage of parasitism ranged between 22.2-57.8% and recorded 57.8% at the end of the season.

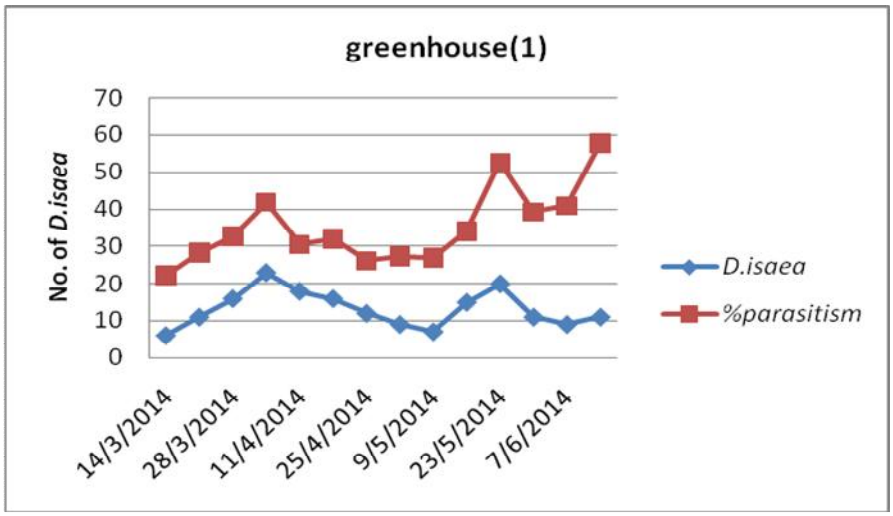
In greenhouse (2), the population of *D. isaea* recorded two peaks of abundance (41 and 18 individuals/50 infested leaflets) occurred in 11th of April and 16th of May respectively, while the percentage of parasitism ranged between 26.6 and 56.9% and recorded 54.5% at the end of the season.

In greenhouse (3), the population of *D. isaea* recorded two peaks of abundance (32 and 24 individuals/50 infested leaflets) on 4th of April and 16th of May respectively, while the percentage of parasitism ranged between 19.4 and 57.1% and recorded 57.1% at the end of the season.

In greenhouse (4), the population of *D. isaea* recorded two peaks of abundance (33 and 26 individuals/50 infested leaflets) in 4th of April and 16th of May respectively, while the percentage of parasitism ranged between (23.1 and 46.4%) and reached 42.1% at the end of the season.

4. CONCLUSION

It can be concluded that, the percentage of natural parasitism by *D. isaea* reached more than 40% in all studied greenhouses thus, it seems that no need to release the parasitoid in such greenhouses . Similar results were obtained by Elkhouly [14] who found that the percentage of parasitism by *D. isaea* in tomato greenhouses ranged between 10.3 and 55.3% when no release treatments were applied. Studies of Awadalla et al. 2009 [15] and EL Khouly, [14] revealed that *D. isaea* had high rates of parasitism on *L. trifolii* in open fields. They indicated that the parasitoid slightly preferred cowpea and kidney bean than tomatoes. The relatively low percentage of parasitism under the Libyan condition in comparison with those of the Egyptian ones may be due to the climatic conditions and the sandy poor soil that produces low quality plant leaves may be less favorable the pest or its Hymenoptrous parasitoids. These results are also in agreement with these of [16] who studied the tomato leafminer *L. bryonia* under Libyan conditions.



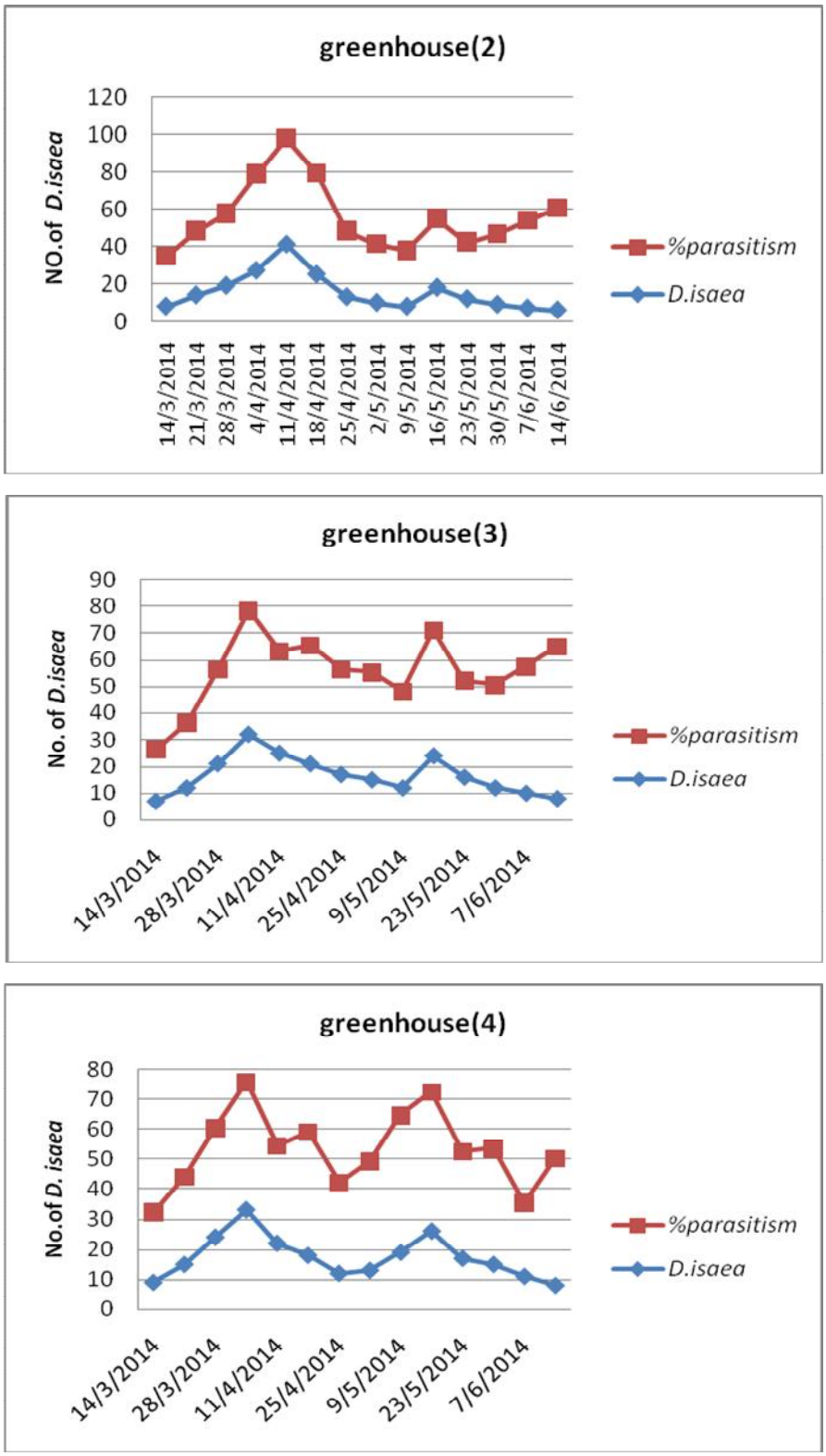


Fig. 1. Natural Abundance of the ectoparasitoid *D. isaea* and percentage of parasitism in four tomato greenhouses in Alzawia region during the growing season 2014

Table 1. Parasitism parameters of *D. isaea* on *L. trifolii* infesting tomato in greenhouses Alzawia region during the growing season 2014

Months	Greenhouse (1)			Greenhouse (2)			Greenhouse (3)			Greenhouse (4)		
	No. of *D. isaea*	% parasitism	% killed larvae (feeding)	No. of *D. isaea*	% parasitism	% killed larvae (feeding)	No. of *D. isaea*	% parasitism	% killed larvae (feeding)	No. of *D. isaea*	% parasitism	Killed larvae feeding %
March	11.0±5.0	27.7±5.2	24.7±7.2	13.7±5.5	33.1±6.1	22.3±2.2	13.3±7.1	26.4±8.2	18.5±1.8	16±7.5	29.4±6.6	19.8±4.7
April	17.3±4.5	32.6±6.6	29.0±3.0	26.4±11.5	49.6±9.8	31.6±2.5	23.8±6.4	42.3±3.8	29.4±3.3	21.3±8.8	36.5±6.3	23.4±4.6
May	12.4±5.9	36.0±10.6	34.9±6.2	11.4±4.0	33.0±3.8	27.9±6.2	15.8±4.9	39.8±4.4	29.1±6.7	18.0±5.0	40.4±5.2	24.6±20.5
June	10.0±1.41	49.4±11.9	44.6±18.9	6.5±0.7	50.6±5.5	38.2±2.5	9.0±1.4	52.4±6.7	22.6±1.7	9.5±2.1	33.2±12.7	22.7±4.9
Mean ± S.D	12.7±3.2	36.4±9.2	33.3±8.6	14.6±8.5	41.6±9.9	30.0±6.7	15.5±6.2	40.2±10.7	24.9±5.3	16.2±5.0	34.9±7.4	22.6±2.0

From Table 1 the parasitoid *D. isaea* showed its highest monthly average numbers in April in the four greenhouses recording (17.3±4.5, 26.4±11.5, 23.8±6.4 and 21.3±8.8 individuals/ 50 infested leaflets) in greenhouses 1,2,3 and 4, respectively. On the other hand monthly average percentage of parasitism recorded its highest numbers in June (49.4±11.9%, 50.6±5.5 and 52.4±6.7%) in greenhouses 1,2 and 3respectively and in may (40.4±5.2%) in green house 4. Monthly average percentages of killed larvae according to host-feeding (no oviposition) recorded its highest numbers in June in greenhouses 1,2 recording (44.6±18.9 and 38.2±2.5) respectively, in April in greenhouses (3) recording (29.4±3.3%), and in may in greenhouses (4) recording (24.6±20.5%).

Theses results show that the larval ectopoarasitoid, *D. isaea* recorded highest average numbers in April when its host *L. trifolii* reached high populations because *D. isaea* prefers the high populations of its host [17]. On the other hand the monthly average percentages of killed larvae according to host-feeding ranged between (18.5±1.8 and 44.6±18.9%). Data presented by Khouly, [14] showed that *D. isaea* females killed 21.3±4.7 of *L. trifolii* larvae 9.6±3.7 of them were host fed and 12.3±3.6 larvae were oviposited. So these results are in agreement with his finding. Another supporting results were presented by Patel et al. [18] who found that the parasitoid *Diglyphus intermedius* kills more hosts than it parasitize. In earlier study, Heinz and Parrella [19] observed that *Diglyphus begini* killed 1.3 *L. trifolii* larvae for every larva used for oviposition. Eventually, despite host – feeding is an effective killing behavior against *L. trifolii* larvae which supporting in combination with oviposition the efficiency of *D. isaea* females, it resulting no reproductive output of the parasitoid progeny.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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