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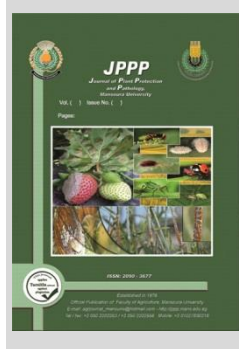
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Parasitism Efficiency of Insect Parasitoids on Some Sugar Beet Insect Pests

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ABSTRACT

For increasing and enhancing role of parasitoids as one of major elements in bio-controlling sugar beet insect pests. This trial was performed at Sakha, Agric. Res., Station and laboratory of Sugar Crops Res., Depart., Sakha- Kafr El-Sheikh Governorate. Results yielded that the parasitism efficiency for *Opius nitidulator* (Nees) (Hymenoptera: Braconidae) on *Pegomyia mixta* Vill. were 36.14% and 43.06% over the two successive seasons, 2022/23 and 2023/24, respectively. Meanwhile, the parasitism efficiency for *Diadegma* spp. Förster (Hymenoptera : Ichneumonidae) on *Scrobipalpa ocellatella* Boyd. were 46.43% and 62.50% during the two seasons, respectively. While, the parasitism efficiency for *Microterys* spp. Thomson (Hymenoptera : Encyrtidae) on *Phenacoccus solenopsis* Tinsley were 86.89% and 46.77% during two seasons, respectively. Moreover, Statistical analysis proved that high significant- positive correlation among previous insect pests and their associated parasitoids through the two seasons. Based on these findings, these parasitoids play an essential role for restraining insect pests.

Keywords: *Opius nitidulator*, *Diadegma* spp., *Microterys* spp., sugar beet insect pests , parasitoids

INTRODUCTION

Sugar beet, *Beta vulgaris* L. is considered one of the most important sugar crops worldwide. It is cultivated at 40 countries of the world and accounts for 40-45% of the world total sugar production. Sugar beet is one of the most important sugar crops and considers the first crop for sugar production in Egypt since 2013 (El- Shafey, 2014). In Egypt, the total area planted with sugar beet reached 700 thousand feddans in 2021/ 22 season that produce more than 1.6 million tons of sugar. Sugar beet is infested with numerous insect pests throughout the whole season, which leads to root and sugar yield reduction (Youssef *et al.*, 2020 and Mansour *et al.*, 2023). Among the insect pests, *Pegomyia mixta* Vill., *Phenacoccus solenopsis* Tinsley and *Scrobipalpa ocellatella* Boyd. are destructive insects and causing high economic losses to sugar beet crop in Egypt. Farmers spray the conventional insecticides in controlling these insects. But, the intensive use of conventional insecticides led to several important drastic problems, i.e. environmental pollution, destruction of the natural enemies and incidence insect resistance to these insecticides (Awad *et al.*, 2014). Insect pest control in sugar beet depends on integrated pest management (IPM) programs to avoid using insecticides. IPM of sugar beet insect pests could be achieved through applying combinations of practices such as biological control by using species of parasitoids to controlling the insect pests population. So, this present work was done to investigate the parasitism ability of the parasitoids to some insects.

MATERIALS AND METHODS

This trail was performed in Sakha Agric. Res. Station, Kafr El-Sheikh Governorate over the two successive seasons, 2022/23 and 2023/24. For calculating the parasitism percent, larvae of *P. mixta*, *S. ocellatella* and nymphs of *P. solenopsis* were collected from the field and put into paper bags. After that these samples were transferred to lab. of Sugar Crops Res.

Dep., Sakha. Specimens of larvae kept in petri dishes (9 cm) with leaves of sugar beet till pupation. Newly pupae were put in other petri dishes till adult stages (emergence or its adult parasitoid). Also, nymphs of *P. solenopsis* kept in petri dishes (9 cm) with leaves of sugar beet till adult stages (emergence or its adult parasitoid). Experiment was conducted in lab. condition (25±2° C and 60- 70% R.H). Total individuals of host and parasitoids were recorded and the parasitism percent was calculated by the following formula:-

$$\text{Parasitism \%} = \frac{\text{No.of emerged parasitoid}}{\text{No of pupae or nymphs}} \times 100$$

$$\text{Parasitism efficiency} = \frac{\text{Total no.of parasitoids over the season}}{\text{Total no.of host over the season}} \times 100$$

Note:Samples of parasitoid individuals were classified through Insect Identification Unit (IIU) - Plant Pro., Res., Inst., Agric., Res., Center, Egypt.

Statistical analysis:

The correlation coefficient values between (*P. mixta*, *S. ocellatella*, *Phenacoccus solenopsis*) and their parasitoids; (*Opius nitidulator*, *Diadegma* spp. and *Microterys* spp.) were calculated according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

1.*Pegomyia mixta*:

The present results arranged in Table (1) indicate that parasitism(%) ranging between (25.00 to 64.29%). Highest percentage of parasitism(64.29%) was recorded on 22 November,2022, as the lowest percentage (25.00%) was monitored on 13 January, 2023. Parasitism efficiency over 2022/23 season was (36.14%). Number of emerged parasitoids were 30 individuals from 83 pupae. While, in second season 2023/24, data illustrated in Table (2) show that parasitism percentage ranging between (20.00 to 63.64 %). Maximum percentage of parasitism (63.64%) was registered on 24 November, 2023, whilst the minimal percentage

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(20.00%) was enrolled on 19 December, 2023. Parasitism efficiency through 2023/2024 season was (43.06%). Total emerged parasitoids were 31 individuals from 72 pupae. The parasitism efficiency were the highest during the second season with 43.06%. These finding demonstrate that *Opius nitidulator* parasitoid is succeed in killing about 40% of *P. mixta* populations to a great extent.

Table 1. Parasitism ratio to parasitoid, *O. nitidulator* on *P. mixta* infesting sugar beet field during first season, 2022/23.

Date	No. of larvae (The last stages)	No. of pupae	No. of emerged Parasitoids	% parasitism
28 Sep. 2022	23	22	6	27.27
26 Oct.	19	19	7	36.84
22 Nov.	16	14	9	64.29
20 Dec.	9	9	3	33.33
13 Jan. 2023	8	8	2	25.00
22 Feb.	12	11	3	27.27
Parasitism efficiency	87	83	30	36.14

Table 2. Parasitism ratio to parasitoid, *O. nitidulator* on *P. mixta* infesting sugar beet field during second season, 2023/24.

Date	No. of larvae (The last stages)	No. of pupae	No. of emerged Parasitoids	% parasitism
29 Sep. 2023	31	29	11	37.93
25 Oct.	22	20	10	50.00
24 Nov.	14	11	7	63.64
19 Dec.	7	5	1	20.00
14 Jan. 2024	6	4	1	25.00
23 Feb.	6	3	1	33.33
Parasitism efficiency	86	72	31	43.06

I. S. ocellatella:

Data in Table (3) clarify parasitism percentage ranging between (33.33%) to (57.50%) during 2022/2023 season. Top value of parasitism was (57.50%) on 14 April, 2023, while less value of parasitism (33.33%) on 20 December 2022 and 13 January, 2023. Parasitism competence throughout 2022/2023 season was (46.43%). Individuals of emerged parasitoids were 65 adults from 140 pupae. In such concern

Table 3. Percentages of parasitism by parasitoid, *Diadegma* spp. on *Scrobipalpa ocellatella* infesting sugar beet field during first season, 2022/23.

Date	No. of larvae (The last stages)	No. of pupae	No. of emerged Parasitoids	% parasitism
20 Dec. 2022	6	6	2	33.33
13 Jan. 2023	13	12	4	33.33
22 Feb.	22	22	8	36.36
20 Mar.	26	26	12	46.15
30 Mar.	37	34	16	47.06
14 Apr.	43	40	23	57.50
Parasitism efficiency	147	140	65	46.43

Table (4) illustrate parasitism percentage ranging between (12.50 to 81.25%) in 2023/24 season. Upper percentage of parasitism (81.25%) on 23 March, 2024. Also, less percentage (12.50%) on 16 January, 2024. Adequacy of parasitism at 2023/2024 season was (62.50%). Aggregate emerged parasitoids were 60 individuals, from 96 pupae. The parasitism efficiency were the highest during the second

season with 62.50%. These results prove that *Diadegma* spp. parasitoid play a major role in suppressing *Scrobipalpa ocellatella* populations.

Table 4. Percentages of parasitism by parasitoid, *Diadegma* spp. on *Scrobipalpa ocellatella* infesting sugar beet field during second season, 2023/24.

Date	No. of larvae (The last stages)	No. of pupae	No. of emerged Parasitoids	% parasitism
25 Dec. 2023	4	2	1	50.00
16 Jan. 2024	10	8	1	12.50
25 Feb.	13	10	6	60.00
23 Mar.	20	16	13	81.25
29 Mar.	31	28	18	64.29
16 Apr.	36	32	21	65.63
Parasitism efficiency	114	96	60	62.50

2. Phenacoccus solenopsis:

Finding in Table (5) light that parasitism(%) ranging between (33.33 to 94.44%) over 2022/23 season. Peak value of parasitism percentage (94.44%) was noticed on 22 February, 2023. On the other hand, lesser value of parasitism percentage (33.33%) on 14 December, 2022. Parasitism efficacy through 2022/23 season was 86.89%. Adult of emerged parasitoids were 53 individuals, from 61 nymphs. As, in second season Table (6) clear that parasitism percentage ranging between (0.00 to 61.90%). Maximum percentage (61.90%) on 27 February, 2024, whereas minimal percentage (21.43%) on 16 January, 2024. Overall of parasitism throughout whole season is 46.77%. The parasitism efficiency were the highest during the first season with 86.89%.

Table 5. Percentages of parasitism by parasitoid, *Microterys* spp. on *Phenacoccus solenopsis* numphs infesting sugar beet field during first season, 2022/23.

Date	No. of nymphs	No. of emerged Parasitoids	% parasitism
14 Dec. 2022	3	1	33.33
20 Dec.	6	5	83.33
13 Jan. 2023	13	11	84.62
22 Feb.	18	17	94.44
20 Mar.	21	19	90.48
Parasitism efficiency	61	53	86.89

Table 6. Percentages of parasitism by parasitoid, *Microterys* spp. on *Phenacoccus solenopsis* numphs infesting sugar beet field during second season, 2023/24.

Date	No. of nymphs	No. of emerged Parasitoids	% parasitism
16 Dec. 2023	1	0	0.00
22 Dec.	3	1	33.33
16 Jan. 2024	14	3	21.43
27 Feb.	21	13	61.90
28 Mar.	23	12	52.17
Parasitism efficiency	62	29	46.77

Data considering in Table (7) show that the correlation coefficient values between (*P. mixta*, *S. ocellatella* and *Phenacoccus solenopsis*) and their parasitoids; (*Opius nitidulator*, *Diadegma* spp. and *Microterys* spp.) were calculated according to Snedecor and Cochran (1989), during 2022/23 and 2023/24 seasons. In the two seasons, highly positive significant correlations were recorded with (R^2) values

(0.861**, 0.963** and 0.933**) and (0.902**, 0.951** and 0.900**) in season 2022/2023 and season 2023/2024, respectively.

Table 7. Correlation coefficient values between *P. mixta*, *S. ocellatella* and *Phenacoccus solenopsis* & their associated parasitoids in sugar beet fields during 2022/23 and 2023/24 seasons.

Relationship	Season,2022/23		Season,2023/24	
	R ² value	Significance Status	R ² value	Significance Status
<i>P. mixta</i> pupae × <i>Opius nitidulator</i>	0.861	**	0.902	**
<i>S. ocellatella</i> pupae × <i>Diadegma</i> spp.	0.963	**	0.951	**
<i>Phenacoccus solenopsis</i> nymphs × <i>Microterys</i> spp.	0.933	**	0.900	**

In such concern, Many authors indicate the importance of parasitoids in reducing sugar beet insects under the threshold injury level (Nema and Sharma, 2002; Abbasipour *et al.* 2012; Hendawy and El-Fakharany, 2017 and Khalifa, 2018). Also, Bazazo (2010) indicated that sugar beet has enormous natural enemies that should be conserved to keep the insect pests under the economic threshold levels. Ballal and Verghese (2015) reported that the use of parasitoids as biological control agents is the most effective, environmentally sound, and cost-effective pest management approach to control insects. Kalyanasundaram and Kamala (2016) indicated that natural enemies has recently gained much interest because of the problems encountered by use of pesticides and environmental concerns. Moreover, Clarke *et al.*, (2019) found that parasitoids are among arthropods that are most widely used in biological control against crop pests and thus are an important elements in (IPM) programs. Further, Mousa (2005) indicated that *O. nitidulator* a main factor in regulating the population density of *P. mixta* in sugar beet fields. The average of parasitism were 18.36% and 20.21% at first season and second season, respectively. EL-Sheikh (2017) reported that the average rates of parasitism by *Opius nitidulator* were 25.00% and 27.22%. Bazazo *et al.* (2017) reported percentage of parasitism by *O. nitidulator* on *P. mixta* ranging between 1.2% to 100% and 9.9% to 52.8% in the two seasons, respectively. Average rates of parasitism, 25.11% and 27.73% in the two seasons, respectively. Awadalla, *et al.* (2018) found that *O. nitidulator* represented by (9.4 ±2.8 and 11.8 ±2.1 individuals) during 2015/16 and 2016/17 seasons, respectively. The average percentages of parasitism on sugar beet were (14.2% and 17.1%). On the other hand, Bazazo and Ibrahim (2019) found that the mean of parasitism by *D. oranginator* were (55.17%, 60.46% and 68.91%) at the three cultivations in 2016/17 season, respectively. While the mean of parasitism were (57.57%, 44.44%, and 62.71%) at the three cultivations in 2017/18 season, respectively. Also, Awadalla, *et al.* (2020) reported that average number of parasitized pupae caused by *Diadegma* sp. was ranged between 0.6±0.24 individuals in August plantation and 2.5±0.42 individuals in October plantation in the first season, 2018/19. While in the second season, 2019/20, the highest average number of the total *S. ocellatella* pupae and the highest average number of emerged moth were recorded in August plantation and represented by 11.2±1.93 and 9.4±2.29 individuals. Bazazo and Hassan (2021) indicated that new parasitoid was identified as

Diadegma aegyptiator on *S. ocellatella* for the first time in Egypt. The Overall of parasitism were 24.52 and 31.03% in 2018/19 and 2019/20 seasons, respectively. Lastly, Japoshvili

and Soethof (2022) reported that survey of parasitoid wasps, the number of encyrtid species known from the Netherlands increased from 106 to 123. *Microterys nederlandicus* Japoshvili sp. n. is described as new for science.

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كفاءة التطفل لبعض الطفيليات الحشرية على بعض حشرات بنجر السكر

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الملخص

من أجل زيادة وتنشيط دور الطفيليات الحشرية كأحد العناصر الهامة للمكافحة البيولوجية لحشرات بنجر السكر. أجريت التجربة الحالية بالمزرعة البحثية لمحطة البحوث الزراعية بسخا وكذلك معمل قسم بحوث المحاصيل السكرية – سخا. كفر الشيخ خلال موسمي 2023/2022 و 2024/2023. أسفرت النتائج عن أن كفاءة التطفل للطفيل *Opius nitidulator* على يرقات ذبابة البنجر كانت 36.14 % و 43.06 % خلال موسم 2023/2022 و 2024 /2023 على التوالي. وكفاءة التطفل للطفيل *Diadegma* spp. على يرقات فراشة البنجر كانت 46.43 % و 62.50 % خلال موسمي الدراسة على التوالي. وكذلك كفاءة التطفل للطفيل *Microterys* spp. على بق القطن الحقيقي كانت 86.89 % و 46.77 % في كلا الموسمين على التوالي. علاوة على ذلك أثبت التحليل الإحصائي أن الارتباط بين هذه الحشرات والطفيليات عالي المعنوية خلال موسمي الدراسة. بناءً على هذه النتائج نجد أن هذه الطفيليات تلعب دوراً هاماً وحيوياً في السيطرة على هذه الحشرات.