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The Larval-Pupal Parasitoid, *Enicospilus repentinus* (Hol.) and Resistant Varieties as Bio-Agents for Regulating Populations of *Scrobipalpa ocellatella* Boyd. in the Egyptian Sugar Beet Fields

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ABSTRACT

Sugar beet is widely grown across the world as a source of sucrose. Like all crops, sugar beet suffers threats to achieving maximum yield due to a range of pests and careful management of these threats is required to limit yield loss. One pest which poses a threat to sugar beet crops all over the world *Scrobipalpa ocellatella Boyd*. Currently, insect pest control in sugar beet fields 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 parasitoids and resistant varieties. Thus, the present paper was carried out at the Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh Governorate Egypt in 2019/ 20 and 2020/21 seasons.

Findings have succeeded to recorded the larval-pupal parasitoid, *Enicospilus repentinus* (Hymenoptera: Ichneumonidae) on *Scrobipalpa ocellatella* Boyd. for the first time in Egyptian sugar beet fields. Seasonal parasitism was 48.83, 50.87 and 62.76% to the three cultivations, respectively in season 2019/20. As, 42.85, 41.50 and 48.45% to the three cultivations, respectively in season 2020/21. Alauda, Maimound and Clgogne varieties are resistant to *S. ocellatella* whereas, Bts 3980, Bts 8115 and Nefirlitis are susceptible. Consequently, *E. repentinus* parasitoid and resistant varieties may be used in IPM program against *S. ocellatella* under the Egyptian sugar beet conditions.

INTRODUCTION

Sugar beet, *Beta vulgaris* L. (Family: Chenopodiaceae) is planted in about 40 countries of the world and accounts for 40-45% of the world's total sugar production. It 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 grown area of this crop is about 650000 Faddans in 2020 season (Anonymous, 2021). The Egyptian government encourages sugar beet growers to increase the cultivated area with sugar beet to raise sugar production and decrease the gap between sugar production and consumption (Mirvat *et al*., 2014). It encourages the growers to grow sugar beet instead of sugar cane as a water-saving measure (Khalifa, 2017). Sugar beet crop attack by numerous insect pests beginning from seed germination up to harvest (Bazazo, 2005; Bazazo, 2010; Khalifa, 2018; El-Dessouki, 2019 and Fatma H. Hegazy and El-Sheikh, 2021). These insect pests proved to reduce the crop quality (Sugar percent) and quantity (roots weight per feddan) (Shalaby *et al*., 2011; Rashed, 2017; Neamat, 2018 and Bazazo, 2019).

Scrobipalpa ocellatella Boyd. (Lepidoptera: Gelechiidae) one of the most destructive insects to sugar beet crop that causes roots weight and sugar percent yield loss (Ahmadi *et al*., 2018). In Egypt (Abo-Saied Ahmed (1998) reported that severe infestation of sugar beet with this insect caused a significant reduction of 38.20 and 52.40% in root weight and sugar content (%), respectively.Many authors recorded assorted species of parasitoids on this insect. They proved the efficiency of these parasitoids in controlling this insect population like; *Trichogramma evanescences* West (Marie, 2004 and Mesbah *et al*., 2004), *Pachycrepoidens Vinedemmiae* (Rondani) (El-Serway, 2008). *Agathis* sp. (Bazazo, 2010), *Microchelonus subcontracts* and *Bracon intercessor* Nees (Abbasipour *et al*., 2012), *Diadegma pusio L*. (Abbasipour *et al*., 2013), *Diadegma* sp. (Khalifa, 2018), *Diadeama oranginator* Aubert (Bazazo and Ibrahim, 2019) and *Diadegma aegyptiator* (Bazazo and Hassan, 2021).

Resistant varieties are an economical and environmentally friendly method of pest control. It plays a vital role in reducing crop losses and protecting the environment. Numerous investigators studied the importance of resistant varieties in managing sugar beet insects without using insecticides such as; Abou El-Kassem (2010) recorded Oscarpoly and Farida as the least resistant cultivars, while Lados the most resistant, Also, Neamat (2018) showed that Marwa and Meralda are the most resistant, as Dreaman and Mirage were the most susceptible to sugar beet insects.

So, this present work was done to research and identify new parasitoids on this insect. In addition to the role of resistant varieties in regulating their populations.

MATERIALS AND METHODS

Insect and Parasitoids:

This research was performed at the Experimental farm of Sakha Agricultural Research Station, Kafr El-Sheikh Governorate during 2019/20 and 2020/21 seasons. One faddan was cultivated with pleno variety on 20th August, 20th September and 21st October during the three cultivations, respectively in 2019/20. On 25th August, 19th September and 20th October to the three cultivations, respectively in 2020/21. The full-grown larvae were gathered by a fine brush from the prior field, 30 plants each sampling date. The larvae were put into paper bags and transmitted to the laboratory and put into Petri dishes (9cm) with pieces of sugar beet leaves, till the later instar under laboratory condition (25 ± 2˚c, 60-70 R.H.). After that, the pupae were posited into another Petri dish till parasitoids or moths emergence. The sampling date is from 30 November to 30 January, 20 December to 20 February and 20 January to 30 March for the three cultivations, respectively in 2019/20. Also, from 29 November to 29 January, 19 December to 19 February and 19 January to 19 March throughout the three cultivations, respectively in 2020/21. Parasitism (%) was calculated on every sampling date. The percentage of parasitism was calculated according to the following formula: -

$$\textbf{Parasitism \%} = \frac{\textbf{No. of emerged parasitoid adults}}{\textbf{No. of } \textbf{\textit{S. ocellatella}} \textbf{ pupae}} \times \textbf{100}$$

Parasitoids were identified by the Department of Insect Taxonomy at the Plant Protection Research Institute, Agricultural Research Center, Egypt. The specimens were identified as *E. repentinus*. The correlation coefficient between the number of *S. ocellatella* pupae and their associated parasitoid, *E. repentinus* was determined for the three cultivations during the first and second seasons.

Resistant Varieties:

This experiment was done in another sugar beet field to evaluate the prorated susceptibility of six sugar beet varieties called; Alauda, Maimouna, Clgogne, Bts 3980, Bts 8115 and Nefirlitis to infestation with the beet moth, *S. ocellatella*. The experimental area for each variety was 63 m2 divided into 3 replicates (each replicate 21 m^2). A completely randomized block design was applied. The previous varieties were planted on 20^{th} October during the two seasons; 2019/20 and 2020/21. All recommended agricultural practices were followed along the growing seasons without any insecticide applications. The examination by the visual record was taken on 30 January, 20 February and 20 March in 2019/20. Also, on 29 January, 22 February and 25 March in 2020/21. Thirty sugar beet plants (10 plants/replicate) for each sampling date were examined. The numbers of larvae and infested plants were counted every date.

Statistical Analysis:

Data of all parameters were statistically analyzed using analysis of Variance (ANOVA) according to the standard procedure of Shedecor and Cochran (1980), and the means were compared using L.S.D. test to check difference at 5% significant level. All statistical analyses were performed with a software package CostateR statistical software, version 6.311 (Costet statistical software, 2005), a product of Cohort software, Monterey, California.

RESULTS AND DISCUSSION

Seasonal Parasitism:

The data presented in Table (1) indicated that in the first season 2019/20, the percentage of parasitism caused by the larval-pupal parasitoid, *E. repentinus* on the beet moth, *S. ocellatella* ranged between (0.00 to 100 %), (0.00 to 75. 00%) and (27.27 to 85.71%) for the three sugar beet cultivations, respectively during 2019/20 season. Also, 43, 57 and 94 pupae were obtained in total, 21, 29 and 59 of which were parasitized to the three cultivations, respectively. Results also, revealed that the average rate of seasonal parasitism recorded 48.83, 50.87 and 62.76% to the three cultivations, respectively.

Table 1: Seasonal parasitism of *E. repentinus* on *S. ocellatella* during 2019/20 season.

Date	1st Cultivation			2nd Cultivation			3rd Cultivation		
	No.*	No.* *	% Parasitism	No.*	No.* *	% Parasitism	No.*	No.* *	% Parasitism
30/11	1	1	100.00	-	-	-	-	-	-
10/12	2	0	0.00	-	-	-	-	-	-
20/12	4	2	50.00	3	0	0.00	-	-	-
30/12	6	2	33.33	5	2	40.00	-	-	-
10/1	8	4	50.00	6	2	33.33	-	-	-
20/1	11	6	54.54	9	3	33.33	8	3	37.50
30/1	11	6	54.54	10	4	40.00	11	3	27.27
10/2	-	-	-	12	9	75.00	11	5	45.45
20/2	-	-	-	12	9	75.00	13	6	46.15
10/3	-	-	-	-	-	-	14	11	78.57
20/3	-	-	-	-	-	-	16	13	81.25
30/3	-	-	-	-	-	-	21	18	85.71
Seasonal parasitism	43	21	48.83	57	29	50.87	94	59	62.76
Parasitoid-host ratio	1: 2.04			1: 1.96			1: 1.59		

* No. of pupae **No. of parasitoids

As shown in Table (2) the percentage of parasitism in the second season 2020/21, varying from (0.00 to 100 %), (0.00 to 54.54%) and (0. 00 to 86.36%) for the three cultivations, respectively. Also, 21, 53 and 97 pupae were obtained in total, 9, 22 and 47 of which were parasitized to the three cultivations, respectively. While the average rate of seasonal parasitism was 42.85, 41.50 and 48.45 % to the three cultivations, respectively. Also, these tables indicate that the parasitoid-host ratio was 1: 2.04, 1: 1.96 and 1: 1.59 for the three cultivations, respectively in 2019/20. In 2020/21 season, 1: 2.33, 1: 2.40 and 1: 2.06 to the three cultivations, respectively.

Table 2: Seasonal parasitism of *E. repentiuns* on *S. ocellatella* during 2020/21 season.

Date	1st Cultivation			2nd Cultivation			3rd Cultivation		
	No.*	No.* *	% Parasitism	No.*	No.* *	% Parasitism	No.*	No.* *	% Parasitism
29/11	0	0	0.00	-	-	-	-	-	-
9/12	1	0	0.00	-	-	-	-	-	-
19/12	1	1	100.00	2	1	50.00	-	-	-
29/12	3	1	33.33	4	0	0.00	-	-	-
9/1	5	3	60.00	7	3	42.85	-	-	-
19/1	5	2	40.00	9	3	33.33	6	0	0.00
29/1	6	2	33.33	9	4	44.44	10	2	20.00
9/2	-	-	-	11	5	45.45	10	3	30.00
19/2	-	-	-	11	6	54.54	15	7	46.66
28/2	-	-	-	-	-	-	16	7	43.75
9/3	-	-	-	-	-	-	18	9	50.00
19/3	-	-	-	-	-	-	22	19	86.36
Seasonal parasitism	21	9	42.85	53	22	41.50	97	47	48.45
Parasitoid-host ratio	1: 2.33			1: 2.40			1: 2.06		

A highly significant correlation coefficient values were calculated according to Snedecor and Cochran (1989), between *S. ocellatella* pupae and their parasitoid, *E. repentinus* during 2019/20 and 2020/21 seasons in Table (3). Highly positive significant correlations values of “r” were 0.966**, 0.920** and 0.957** in the three cultivations, respectively in the 2019/20 season. While, values of “r” were 0.881**, 0.921** and 0.944** in the three cultivations, respectively in the 2020/21 season.

Table 3: Correlation coefficient between *S. ocellatella* pupae and associated parasitoid, *E. repentinus* in sugar beet fields, to the three cultivations, during 2019/20 and 2020/21 seasons.

Relationship	2019/2020					
	1st Cultivation		2nd Cultivation		3rd Cultivation	
S. ocellatella pupae x *E. repentinus*	“r” value	Status of Significance	“r” value	Status of Significance	“r” value	Status of Significance
	0.966	**	0.920	**	0.957	**
	2020/2021					
	1st Cultivation		2nd Cultivation		3rd Cultivation	
	“r” value	Status of Significance	“r” value	Status of Significance	“r” value	Status of Significance
	0.881	**	0.921	**	0.944	**

Also, in Warsaw, Sawoniewicz (1982) indicated that *E. repentinus* is an important parasitoid against larvae and pupae of insects. Hilal (2015) recorded the dominant hosts of *E. repentinus* are *Agrotis ripae* Hub. (Noctuidae), *Lycia hirtaria* Cl. (Geometridae), *Phigalia* *pilosaria* Denis (Geometridae) and *Zerynthia ruminaL.* (Papilionidae) these previous hosts are lepidopterous larvae. In Britain's fields, Broad and Shaw (2016) noted that *Enicospilus stephens* is a distinctive genus of primarily nocturnal parasitoids of relatively large Lepidoptera larvae (Lasiocampidae, Geometridae and Notodontidae). Also, Klopfstein *et al*., (2019) showed that the Ichneumonidae is one of the largest families of insects and the largest in the order Hymenoptera, with more than 25000 species. *E. repentnus* is an important ichneumonide parasitoid in Switzer land.

Resistant Varieties:

Tables (4 and 5) show that Alauda, Maimouna and Clgogne are resistant to *S. ocellatella*. Whereas, Bts 3980, Bts 8115 and Nefirlitis are susceptible varieties to this insect during the two seasons. Statistical analysis revealed significant differences among the evaluated varieties. The number of infested plants and larvae is higher in susceptible varieties than resistant ones. In the 2019/20 season, the mean number of the infested plants were; 2.66, 2.33 and 2.66 to Alauda, Maimouna and Clgogne, respectively. As, 16.33, 17.33 and 17.66 to Bts 3980, Bts 8115 and Nefirlitis, respectively. Concerning, the mean number of larvae were 3.00, 3.00 and 3.33 to Alauda, maimouna and clgogne, respectively. While, 17.00, 18.66 and 18.00 to Bts 3980, Bts 8115 and Nefirtitis, respectively.

In the 2020/21 season, the mean number of the infested plants were; 2.33, 2.00 and 2.00 to Alauda, Maimona and Clgogne, respectively. While, 11.00, 11.33 and 11.00 to Bts 3980, Bts 8115 and Nefirtilis, respectively. In case of the mean number of larvae were 2.00, 2.66 and 2.66 to Alauda, Maimouna and Clgogne, respectively. While, 14.00, 13.33 and 13.00 for Bts 3980, Bts 8115 and Nefirlitis, respectively.

Many investigators demonstrated the relationship between resistant varieties against insects and sugar beet yield. Resistant varieties are more high yield than susceptible ones. In England, Dewar and Cooke (2006) reported that the sugar beet crop is infested by a wide range of pests that cause damage to the leaves and roots, leading to substantial yield loss.
Also, Dewar (2005) concluded that resistant varieties to beet insects are more high yield than susceptible ones. In such Concern, Luczak (1996) showed that resistant varieties to leaf-feeding insects such as beet moth are major elements in increasing sugar beet yield.

Table 4: Seasonal mean number of infested plants and *S. ocellatella* larvae on certain sugar beet varieties during 2019/20 season.

Varieties	No. of infested plants	Mean number of infested plants /30 plants	No. of larvae	Mean number of larvae/ 30 plants	Degree
Alauda	8	2.66[b]	9	3.00[b]	Resistant
Maimouna	7	2.33[b]	9	3.00[b]	Resistant
Clgogne	8	2.66[b]	10	3.33[b]	Resistant
Bts 3980	49	16.33[a]	51	17.00[a]	Susceptible
Bts 8115	52	17.33[a]	56	18.66[a]	Susceptible
Nfirtitis	53	17.66[a]	54	18.00[a]	Susceptible
L.D.S 0.05%	2.98				

In a column, means followed by the same letter are not significantly differential the level 5%.

Table 5: Seasonal mean number of infested plants and *S. ocellatella* larvae on some sugar beet varieties in 2020/21 season.

Varieties	No. of infested plants	Mean number of infested plants /30 plants	No. of larvae	Mean number of larvae/ 30 plants	Degree
Alauda	7	2.33[b]	6	2.00[b]	Resistant
Maimouna	6	2.00[b]	8	2.66[b]	Resistant
Clgogne	6	2.00[b]	8	2.66[b]	Resistant
Bts 3980	33	11.00[a]	42	14.00[a]	Susceptible
Bts 8115	34	11.33[a]	40	13.33[a]	Susceptible
Nfirtitis	33	11.00[a]	39	13.00[a]	Susceptible
L.D.S 0.05%	3.21				

In a column, means followed by the same letter are not significantly differential the level 5%.

CONCLUSION

According to the results of the study, the parasitoid, *E. repentinus* was recorded for the first time on the beet moth, *S. ocellatella* in the Egyptian sugar beet fields. This study showed that the sugar beet varieties: Alauda, Maimouna and Clgogne are resistant to *S. ocellatella* in comparison to other varieties: Bts 3980, Bts 8115 and Nefirlitis to this insect. Thus, *E. repentinus* parasitoid and resistant varieties can be applied in IPM program against *S. ocellatella* under the Egyptian sugar beet conditions.

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ARABIC SUMMARY

دور الطفيل اليرقي-العذري (.Hol) *Enicospilus repentinus* والأصناف المقاومة كعناصر حيوية في الحد من عشيرة حشرة فراشة البنجر في الحقول المصرية لبنجر السكر

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[2] قسم الحشرات الاقتصادية والحيوان الزراعى – كلية الزراعة – جامعة المنوفية – مصر

يزرع بنجر السكر على نطاق واسع في جميع أنحاء العالم كمصدر للسكروز. يعاني بنجر السكر مثل جميع المحاصيل من تهديدات لتحقيق أقصى قدر من المحصول بسبب مجموعة من الآفات ، ويلزم بحرص إدارة لهذه التهديدات للحد من فقد المحصول. وتعتبر فراشة البنجر أحد الآفات التي تشكل تهديدًا لمحاصيل بنجر السكر في جميع أنحاء العالم. حاليًا ، تعتمد مكافحة الآفات الحشرية في حقول بنجر السكر على برامج الإدارة المتكاملة للآفات (IPM) لتجنب استخدام المبيدات الحشرية. يمكن تحقيق المكافحة المتكاملة للآفات الحشرية في بنجر السكر من خلال تطبيق مجموعة من الممارسات مثل الطفيليات والأصناف المقاومة. ولذلك تم إجراء هذا البحث بالمزرعة التجريبية بمحطة البحوث الزراعية بسخا بمحافظة كفر الشيخ مصر في موسمي 20/2019 و 21/2020.

نجحت النتائج في تسجيل الطفيل (Hymenoptera: Ichneumonidae) *Enicospilus repentinus* اليرقي-العذري لحشرة فراشة البنجر ، لأول مرة في الحقول المصرية لبنجر السكر. بلغت نسبة التطفل الموسمي 48.83 و 50.87 و 62.76٪ للعروات الثلاثة على التوالي في موسم 20/2019. كما بلغت 42.85 و 41.50 و 48.45٪ للعروات الثلاثة على الترتيب فى موسم 21/2020. وكانت أصناف Alauda و Maimound و Clgogne مقاومة لحشرة فراشة البنجر، في حين أن أصناف Bts 3980 و Bts 8115 و Nefirlitis كانت حساسة للإصابة. وبالتالي ، يمكن استخدام الطفيل *E. repentinus* والاصناف المقاومة في برنامج المكافحة المتكاملة للآفات ضد حشرة فراشة البنجر علي بنجر السكر تحت الظروف المصرية.

كلمات مفتاحيه: فراشة البنجر - الطفيل *Enicospilus repentinus* - الاصناف المقاومة - بنجر السكر- الحقل.