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Field Evaluation of Organophosphorus Insecticides, Chlorpyrifos and Fungal Bio-Pesticides, *Beauveria bassiana* Towards the Sugar Beet Moth *Scrobipalpa ocellatella* (Lepidoptera: Gelechiidae) and Studying their Effect on the Population Size of the Associated Arthropod Predators in the Egyptian Sugar Beet Fields.

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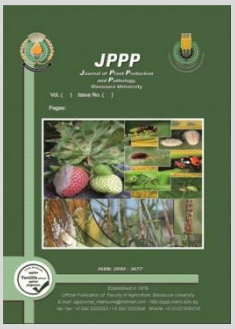

ABSTRACT

The sugar beet productions are generally threatened by the sugar beet moth *Scrobipalpa ocellatella* causing enormous yield loss. The current study was done to evaluate the effectiveness of one of the traditional insecticides (Chlorpyrifos) and the fungal-based bio-pesticides (Biossiana®) against the sugar beet moth during the two successive growing seasons (2020-2021) and to investigate their safety in the associated arthropod predators in Kafr El-Sheikh Governorate. The dose recommended by the Egyptian agricultural ministry was used to apply the tested pesticides. Results showed that the tested Chlorpyrifos induced a high reduction percentage in the size population of *S. ocellatella* as well as for the arthropod predators associated with the pest through the two seasons of investigation while the tested bio pesticides product based on entomopathogenic *B. basssiana* (Biossiana®) Caused maximum reduction percentage for *S. ocellatella* that reaches 92.9 % in both seasons. When compared to untreated areas, Tac® was effective against the S. ocellatella larvae population after the initial treatment and three days later, causing 77.03 and 83.05% respectively. The obtained results showed that the tested Biossiana® lower reduction percentage for the arthropod predators associated with the pest compared to the untreated area in addition to the ability of the arthropod predators to compensate for their effect. Therefore, it is considered that farmers in Egypt can effectively utilize Tac® and Biossiana® as a part of integrated pest management. Programs. Biossiana® might be an excellent alternative that could be used in IPM control programs with no considerable hazards to associated arthropod predators.

Keywords: *Scrobipalpa*, Chlorpyrifos, *beauveria*, predators, biological control.

INTRODUCTION

The Sugar beet (*Beta vulgaris* L.) (Family: Chenopodiaceae) is an industrial economic crop that benefited from a high sucrose source of Egypt's sugar supply (El-Fergani, 2019). The sugar beet moth *Scrobipalpa ocellatella* (Lepidoptera: Gelechiidae) is one of the most serious threats to sugar beet production in Egypt causing economically great yield loss (Amin *et al*., 2008, El -Khouly *et al*.,2011). *Paederus alfireri* and *Coccinella* sp. are important beneficial insects in sugar beet fields feeding on the different stages of *S. ocellatella* (El-Dessouki *et al*. (2014). Larvae of *P. alfireri* occur naturally over the year in the field and can be produced commercially and participate successfully in biological control programs (Pappas *et al*. 2011). In the sugar beet fields, the picture of the beneficial insect differed greatly due to the provocative use of insecticides in the control programs. This harmful effect on the natural enemies should be condemned and new insecticide groups with a novel mode of action along with some biological control agents such as entomo-pathogenic fungi should be developed. *Beauveria bassiana* is considered one of the main bio-pesticide agents used to maintain the pest density below the economic threshold due to its unique behaviour to infect the target host directly through the integument (Lacey et al., 1996). In the present study, we investigate the role of one of the most extensively used organophosphorus insecticides, chlorpyrifos (Tac®), and one of the promising biopesticides products based on entomopathogenic *B. basssiana* (Biossiana®) to suppress the population of the sugar beet moth *S. ocellatella* larvae. At the same time, their toxicity toward their common associated arthropod predators, Coccinellidae (adults) and *P. Alfieri (larvae)* was screened out. Our study aimed principally to find some selective insecticides that could be used in compatible with biological control and to evaluate their potential use in IPM programs in Egypt.

MATERIALS AND METHODS

Tested Insecticides

1- Biopesticidesdes: Biossiana®, *Beauveria bassiana*, ($1x10^8$ CFU^1 /gm) 2.5%WP applied at the rate of 250 gm/100L. The commercial bio-pesticides were procured locally from the Bio-insecticide Production Unit, Plant Protection Research Institute, Agriculture Research Centre, Dokki, Giza.

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2- Organophosphorus compound, Chlorpyrifos (Tac ®, Organophosphorus: *O, O*-Diethyl *O*-(3, 5, 6-trichloropyridin-2-yl) phosphorothioate, Acetylcholinesterase (AChE) inhibitors, 48% E.C., China) applied at the rate of 1L/Feddan.

Study site:

The field experiments were conducted in the Dafarea district, Kafr El-Sheikh Governorate, Egypt.

Field trials

The field trials involved cultivating sugar beet that had been infected with *S. ocellatella* during the two subsequent planting seasons in December 2020 and 2021, Each year, identical treatments were done in the two field studies. The local (Farida) variety of sugar beet was grown at the end of December for the two seasons in an area of about 168 m^2 in a complete randomized block design. The experimental area was divided into four plots (each about 42 m^2). Two rows of plants as control were left untreated in between each plot. The treatments were carried out on January 15th. The spraying was carried out three times with two weeks intervals between sprays. All treatments were performed at the sunset using one motor knapsack sprayer with 20 litres of spraying preparation for both compounds. While control plots were sprayed with water only, the tested pesticides were treated with the recommended field rates. From each plot of every treatment,10 plants were selected and examined immediately just before the first application and after 1, 3 and five days after application of Tac ® and after 3, 7 and ten days after application of Biossiana®. At the same field investigation time, samples of the associated arthropod species; Coccinellidae (adults) and *P. alfireri (larvae)* were selected and counted The efficiency of the organophosphorus insecticides Tac ® and bio-insecticides Biossiana® was measured as a percentage of reduction in infestation density of *the sugar beet moth S ocellatella* larvae as well as against the beneficial predators *Coccinella* sp and *P. alfireri*. The agricultural practices were followed according to the recommendations of the Ministry of Agricultural.

Statistical analysis

Reduction in the *S ocellatella* larvae population, as well as the associated arthropod predators for all treatments in the two growing seasons, were calculated using Henderson and Tilton's formula (1955) as follows:

$$\text{Reduction \%} = \left\{1 - \frac{n \text{ in Co before treatment} \times n \text{ in T after treatment}}{n \text{ in Co after treatment} \times n \text{ in T before treatment}}\right\} \times 100.$$

n: Insect population, T: treated Co: control

RESULTS AND DISCUSSION

During two successive seasons, December (2020-2021) the efficiency of the recommended Organophosphorus compound Chlorpyrifos (Tac ®) 48% E.C and fungal-based Bio-pesticides Biossiana®, *Beauveria bassiana* 2.5%WP were assessed through field evaluation for suppressing *S. ocellatella* larvae colonies in sugar beet fields. Meanwhile, the capacity of the most associated arthropod predators, Coccinellidae (adults) and *P. alfireri (larvae)* to withstand the side effects of these treatments during the whole investigation. The number of *S. ocellatella* larvae and the targeted predators were recorded before and after treatments and the reduction percentage was calculated (Tables 1&2 and 3).

The data in Table (1) represents the reduction percentage of the *S. ocellatella* larvae population in the sugar beet field after treatment with both tested insecticides during the 2020 season. During field investigation in the first season, 2020 it was noticed that Tac ® was effective against the *S. ocellatella* larvae population after initial treatment and three days post-treatment compared to untreated areas causing nearly 77.03% and 83.05% respectively. Biossiana® showed a gradual reduction in the population size and reached 74.56 % after seven days compared with the untreated area. After ten days post-treatment, high reduction percentages were achieved with a complete reduction of 100% by Tac® the time that Biossiana® showed a high reduction percentage of 92.38%. Table (2) represented the reduction percentage of the *S. ocellatella* larvae population treated with the tested insecticides in season 2021. There were no differences in the effect of both insecticides against the *S. ocellatella* larvae population in the two seasons of study. The obtained data showed that Tac ® achieved about 78.35, 86.23 and 92.59 % reduction percentage after 1, 3 and 7 days respectively These results were in line with Hegazy (2018) who mention that Tac ® induced reduction in the population size of *S. ocellatella* in the 1st and 2nd season about nearly 91, 92 % respectively. Biossiana® showed a 66.66% reduction percentage after seven days post treatments compared to the untreated area. While complete reduction of 100% was achieved by Tac® after 10 days post-treatment and Biossiana® showed a 92.5% reduction percentage compared to the untreated area. As well, the overall mean reduction percentage in the 1st and 2nd seasons were 91.32 & 92.9% for Tac ® and 68.21 & 63.8% for Biossiana® respectively. The associated predators with *S. ocellatella* were Coccinella sp (adults) and *P. alfierii*. As for the effect of the tested insecticide (Tac 48% EC) and biopesticide, Biossiana®, *Beauveria bassiana* 2.5%WP) on the population size of the associated predatory insect, Coccinella sp (adults) and *P. alfireri* (larvae), In the first season 2020, the obtained data in Table 3 showed that the reduction percentage in the population size of the *Coccinella sp.* in sugar beet fields greatly influenced after treatment with Tac ® that cause complete reduction during the first week and reached 95% after ten days, the same pattern of the reduction happened in the next season 2021. On the other hand, Biossiana® caused a minimal reduction percentage that did not exceed over 37% in the first season and 49% in the second season ten days post treatments. Meanwhile, the population size of *P alfireri* was dramatically affected after the treatment with Tac ® until the 10 days in both seasons 2020-2021. On the contrary, in the case of treatments with Biossiana®, the reduction percentage did not exceed 49 and 40% during the 1st and 2nd seasons respectively. The overall mean reduction percentages ranged between 30.8 to 31.97 in the case of treatments with Biossiana® and in the case of treatment with Tac ® ranged between 99.18 to 99.12 during the 1st and 2nd seasons respectively. Our findings agreed with Abd El-Gawad (2007) who revealed that the conventional insecticides were the most effective towards the sugar beet moth *S. ocellatella* with a highly suppressive effect on their associated predators Coccinellidae (adults) and *P. alfierii*.

The complete eradication of *P. alfierii* throughout the investigation proved that it could not withstand chlorpyrifos with the recommended doses and these results disagree with El-Maghraby *et al*., (1994) who mentioned that some

predators showed the ability to adapt to treatment with low dosages of certain insecticides through complete chemical applications. On the other hand, Biossiana® has a promising effect on the sugar beet moth especially in cases of early infestation with minimal effect on the associated predators compared to traditional insecticides. Entomopathogenic Hyphomycetes such as *B. bassiana* and *Metarihizium anisopliae* were suggested in control programs due to their high effectiveness with a wide range of pest populations Smith *et al*. 1999 and Ahmed *et al*. 2020. Fergani and Refaei, (2021) proved that B. bassiana-based bio insecticides were more effective than other microbial pesticides causing high mortality percentage and morphogenetic abnormalities in different stages of larvae, egg and adult including pupation period in the soil in lepidopterous insects in the time it considered as an excellent alternative to conventional insecticides offering eco-friendly control agent with minimal residue (Fergani and Yehia 2020) and no hazardous to associated arthropod predators. This also was in alignment with (Hanafi, 1999 and El-Fergani, 2019) that revealed that bio-pesticides showed satisfactory results in control programs when the initial level of infestation with lepidopterous insects was relatively low and considered safer to the natural enemies under the field conditions as well as eco-friendly to plants, humans, and animals (Wu et al., 2014) and recommended to be included in IPM programs with selected insecticides groups.

Table 1. Reduction percentage of *Scrobipalpa ocellatella* larvae in sugar beet field after treatment with the tested insecticides during the 2020 season.

Treatments	Before treatment	Days after treatments								Overall mean of reduction (%)
	Mean	1 DAY (initial)		3 DAYS		7 DAYS		10 days		
		Mean	Reduction%	Mean	Reduction%	Mean	Reduction%	Mean	Reduction%	
Biossiana®	8.75			6.25	37.73	2.75	74.56	1	92.38	68.21
Tac ®	9.00	2.25	77.03	1.75	83.05	1	91.01	0	100	91.32
Untreated area	8.50	9.25		9.75		10.50		12.75		

Table 2. Reduction percentage of *Scrobipalpa ocellatella* larvae in sugar beet field after treatment with the tested insecticides during 2021season.

Treatments	Before treatment	Days after treatments								overall mean of reduction (%)
	Mean	1 DAY (initial)		3 DAYS		7 DAYS		10 days		
		Mean	Reduction%	Mean	Reduction%	Mean ±SE	Reduction%	Mean	Reduction%	
Biossiana®	9			6.5	40.33	4.5	66.66	10	92.5	63.8
Tac ®	9	2	78.35	1.5	86.23	1.00	92.59	0	100	92.9
Untreated area	9.5	9.75		11.50		14.25		17		

Table 3. The reduction percentage of associated predators population in sugar beet field after treatment with the tested insecticides during the 2020/ 2021 season.

Treatment	Reduction percentage at indicated days after treatments (%)												Overall mean reduction for all predators(%)	
	Coccinella sp.						*Paederus alfireri*							
	(2020)			(2021)			(2020)			(2021)				
	3 days	7 days	10 days	3 days	7 days	10 days	3 days	7 days	10 days	3 days	7 days	10 days	(2020)	(2021)
Biossiana®	18	31	37	15	32	49	24	30	49	20	36	40	30.8	31.97
Tac ®	100	100	95	100	100	95	100	100	100	100	100	100	99.18	99.12

CONCLUSION

Although the traditional insecticides such chlorpyrifos have a very strong effect on sugar beet pests, they dramatically affect their natural enemies as the associated predators. So some new fungal-based bio insecticides such as Biossiana® should be considered in control programs as a safe alternative to suppress the sugar beet moth if used with the recommended dose and time of application with normal agricultural practices to maintain the population of the pest below the economic threshold and could be considered as a biological control agent of economic pests in agriculture in Egypt and produced on a large-scale.

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التقييم الحقلي للمبيد الفسفوري الكلوروبيروفوس والمبيد الحيوي البيوسيانا تجاه فراشة بنجر السكر ودراسة تأثيرهم على تعداد المفترسات المصاحبة لها في حقول البنجر بمصر

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الملخص

أجريت الدراسة الحالية بمنطقه دفريه محافظه كفر الشيخ – مصر خلال موسمين متتاليين ٢٠٢٠/٢٠٢١ حيث تتغذي فراشات بنجر السكر على أوراق وجذور بنجر السكر وتتسبب في احداث انخفاض كبير في انتاجيه المحصول لذلك كان الهدف من الدراسة اختبار فاعليه وكفاءة كلا من المبيد الفسفوري البيروفوس والمبيد الحيوي البيوسيانا على فراشه بنجر السكر وكذلك تقييم تأثير كلا منهم على حدا تجاه اثنان من المفترسات المصاحبة لفراشة البنجر حيث تعتبر المفترسات من الأعداء الحيوية الطبيعية في المكافحة البيولوجية للحشرات. تم استخدام كلا المبيدين في إطار دراستهم من أجل الوصول لتطبيق حقلي فعال في المكافحة المتكاملة في الظروف البيئية المصرية. وتم إجراء المعاملات الحقلية بالجرعات الموصي بها من وزارة الزراعة.أظهرت النتائج أن المبيدان كانا لهما تأثير عالي السمية في الموسمين حيث أحدثا نسبه خفض في تعداد الفراشات وصلت الي ١٠٠ و٩٢ % للكلوروبيروفوس والبيوسيانا خلال الموسمين ٢٠٢٠ / ٢٠٢١علي التوالي , كما أظهرت النتائج أيضاً ان لمبيد الكلوروبيروفوس تأثير قوي ومدمر لتعداد المفترسين محل الدراسة حيث وصلت متوسط نسبه الخفض الي ٩٩ % خلال الموسمين بينما اظهر مبيد البيوسيانا تأثير منخفض علي كلا المفترسين وصل متوسط الي تقريباً ٣٠% ولهذا تؤكد هذه النتائج ان مبيد البيوسيانا يعتبر من المبيدات الواعدة التي يمكن استخدامها في تقليل تعداد هذه الأفة الخطيرة ومكافحاتها بأمان . كما توصي الدراسة بإدراج مركب البيوسيانا ك ضمن خطط المكافحة المتكاملة لهذه الأفة في مصر.