وزارة الزراعة واستصلاح الاراضى
Ministry of Agriculture and Land Reclamation
مركز البحوث الزراعية
Agricultural Research Center

Egyptian Journal of Plant Protection Research Institute

www.ejppri.eg.net

PLANT PROTECTION RESEARCH INSTITUTE
PPRI

Field evaluation of some insecticides on *Spodoptera littoralis* (Lepidoptera: Noctuidae) larvae and the predator *Chrysoperla carnea* (Neuroptera: Chrysopidae) as well as their effect on roots and sugar level on sugar beet crop

Hend, A. A. Gad

Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

ARTICLE INFO
Article History
Received: 17/ 5/2023
Accepted: 27/6/2023

Keywords

Spodoptera littoralis , field evaluation , insecticides , *Chrysoperla carnea* , roots , sugar level and sugar beet .

Abstract

The efficacy of lufenuron, bancoron 20 % EC, pyridalyl, benadryl 10 % EC and chlorfenapyr, salingersuper 24 % SC were evaluated in the field for controlling *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) and their side effects on *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae) populations, in addition to sugar beet yield throughout 2021 and 2022 seasons. The tested compounds were sprayed at the recommended dose proposed by Agricultural Pesticide Committee (APC). Findings revealed that bancoron incidence had a reduction in *S. littoralis* larvae by 73.02 and 78.75 % during the two seasons, respectively. Also, it caused a reduction in the predator, *C. carnea* populations with 23.40 and 19.46 % in the two seasons, respectively. In such concern, the conventional insecticides (Benadryl and salingersuper) induced a reduction in *C. carnea* ranging between 84.95 to 92.21 %. Moreover, the findings indicated that there were insignificant differences between treated plots with bancoron and conventional insecticides in root and sugar yield of sugar beet during the two seasons. Considering these results, lufenuron is the preferred insecticide in controlling *S. littoralis* larvae and maintaining *C. carnea* populations in comparison with conventional ones. Also, the three insecticides have the same yield.

Introduction

Sugar beet, *Beta vulgaris* L. (Family: Chenopodiacae) is grown commercially for sugar production mostly in temperate regions, due to its high sucrose content in roots. Also, this crop is a promising alternative energy source for ethanol production (Rashid, 1999). Sugar beet is used extensively in the sugar industry in Egypt, providing about 40% of the world sugar production. Nowadays, sugar beet is represented as the first source of sugar in Egypt, from 2014 until now (Anonymous, 2022).

The annual cultivated area of sugar beet is about 700000 feddans. Sugar beet plants are subject to attack by several insect pests from seed germination up to harvest (Saleh *et al*., 2009; Abou-El Kassem, 2010 and Bazazo and Hassan, 2021). Among the most important of them is *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) (Khalifa, 2018). *S. littoralis* is one of the most dangerous insects that infest sugar beet crops, mainly the early plantations (August and September) which may need to be replanted or abolished. In addition, this insect causes great losses in the quantity and quality of sugar beet crops (Amine *et al*., 2022). It became a destructive pest for sugar crops, causing high economic damage (Mahmoud *et al*., 2011).

In Egypt, because of the relatively high temperature throughout August and September, *S. littoralis* severely attack the seedling of the sugar beet crop, causing large bare batches in the field and resulting in high economic losses (El-Mahalawy, 2011). In addition, Said *et al.* (2012) reported that *S. littoralis* is considered as one of the important insects in sugar beet crops. It is active almost all year round. In such concern, Mesbah (1984) in a laboratory study, estimated the leaf area of sugar beet consumed by the entire larval stage of *S. littoralis* as 239.26 cm^2/larvae. Usually, this pest is controlled by using many conventional insecticides which often result in numerous bad and undesirable side effects such as environmental pollution, resistance appears in the target pests and reducing natural enemies. Insecticide resistance is a major problem in the management of this insect because it has developed resistance to many insecticides (Su and Sum, 2014). On the other hand, it was recommended to use new chemistry insecticides that proved to be preferable to conventional insecticides due to their novel mode of action with less eco-toxicity (Che *et al.,* 2013). Insect growth regulators (IGRs) such as lufenuron represent a class of insecticides favorable mammalian and non-toxic to natural enemies (Gogi *et al.,* 2006). Lufenuron, a phenyllbenzoyl urea, is a chitin synthesis inhibitor. It is used to control lepidopterous, dipterous, and coleopterous pests, at the same time is considered compatible with natural enemies (Liopis *et al.,* 2004).

For all previous reasons, the present study was designed to evaluate the efficacy of lufenuron on *S. littoralis* larvae, the predator *C. carnea* and sugar beet yield in comparison with conventional insecticides. Numerous investigators demonstrated that *C. carnea* larvae are effective method for controlling *S. littoralis* (eggs and larvae) in Egyptian sugar beet fields (El-Khouly, 2006; Shalaby, 2012 and Al-Habshy, 2018).

Materials and methods

These field trials were done during the two successive seasons 2021 and 2022 at the experimental farm of Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. Nader sugar beet variety was planted on the 15th and 16th of September during the two seasons, respectively. The experimental plots received recommended agricultural practices. Three insecticides were sprayed (Table 1). One of them was lufenuron and the others were with conventional insecticides pyridalyl and chlorfenapyr.

Each insecticide was replicated four times (3x4=12 replicates) in addition to four replicates as a control (Check). Each replicate measured 42m^2. A completely randomized block design was assigned (CRBD).

Knapsack sprayer (Zol volume) was used for spraying these insecticides. The date of spraying was 15th and 16th October throughout the two seasons, respectively. Inspection of 10 plants/replicate was carried out just before the application and after one, 7 and 10 days post treatment for conventional insecticides. While three, 7 and 10 days after spraying for lufenuron according to Anonymous (2020). Numbers of larvae of

S. littoralis and *C. carnea* larvae were counted by the visual record in the field before and after one, 3, 7 and 10 days post spraying. After 3, 7 and 10 days for IGRs. While 1, 7 and 10 days for conventional insecticides.

Statistical analysis:

Reductions in insect larvae were calculated through Henderson and Tilton, 1955 formula as follows:

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

N: Larvae numbers Co: Control T: Treatment

- Differences between means were done using analysis of variance (ANOVA) at p= 0.05 using Minitab v.16 software (Duncan, 1955).

Estimation of root and sugar yield:

The roots of treated and check plots (168 m^2) were weighed after harvest to determine the root yield per feddan. In addition to, sugar content (%) was determined by using a sucrometer device according to the Association of Official Analysis Chemists (1990), at the laboratory of sugar crops research department, Sakha Agricultural Research Station to estimate sucrose content (%) and calculate the sugar yield per feddan.

Table (1): Certain insecticides sprayed against *Spodoptera littoralis* during 2021 and 2022 seasons.

Common name	Trade name	Category	Rate/fed.
Lufenuron	Bancoron 20% EC	IGRs	40 cm^3
Pyridalyl	Benadryl 10% EC	Conventional	250 cm^3
Chlorfenapyr	Salinger super 24% SC	Conventional	100 cm^3

Results and discussion

1. Effect of certain insecticides (Lufenuron, pyridalyl and chlorfenapyr) on *Spodoptera littoralis* and *Chrysoperla carnea*:

In both seasons, data presented in Tables (2 and 3) clarify that lufenuron caused a reduction in *S. littoralis* larvae with 73.02 and 78.75% in the two seasons, respectively. In such concern the same previous insecticide caused a reduction in the predator, *C. carnea* populations with 23.40 and 19.46% in the two seasons, respectively. Concerning the conventional insecticides, the elimination in *S. littoralis* larvae was 88.66 and 90.97% for pyridalyl in the two seasons, respectively.

Also, the values were 84.07 and 85.55% for chlorfenapyr in the two seasons, respectively. On the other hand, pyridalyl caused a reduction in *C. carnea* with 88.66 and 90.97% in the two seasons, respectively. While chlorfenapyr induces a reduction in *C. carnea* with 92.21 and 84.95% in the two seasons, respectively. James (2004) reported that IGRs are generally considered compatible with natural enemies conservation.

Also, Naranjo *et al.* (2004) showed that the use of these IGRs could further facilitate biologically based management in agro ecosystems. In another study, Carmo *et al*. (2010) demonstrated that the IGRs are usually regarded as less harmful to beneficial insects, when compared to other chemical groups, mainly conventional insecticides. In addition, Lopez and Osuna (2020) indicated that effective plant protecting programs seek to increase compatibility between control methods including between chemical and biological methods.

Pesticides that are safer for the environment and have low toxicity to natural enemies are more useful in IPM. IGRs are an option for use in IPM and their use has increased, especially chitin synthesis inhibitors.

Lastly, these results showed that lufenuron reduces *S. littoralis* larvae with acceptable value, at the same time conserves *C. carnea* populations in comparison with conventional insecticides.

Table (2): Reduction in *Spodoptera littoralis* larvae due to applied lufenuron and conventional insecticides in 2021and 2022 seasons.

Compound	Before spray	After one day		Three days		7 days		10 days		Overall mean
	M.	M.	Red.	M.	Red.	M.	Red.	M.*	Red.	
2021										
Bancoron	20.00	---	---	10.75	53.26	5.5	78.21	3.75[a]	87.6	73.02
Benadryl	20.25	5.0	76.76	---	---	4.25	83.37	2.5[b]	91.83	83.98
Salinger super	20.25	5.5	74.43	---	---	4.00	84.35	2.25[b]	92.69	83.81
control	20.00	21.25	---	23.00	---	25.25	---	30.25[c]	---	---
2022										
Bancoron	19.00	---	---	9.00	60.78	4.50	82.29	2.00[a]	93.18	78.75
Benadryl	19.50	4.75	76.84	---	---	3.75	85.62	1.75[a]	94.19	85.55
Salinger super	19.25	4.5	77.77	---	---	3.25	87.37	1.50[a]	94.95	86.61
Control	19.25	20.25	---	23.25	---	25.75	---	29.75[b]	---	---

***The Duncan test at level of 5% probability was applied, the mean followed by the same letter do not differ significantly.**

Table (3): Reduction in *Chrysoperla carnea* larvae due to applied lufenuron and conventional insecticides in 2021 and 2022 seasons.

Compound	Before spray	After one day		Three days		7 days		10 days		Overall mean
	M.	M.	Red.	M.	Red.	M.	Red.	M.*	Red.	
2021										
Bancoron	8.25	---	---	7.5	17.61	7.5	22.45	7.75[a]	30.14	23.40
Benadryl	8.00	0.75	90.93	---	---	1.25	86.67	1.25[b]	88.38	88.66
Salinger super	8.00	0.50	93.95	---	---	0.75	92.00	1.00[b]	90.70	92.21
Control	7.25	7.50	---	8.00	---	8.50	---	9.75[c]	---	---
2022										
Bancoron	7.5	---	---	7.25	11.86	7.00	19.62	7.25[a]	26.91	19.46
Benadryl	7.25	1.00	87.04	---	---	0.75	91.09	0.5[b]	94.78	90.97
Salinger super	7.5	1.25	84.34	---	---	1.25	85.64	1.5[c]	84.87	84.95
Control	7.75	8.25	---	8.50	---	9.00	---	10.25[d]	---	---

***The Duncan test at level of 5% probability was applied, the mean followed by the same letter do not differ significantly.**

2. Root and sugar yield:

Table (4) indicates insignificant differences between treated plots with lufenuron insecticide and conventional ones in the root and sugar yield of sugar beet during the two seasons. Data clarifies those significant differences between the treated plots and untreated ones (Control). These insignificant differences because lufenuron killed the larvae in sufficient percentages. In addition, lufenuron does not affect the population of the predator *C. carnea* in high percentages in comparison with conventional insecticides.

Table (4): Impact of certain insecticides against *Spodoptera littoralis* on root and sugar yield.

Treatment	2021 season				
	Root weight ($kg/168m^2$)		Root yield (ton/fed)	Sucrose %	Sugar yield (ton/fed)
	Total	Mean			
Bancoron	910	227.50[a]	21.67[a]	16.10	3.49[a]
Benadryl	915	228.75[a]	21.79[a]	16.23	3.54[a]
Salinger	916	229.00[a]	21.81[a]	16.15	3.52[a]
Control	501	125.25[b]	11.93[b]	11.00	1.31[b]
2022 season					
Bancoron	914	228.50[a]	21.76[a]	16.00	3.48[a]
Benadryl	916	229.00[a]	21.81[a]	16.20	3.53[a]
Salinger	916	229.00[a]	21.81[a]	16.19	3.53[a]
Control	520	130.00[b]	12.38[b]	12.11	1.50[b]

***The Duncan test at level of 5% probability was applied, the mean followed by the same letter do not differ significantly.**

In conclusion, these results proved that lufenuron insecticides besides *C. carnea* as a major predator were able to suppress *S. littoralis* population and enhance sugar beet productivity.

References

Abou- El Kassem, A. (2010): Ecological and biological studies on insects of sugar plants at Kafr El-Sheikh Governorate. Ph. D. Thesis, Fac. Agric., Kafr El-Seikh, Tanta University.

Al-Habshy, A. (2018): Ecological studies on beet fly infesting sugar beet fields in Sharkia Governorate, Egypt. 11(6): 51-61.

Amine, H.; Hamed, S.; Anbar, H.; Shalaby, G.; Khazal, N. and El-Rahman, H. (2022): Effect of different silica sources on cotton leafworm population in sugar beet plants, and their influence on sugar beet yield. J. of Entomology and Zoology Studies, 10 (3): 55-60.

Anonymous (2020): Protocol of evaluating the efficiency of agricultural pest pesticides. Ministry of Agriculture and Land Reclamation, Agricultural Pesticide Committee (APC). Annual Report (In Arabic).

Anonymous (2022): Annual report of 2021, Sugar Crops Council, Ministry of Agriculture and Land Reclamation, Arab Republic of Egypt (in Arabic).

Association of Official Analysis Chemists (1990): Official Methods of Analysis. 15th Ed. Washington, DC, USA.

Bazazo, K. and Hassan, H. (2021): *Diadegma aegyptiator* Shaumer 1966 (Hymenoptera : Ichneumonidae): New record parasitoid on the ribminer, *Scrobipalpa ocellatella* Boyd. In Egyptian sugar beet fields. J. Plant Prot. And Path., Mansoura Univ., 12(3): 229-231.

Carmo, E.; Bueno, A. and Bueno, R. (2010): Pesticide selectivity for the insect egg parasitoid *Telenomus remus*. J. Inter. Organ. Biolo. Cont., 55(4): 455-464.

Che, W.; Shi, T. ; Wu, Y. and Yang, Y. (2013): Insecticide resistance status of field populations of *Spodoptera exigua* from China. J. Econ. Entomol., 106(4): 1855-1862.

Duncan, D. (1955): Multiple range and Multiple F-test. Biometrics, 1: 1-17.

El-Khouly, M. (2006): Populations of *Pegomyia mixta* in relation to certain associated natural enemies in sugar beet fields. Egyptian J. of Biol. Pest Control., 16(2): 25-28.

El-Mahalawy, N. (2011): Ecological and biological studies on some sugar beet insects. M. Sc. Thesis, Fac. Agric., Tanta University.

Gogi, M.; Sarfraz, R.; Keddie, A. and Ashfaq, M. (2006): Effectiveness of two insect growth regulators against *Bemisia tabaci* and *Helicoverpa armigera* and their impact on population densities of arthropod predators in cotton in Pakistan. Pest Manag. Sci., 62: 982-990.

Henderson, G. and Tilton, E. (1955): Test with acaricides against the brown wheat mite. J. Econ. Entomol., 48: 157-161.

James, D. (2004): Effect of buprofesin on Hamamia oxyridis, Stethorus and Geocorius. J. Econ. Entomol., 97: 900-904.

Khalifa, A. (2018): Natural enemies of certain insect pests of sugar beet plants at Kafr El-Sheikh Governorate. J. Plant Prot. And Path., Mansoura Univ., 9(8): 507-510.

Liopis, N.; Giner, C. and Yufera, P. (2004): Efficacy of lufenuron as chemosterilart against *Ceratitis capitata* in field trials. Pest Manag. Sci., 60: 914-920.

Lopez, Y. and Osuna, E. (2020): Lethal and sublethal effects of lufenuron on the predator *Chrysoperla carnea* (Neuroptera). Crop Protection, 135: 105-217.

Mahmoud, M.; Ibrahim, I.; El-Shorbagy, M. and Mohisen, M. (2011): Evaluate the applied of the egg parasitoid, *Trichogramma evanescens* West to reduce the infestation of *Spodoptera exigua* in sugar beet fields at El-Aiat region, Giza Governorate. J. Plant Prot. And Path., Mansoura Univ., 2(8): 741-747.

Mesbah, I. (1984): Biological and ecological studies on *Spodoptera littoralis* to determine the economic threshold in cotton fields. M. Sc. Thesis Cairo University.

Naranjo, S.E.; Ellsworth, P.C. and Hagler, J.R. (2004): Conservation of natural enemies in cotton: role of insect growth regulators in management of *Bemisia tabaci***.** Biological control , 30 (1): 52-72.

Rashid, M. (1999): Saby Biggam (in Bengali), Rashid Publishing House, 94, Old DoHS, Dhaka. P.455.

Said, A.; Shaheen, F.; Sherief, E. and Fouad, H. (2012): Estimation of certain compound against cotton leafworm, *Spodoptera littoralis* (Boisd) on sugar beet plants. J. Plant Prot. And Path., Mansoura Univ., 3(12): 1321-1330.

Saleh, M.; Draz, K.; Mansour, M.; Hussein, M. and Zawrah, M. (2009): Controlling the sugar beet beetle, *Cassida vittata* with entomopathogenic nematodes. J. Pest. Sci., 82(3): 289-294.

Shalaby, G. (2012): Enhancement role of *C. carnea* as a biocontrol agent for controlling insects in sugar beet fields. Zagazig J. of Agricultural Research, 39(2): 299-304.

Su, Y. and Sun, X. (2014): High level of melaflumi zore resistance and multiple insecticides in field populations of *S. exigua* in China. Crop Protection, 61: 58-63.