Egyptian Journal of Plant Protection Research Institute
www.ejppri.eg.net

Effectiveness of biocides for controlling aphids (Hemiptera: Aphididae) without decreasing insect predator population in Egyptian sugar beet fields

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ARTICLE INFO
Article History
Received: 21/4 /2023
Accepted: 27/6/2023

Keywords

Aphids, biocides, insect predators, sugar beet fields, control, and Egypt.

Abstract

The present investigation was conducted at the experimental farm of Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt, seasonally during 2021/ 2022 and 2022/ 2023. The field study evaluated the efficiency of biocide, Biosiana® 2.5 wp and Billy®, Basudin® as conventional insecticides against aphids and their side effects on insect predators. The results showed that the mean reduction in the populations of aphids caused by Biosiana was 73.07 and 70.68% in the first and second seasons, respectively. Applications of the conventional insecticide, Billy resulted in 71.57 and 71.15 % mean population reduction in the two seasons, respectively. Also, 67.11 and 72.94 % mean reduction in aphid populations during the two seasons, respectively, for Basudin®. In such concern, the insect predators associated with aphid numbers, the application of Biosiana reduced the densities of insect predators by 25.93 and 24.0 % in the two seasons, respectively. While the density of insect predator plots treated with conventional insecticides was reduced by 79.66 and 79.60 % for Billy® in the two seasons, 74.87 and 78.72 % for Basudin® during the two seasons. These findings indicate that Basudin® reduces the population of aphid high percentages, while not significantly reducing densities of insect predators, as seen in plots treated with conventional insecticides. In addition, this study surveyed four species of aphids [*Aphis craccivora* (Koch), *Aphis gossypii (Glover), Myzus persicae* (Sulzer) and *Schizaphis graminum* (Rondani) (Hemiptera: Aphididae)] . Moreover, surveying 9 predatory insect species, belonging to 7 families and four orders. In conclusion, Biosiana® can be used as a tactic in a successful integrated pest management program for aphid species in sugar beet fields, thereby reducing reliance on conventional insecticides.

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Introduction

Sugar beet (*Beta vulgaris* L.) is considered one of the most important sugar crops worldwide. In Egypt, it is the first important sugar crop before sugar cane for sugar production (Hellal *et al*., 2009). The Egyptian agricultural policy depends on reducing the gap between sugar production and consumption by encouraging the farmers to increase the cultivated area of sugar beet (Afifi, 2001).

In 2021 / 2022 season, the total area cultivated with sugar beet reached 700 thousand feddans in Egypt that produce more than 1.6 million tons of sugar. Sugar beet is liable to be attacked by many destructive insect pests during its different growing stages. So, many authors were attracted to study a group of insect pests that cause serious problems for farmers and cause reductions in sugar beet yield (Roots and sugar percent %) (Bassyouny and Khalafalla, 1996; Ebieda, 1997 and El-Dessouki, 2019). The overall loss resulting from insect pest infestations in sugar beet crops range between 8.2 to 12.4 % (Kolbe, 1967). The piercing sucking insects such as aphids are considered among the economic pests of sugar beet plants at the present time (Farag *et al*., 1998; Al-Habshy *et al*., 2014; Bazazo *et al*., 2017 and Khalifa, 2017 and 2018) causing significant damage by piercing and sucking the plant sap and indirect damage by transmission of many virus diseases from plant to another, also can substantially decrease crop yields (Frédéric *et al*., 2022 and Anabelle *et al*., 2023). In Czech Republic, Muska (2007) mentioned that aphids belong to the most important pests of sugar beet crops. The green peach aphid *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) causes damage.

By sucking and transmission of virus diseases. Damage is evident in all sugar beet growing regions in the Czech Republic. In Belgium, Albittar *et al*. (2016) reported that *M. persicae* is responsible for losses in yield and viral diseases. In Egyptian fields, Sherief *et al*. (2013) found that *M. persicae* recorded one peak of abundance in the first season. It was recorded on the 2nd week of February and represented by 2945 indiv. / 50 plants. While, in the second season, one peak of abundance was also recorded on the 3rd week of February and represented by 3089 insects / 50 plants. Moreover, Al-Habshy *et al*. (2014) mentioned that the seasonal abundance of *M. persicae* of the sugar beet crops recorded two peaks for *M. persicae*. The first one occurred in the 2nd week of December with 275 and 316 insects / samples for the two seasons, respectively. The second one was observed in the 4th week of January represented by 417 and 548 indiv. / Sample for the two seasons, respectively.

The previous results showed that *M. persicae* in addition to the presence of *Aphis craccivora* (Koch) (Hemiptera: Aphididae) recorded a total number of 3417 to 3590 and 94 to 104 insects / Plant samples for the two seasons, respectively. In addition, El-Dessouki (2014) found that in the first season (2010–2011), no special pattern could be obtained as regards aphids on sugar beet throughout different planting dates. Aphid populations were very high on the plants of Mid-Nov. plantation by Mid-Oct. and finally by Mid-Aug. plantation during 2011-2012. In such concern, Khalifa (2017) showed that the aphid population density was 26.17, 17.75 and 15.83 nymphs and adults / 25 sugar beet plants in August, September, and October plantation, respectively.

Concerning insect predators of aphids, many authors surveyed that coccinellidae, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae); Carabidae, *Paederus alfierii* Koch (Coleoptera:Staphylinidae) , *Scymnus interruptus* Goeze (Coleoptera: Coccinellidae), *Syrphus corolla* Fabricius (Diptera: Syrphidae) are dominating predators of aphids. They play an important role in managing aphids in sugar beet fields (Shalaby, 2012; Sherief *et al*., 2013; El-Dessouki , 2014 ; Khalifa, 2017 and Al-Habshy, 2018).

Seni and Halder (2022) noted that using insect predators as a biological control agent is very useful in insect pest management. More than 30 families of predators in nature and among them, the Coccinellidae, Syrphidae, Anthocoride, Staphylimidae, Reduviidae, Carabidae and Formicidae are important agri-horticultural perspective. Aphids are devoured by various previous predators. Microbial insecticides are increasingly being considered environmentally friendly alternatives in comparison to conventional insecticides (Ramanujam *et al.*, 2014).

Also, El-Husseini *et al.* (2004) reported that microbial insecticide (Fungicides) is effective in controlling sugar beet insects. In addition, using neonicotinoid insecticides had a big role in protecting sugar beet from aphid infestation which is considered to decrease the loss of insects (Wagner, 2020; Barmentlo *et al*., 2021 and François *et al.*, 2022).

So, the current study was done to determine the effectiveness of biocides on aphids, moreover their impact on insect predators in comparison with traditional insecticides.

Materials and methods

This study was conducted at a sugar beet field planted with Sahar cultivar on the 10th of October at Sakha Agricultural Research Station for two successive seasons: 2021/2022 and 2022/2023. Three treatments were used, and each treatment was replicated four times (3X4=12 plots), each plot measured 42m^2, moreover four plots as a check.

The insecticides tested against aphid populations infecting sugar beet crops are presented in Table (1). The number of aphids and insect predators was counted by visual examination on 40 sugar beet plants just before spraying and one, 7 and 10 days post spraying for conventional insecticides. Also, three, 7 and 10 days post spraying for biocide insecticide. Knapsack sprayer (20L volume) was used for spraying on 10th March in the two seasons. The samples of aphids were taken with a fine brush and put into vials containing alcohol 70%, after that transported to the laboratory.

Table (1): Insecticides sprayed against aphids during the two seasons.

Trade name	Chemical class	Common name	Rate/fed.
***Biosiana® 2.5% WP**	Biocide (fungi)	*Beauveria bassiana* Bals. (1X10^8 cfu)	500 gm
****Billy® 25% WG**	Neonicotinoids	Thiamethoxam	125 gm
****Basudin® 60% EC**	Organophosphate	Diazinon	1000 ml

*Biocides **Conventional insecticides.

Results and discussion

In the current study, five species (Table 2) of aphids were recorded belonging to one family. The survey was carried out using a fine brush method.

Table (2): Survey of aphid species inhabiting sugar beet plants during 2021/2022 and 2022/2023 seasons.

Order	Species	Family
Hemiptera	*Aphis gossypii* (Glover) *Aphis craccivora* (Koch.) *Myzus persicae* (Sulzer) Schizaphis *graminum* L.	**Aphididae**

Various investigators demonstrated the danger of aphid species on sugar beet crops during the three plantations. They cause direct damage by piercing and sucking the sap of plants, consequently, reducing the sugar beet root weight and sugar content percentages. Also, they cause indirect damage by transmission of virus diseases (Khalifa, 2018).

Table (3): Survey of insect predators associated with aphid species during 2021/2022 and 2022/2023 seasons.

Order	Family	Species
Coleoptera	Anthicidae	*Anthicus* sp.
	Carabidae	*Bembidion mixtum* Schaum
	Coccinellidae	*Coccinella undecimpunctata* L.
		Scymnus interuptus Goeze
		Coccinella septempunctata Reiche
	Staphylinidae	*Paedrus alfierii* L.
Hymenoptera	Formicidae	*Solenopsis* sp.
Diptera	Syrphidae	*Syrphus corolla* F.
Neuroptera	Chrysopidae	*Chrysoperla carnea* Steph.

Table (3) indicated that the survey revealed the occurrence of nine predatory insect species, belonging to seven families and four orders. Numerous authors showed that these previous predators are fed upon aphids in Egyptian sugar beet fields. These predators are important agents in controlling aphids (Shalaby, 2012 and Al-Habshy, 2018).

Table (4): Effect of different insecticides on aphid populations under field conditions, during 2021/2022 and 2022/2023 seasons.

Insecticides	Before	After								Overall mean of reduction
		1		3		7		10		
	M.	M.	Red.	M.	Red.	M.	Red.	M.	Red.	
2021/ 2022										
Biosiana®	20.00	-------	------	10.0	53.52	4.75	78.67	3.0	87.11	73.07[a]
Billy®	20.25	11.5	45.28	------	------	4.5	80.05	2.5	89.39	71.57[b]
Basudin®	20.25	12.5	40.52	------	------	5.25	76.72	3.75	84.09	67.11[c]
Check	19.75	20.5	------	21.25	------	22.0	-----	23.0	------	-------
2022 / 2023										
Biosiana®	20.5	------	---------	10.5	51.65	5.5	79.76	3.75	84.63	70.68[a]
Billy®	20.75	10.75	49.39	------	-----	5.0	78.23	3.5	85.83	71.15[a]
Basudin®	20.75	10.5	50.57	------	-----	4.5	80.41	3.0	87.85	72.94[a]
Check	21.00	21.5	------	22.25	-----	23.25	-----	25.0	------	--------

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

According to aphid populations reduction percentages (Table 4), there were statistically significant differences among the means of the applied treatments. The overall reduction means of aphids due to Biosiana® were compared to Billy and Basudin applications, respectively, during the two seasons. The overall mean of reductions during 2021/2022 season for Biosiana was 73.07 followed by Billy and Basudin by decreasing 71.57 and 67.11, respectively. While in the second season 2022/2023 the pesticide Basudin had an overall reduction reach of 72.94 followed by Billy and Biosiana with 71.15 and 70.68, respectively.

These results may be near to the results of Anabelle *et al*. (2023) which conducted that spinetoram and flonicamid caused a reduction in aphid numbers, while biopesticide was less effective.

Table (5): Impact of certain insecticides on insect predators associated with aphid species under field conditions, 2021/2022 and 2022/2023 seasons.

Insecticides	Before	After								Overall mean of reduction
		1		3		7		10		
	M.	M.	Red.	M.	Red.	M.	Red.	M.	Red.	
2021 / 2022										
Biosiana®	7.5	-------	--------	6.75	18.43	6.5	23.83	6.0	35.55	25.93[a]
Billy®	7.5	1.5	80.66	-----	------	1.75	79.49	2.25	78.83	79.66[b]
Basudin®	7.25	1.75	76.66	------	------	2.0	75.75	2.5	72.22	74.87[c]
Check	7.25	7.5	------	8.0	------	8.25	------	9.0	------	---------
2022 / 2023										
Biosiana®	6.50	-------	-------	6.00	17.24	5.50	26.66	5.75	28.12	24.00[a]
Billy®	6.75	1.25	82.16	------	------	1.50	80.74	2.00	75.92	79.60[b]
Basudin®	6.75	1.00	85.73	------	------	1.75	77.53	2.25	72.91	78.72[b]
Check	6.50	6.75	------	7.25	------	7.50	------	8.00	------	------

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

Concerning the insect predators in Table (5), Biosiana is safer than these predators in comparison with conventional insecticides (25.93 and 24.00 %) for Biosiana. In addition to, (79.66 and 79.60 %) for Billy, (74.87 and 78.72 %) for Basudin in the seasons, respectively. The results demonstrated that Biosiana is effective against aphid populations, moreover very safe for insect predators in comparison with conventional insecticides.

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