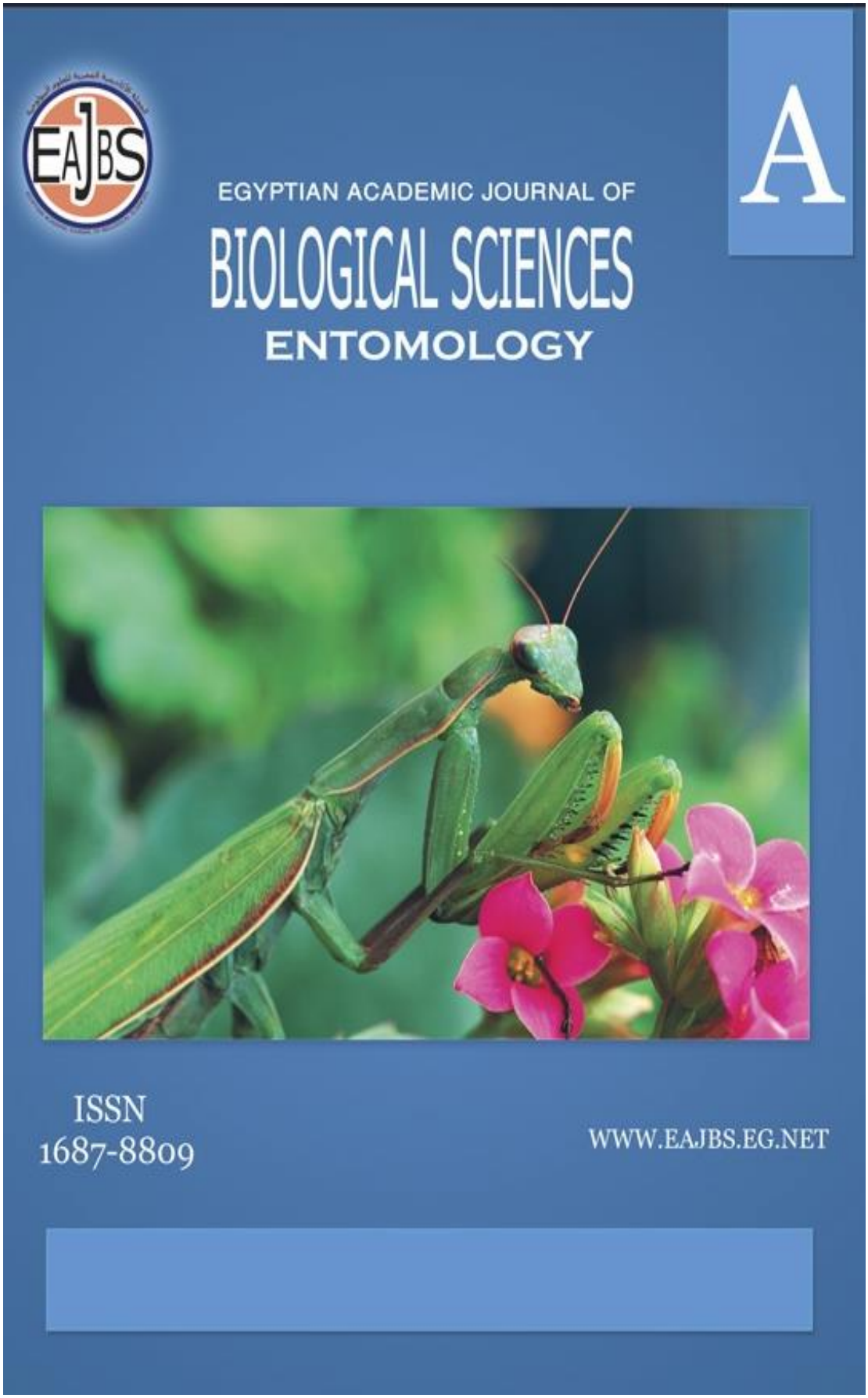

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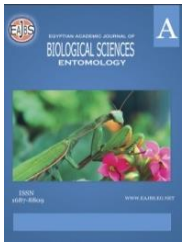

Effect of the Utilization of the Bioinsecticide Spinosad on the Whitefly, *Bemisia tabaci* (Genn.) and the Cabbage Aphid, *Brevicoryne brassicae* (L.), Attacking the Red Cabbage Plants and Also Estimating its Effect on the Mummies of the Aphid Parasitoid *Diaeretiella rapae* (McIntoch), in the Greenhouses Located in Giza Governorate.

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ABSTRACT

In Egypt, the red cabbage *Brassica oleracea* var. *capitata* L. (Cruciferae) is considered as one of the most important vegetable crops. It is liable to attack by many major piercing-sucking insectś pests; such as the whitefly, *Bemisia tabaci* (Genn.) and the cabbage aphid, *Brevicoryne brassicae* (L.). However, the present study was conducted to evaluate the effect of utilizing the natural compound Spinosad (Tracer 24%) against the population densities of these two common pests and also on the formation of the mummies of the parasitoid *Diaeretiella rapae* (McIntosh) parasitizing the cabbage aphid. The occurrence periods of the whitefly, *B. tabaci* were extended from November, 2017 to April, 2018. The percentage of reduction in the population density of the whitefly, *B. tabaci* per season was 62.53%, in comparing the untreated control with that treated by the natural insecticide Spinosad. As for the cabbage aphid, *B. brassicae*, the occurrence period was extended during the whole season expect the last week of November, 2017. The percentage of reduction in the population density of the cabbage aphid, *B. brassicae* per season was 70.14%. The aphid parasitoid *D. rapae* was the only common recorded parasitoid́ species parasitizing the cabbage aphid, *B. brassicae* attacking the red cabbage plants. The highest total numbers of the mummies of the parasitoid *D. rapae* (164 & 56 individuals) were recorded during the first week of March, 2018 and the third week of February, 2018, in case of the untreated control and the treatment, respectively. The mean total numbers of the mummies of the parasitoid *D. rapae* per season were; 54.00±13.01 and 12.07±4.01 mummies, in case of the untreated control and the treatment, respectively. The highest population densities of the mummies of the parasitoid *D. rapae* (450 & 177 aphid mummies) were recorded during the months of March and February, in both of the untreated control and the treatment, respectively. The percentage of reduction in the total numbers of the formed mummies of the aphid parasitoid *D. rapae* parasitizing the cabbage aphid, *B. brassicae* was 21.24%. The natural compound Spinosad can be used against the whitely, *B. tabaci* and the cabbage aphid, *B. brassicae* on the red cabbage plants or other plants that are subjected to these pests attack. Besides, the occurrence of less harmful effect on the formation of the parasitoid *D. rapae* mummies, in the frame of Integrated Pest Management (I.P.M.), side by side with other safe control methods, for giving less pollution to the surrounding environment.

INTRODUCTION

In Egypt, the red cabbage, *Brassica oleracea* var. *capitata* L. (family Cruciferae), is considered as one of the most important vegetable crops. It is a good source of fibers, vitamins, minerals, having low calories with remarkable high content levels of Calcium, Iron, Iodine, Potassium, Sulfur, and Phosphorus. The anti-cancer properties found in the cabbage plants make it a suitable food to increase the human immunity against many of the common feared disease occurred like cancer (USDA, 2009).

The red cabbage plants are attacked by many major piercing-sucking insectś pests; such as the cabbage aphid, *Brevicoryne brassicae* (L.) (Hemiptera: Aphididae) and the whitefly *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae) (Zhang & Hassan, 2003 and Germanio *et al*., 2006). These insects' pests were recorded attacking many vegetable crops in the fields as well as in the greenhouses (Hassan *et al.*, 2008). In Egypt, they really were considered as the most common insects' pests infesting the cabbage plants (El-Fakharany & Hendawy, 2010 and Abdel-Galil *et al.*, 2019). The obvious damage of these common piercing-sucking insectś pests has resulted from the individualś congregating on the lower and the upper leaveś surfaces, where, they pierce the plants sap with their needlelike mouthparts resulting in curl downward of the plants leaves. For example, the continuous feeding caused by the aphids' specieś makes the occurrence of the yellowing, the wilting and the stunting of the plants following the loss of the plant juices (Opfer & Grath, 2013). Besides, the honeydew secreted by the aphids makes the plants to be sticky and enhances the development of the black sooty mold on the plants foliage which can eventually lead to the leaveś death (Griffin & Williamson, 2012).

The excessive use of the harmful insecticides particularly those of the long residual effects has disrupted the natural balance that is existed between the pests and their associated natural enemies (Moussa *et al*., 2014), such as the parasitoids (Jiu & Waage, 1990 and Abdel-Galil *et al.*, 2019). In this way, the continuous sharp use of the chemical insecticides practices including the aphids' control had resulted in many difficult environmental problems such as pollution (Scorsetti *et al*., 2007). Therefore, there was a need for using more safe control methods in the frame of Integrated Pest Management (I.P.M.), such as applying the natural insecticides. From these natural compounds, Spinosyns are a family of broad-spectrum insecticides including the natural Spinosad (Tracer 24%) compound. Many investigators tested Spinosyns against some piercing-sucking insects' pests; like the whitefly *B. tabaci* (Bacci *et al*., 2016) and also the aphidś species (Niktta *et al.*, 2013). Besides, many investigators evaluated its effect on many of the common natural enemies such as the parasitoids (Williams *et al.*, 2003).

So, this study was carried out during the season 2017/2018 in an Agricultural Greenhouse located in Giza Governorate (that was cultivated with the red cabbage plants), the following experiments were concerned including two experiments were conducted by applying the natural compound Spinosad against the population density of the whitefly, *B. tabaci* and also against the cabbage aphid *B. brassicae* infesting the red cabbage plants. The experiment concerning the cabbage aphid, *B. brassicae* infesting the red cabbage plants was also extended to evaluate the effect of using this natural compound Spinosad on the formation of the mummies of its parasitoid *D. rapae*. However, the untreated control area was compared with those recorded after the treatment with the natural insecticide Spinosad for the two insects' pests and also comparing the effect on the formation of the mummies of the parasitoid *D. rapae* parasitizing the cabbage aphid, *B. brassicae*.

MATERIALS AND METHODS

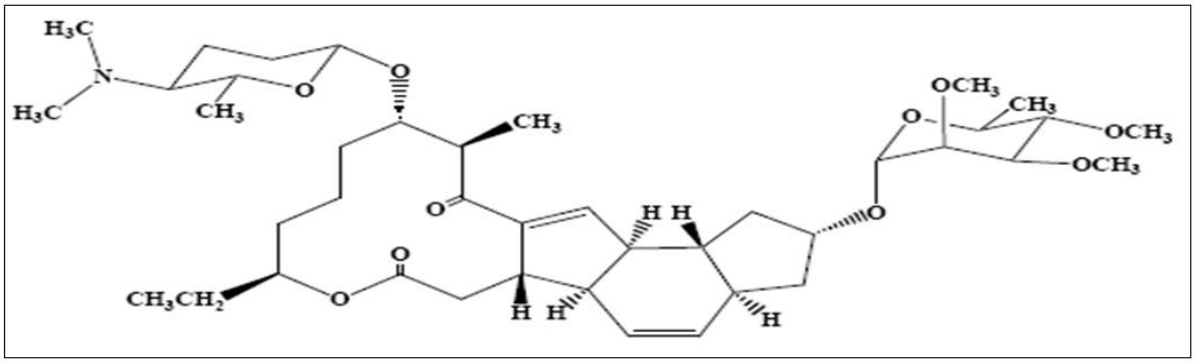
The experiment was conducted in the Greenhouses of the Central Laboratory of the Agriculture Climate, Agricultural Research Center (A.R.C.). An area of about 67.5m^2 was chosen that was cultivated with the red cabbage plants (variety Primero), during 2017/2018 season, where the period of the experiments extended from the last week of November 2017 till the third week of April 2018. No chemical insecticides were applied during the period of the investigation; only the normal agricultural practices were performed.

A- Material Used:

The natural compound Spinosad (Tracer 24%SC) was a metabolite produced during the fermentation of the microorganism Actinomycete, *Saccharopolyspora spinosa* (that is a soil-inhabiting microorganism). It is a mixture of two Spinosyns formations A (85%) and D (15%), where they represent the two biologically active metabolites responsible for inducing the insecticidal activity (Salgado 1998).

Also, this compound is considered as one of the most interesting products to be used against agricultural pests (Bacci *et al.*, 2016). However, the chemical structures of Spinosyns formations A and D was as follows (Fig., 1):

- Spinosyn A: $C_{41}H_{65}NO_{10}$



- Spinosyn D: $C_{42}H_{67}NO_{10}$

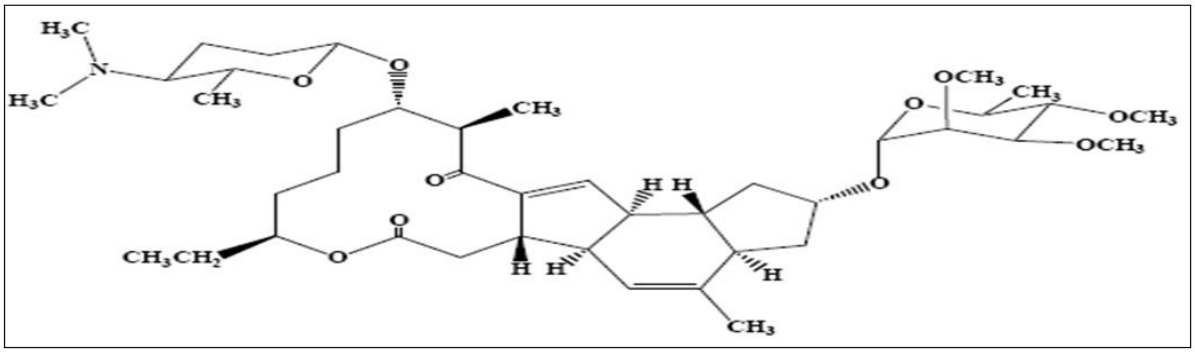


Fig. (1): The chemical structures of Spinosyn A and Spinosyn D.

B- Experimental treatments.

The natural components Spinosad (Tracer 24%SC) was chosen to be utilized against the whitefly, *B. tabaci* and the cabbage aphid, *B. brassicae* on the red cabbage plants. Its effect was also estimated on the formation of the mummies of the parasitoid *D. rapae* parasitizing the cabbage aphid *B. brassicae*. The following procedures were done to carry out the two control experiments:

1-Three cultivated red cabbage pieces each of 22.5m^2 (3×7.5m^2), were chosen (the total areas were 67.5m^2) for the experimental purpose. The areas of the experiments were cultivated with the red cabbage plants in 10/11/2017 and ended in 16/4/2018. Each piece included three double rows that represent three replicates and was planted on both sides with

the red cabbage plants (a total number of eighteen single rows for three the treatments =9 double rows×2 rows), including; the area of the untreated control, the area of the treatment of the cabbage aphid, *B. brassicae* & its parasitoid *D. rapae* and also the area of the treatment of the whitefly, *B. tabaci*. The distance between each double row and another one was 50cm and the limit of the piece was 25cm from each side. The plants were planted on the double rows, with a total of 30 plants/replicate (=15 plants/single row). The width of each double row was 50cm, and the distance between the red cabbage plants was 50cm. The untreated control was the piece that all agricultural practices were made without using any chemical treatments (no treatments only water spray). The second piece represents the area of the treatment area concerning the cabbage aphid, *B. brassicae* & its parasitoid *D. rapae* and the last area represent the treatment area concerning the whitefly, *B. tabaci* on the red cabbage plants (Fig., 3). The date of spraying Spinosad was the first week of January 2018 in case of the area infested with the whitefly, *B. tabaci*. The date of spraying Spinosad was in the second week of February 2018 in case of the area infested with the cabbage aphid *B. brassicae* on the red cabbage plants. The spraying was made by using the recommended concentration of the Ministry of Agricultural. Sampling began early in the morning on both surfaces of the red cabbage leaves.

2- Random weekly samples were taken from the untreated control, the area of the treatment concerning the cabbage aphid, *B. brassicae* & the mummies of its parasitoid *D. rapae* and also the area of the treatment concerning the whitefly, *B. tabaci*. The weekly investigated sample of the red cabbage plants were 90 plants for the three treatments (i.e., the total numbers of the investigated red cabbage leaves were 270 leaves =30 plants×3 leaves/plant×3 treatments). The leaves of the red cabbage were directly examined in the field and the total numbers of the cabbage aphid, *B. brassicae* & the mummies of its parasitoid *D. rapae* and also the adults of the whitefly, *B. tabaci* were recorded.

3- Then, the infested red cabbage plants with the cabbage aphid, *B. brassicae* were taken to the laboratory in paper bags, where they were left for a week until the formation of any new mummies for the parasitoid *D. rapae* to calculate the total numbers of the parasitoid mummies of the cabbage aphid *B. brassicae*. While, in case of the whitefly, *B. tabaci* nymphs, the infested leaves by the pest nymphs were investigated by the aid of the binocular. So, the total numbers of whitefly, *B. tabaci* individuals were calculated (adults & nymphs).

4- The percentage of reduction was estimated throughout the season (in the experiment area of the red cabbage plants infested with the whitefly *B. tabaci*), in the population density of the whitefly, *B. tabaci*, by using the natural insecticide Spinosad, in comparing with the untreated control. The percentages of reduction were estimated throughout the season (in the experiment area of the red cabbage plants infested the cabbage aphid, *B. brassicae),* on the population density of the cabbage aphid, *B. brassicae* and also on the formation of the mummies of the parasitoid *D. rapae* parasitizing the cabbage aphid *B. brassicae*, by using the natural insecticide Spinosad, in comparing with the untreated control.

5- Obtained data were statistically analyzed according to SPSS program version (15.0), for evaluating the means values. The correlation coefficient (r-value) in relation to the weather factors (including the means of the temperature and the relative humidity) was also recorded. The weather factors (including the means of the temperature and the relative humidity) were obtained from the Meteorological Station at A.R.C.

Fig.2: the cultivation of the red cabbage plants, that were used for the experimental purpose, during the growing season 2017/2018, in the Greenhouses located in Giza Governorate.

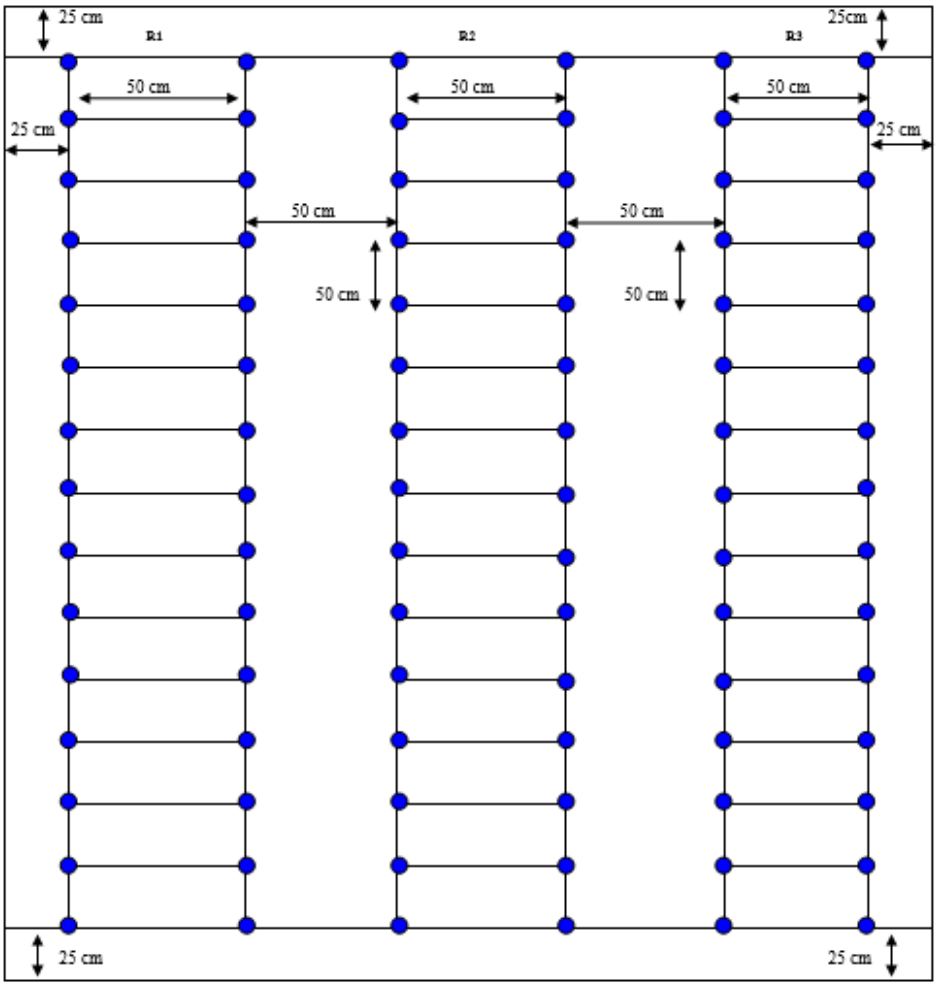


Fig. (3): A diagram showing the areas of the agricultural experiment of the three treatments; the untreated control, the area of the treatment of the cabbage aphid, *B. brassicae* & its parasitoid *D. rapae* and also the area of the treatment of the whitefly, *B. tabaci*.

RESULTS AND DISCUSSION

Data presented in Tables (1&2) and Fig. (4) showed the effect of the natural components Spinosad that was utilized against the whitefly, *B. tabaci*, the cabbage aphid, *B. brassicae* and also estimated its effect on the formation of the mummies of the aphid

parasitoid *D. rapae* parasitizing the cabbage aphid on the red cabbage plants, during 2017/2018 season, in Giza Governorate.

1-The effect of Spinosad on The Population Density of the Whitefly *B. tabaci* Infesting the Red Cabbage Plants.

Data presented in Table (1) and Fig. (4) indicated the effect of spraying the natural compound Spinosad on the population density of the whitefly *B. tabaci*, by comparing the treated area with that of the untreated control, on the red cabbage plants during 2017/2018 season. In the untreated control, the population density of the whitefly, *B. tabaci* began to appear with a few numbers (15 individuals, at means of the temperature of 18.49C° and means of the relative humidity of 60.27 %R.H.) in the last week of November 2017. Then, they reached the highest total number (2139 individuals, at 15.87C° and 53.96% R.H.), during the third week of January 2018. Finally, it ended (with a total number of 23 individuals, at 25.56°C and 40.43%R.H.), in the third of the week of April, 2018. While, the corresponding for the treated area by the natural compound Spinosad against the whitefly, *B. tabaci* were; 15 individuals (at 18.49C° and 60.27 % R.H.) in the last week of November 2017, 1469 individuals (at 15.89C° and 59.01% R.H.) during the first week of January 2018 and 9 individuals (at 25.56C° and 40.43% R.H.), at the end of the season, respectively. The month of January 2018 represented the month having the highest population density of the whitefly *B. tabaci* (7712 and 2409 individuals) for both the untreated control and treatment, respectively. The mean total numbers of the whitefly, *B. tabaci* individuals per the season were; 699.05±152.23 &

Table 1: The weekly total numbers of the whitefly, *B. tabaci* individuals (adults & nymphs), that occurred on the red cabbage plants in comparing the untreated control with that sprayed by Spinosad, during the growing season 2017/2018, in the Greenhouses located in Giza Governorate.

No.	Dates of sampling	Total no. of the whitefly *B. tabaci* (A + N)		Mean weather factors	
		Untreated control	Treatment	Temperature (C°)	Humidity R.H (%)
1	Last week of November, 2017	15	15	18.49	60.27
2	1st week of December	62	59	18.09	68.01
3	2nd week	134	128	16.90	64.70
4	3rd week	396	384	19.67	67.03
5	Last week	654	647	17.15	58.64
6	1st week of January, 2018 •	1581	1469	15.89	59.01
7	2nd week	2128	336	16.50	60.83
8	3rd week	2139	320	15.87	53.96
9	Last week	1864	284	14.67	64.63
10	1st week of February	745	217	15.89	59.01
11	2nd week	273	100	16.50	60.83
12	3rd week	448	182	15.87	53.96
13	Last week	604	151	14.76	64.36
14	1st week of March	659	232	23.36	44.73
15	2nd week	732	258	20.89	51.87
16	3rd week	564	156	22.31	43.69
17	Last week	453	146	22.12	43.34
18	1st week of April	451	122	21.10	56.54
19	2nd week	56	24	23.33	44.14
20	3rd week	23	9	25.56	40.43
Total/season		13981 (15-2139)	5239 (15-1469)	18.75C° (14.67- 25.56 C°)	56.00% (40.43-68.01%)
Mean /season		699.05±152.23	261.95±71.86		
- % Reduction in the population density of the whitefly *B. tabaci* 62.53%					
- Statistical analysis: - A significant difference was recorded in case of comparing the untreated control with the treatment of the red cabbage plants (that were infested by the whitefly *B. tabaci*), in season 2017/2018 (r-value =0.505*&sign. =0.023).					

• = (Date of spray) (A + N) =Adults + Nymphs - Significant (0.500-0.600) **Moderate significant (0.600-0.800) ***Highly significant (0.800-0.900) ****Very highly significant>0.900

261.95±71.86 individuals, for the untreated control and the treatment by the natural compound Spinosad, respectively. The percentage of reduction in the population density of the whitefly *B. tabaci* was 62.53% (Table, 1). These findings with similar to those results found by Thomas *et al.* (2006) who showed that systemically applied Spinosad, gave excellent control of the nymphs of the greenhouse whitefly *Trialeurodes vaporariorum,* but they stated that this compound was less toxic to the whitefly adults. In addition, El-Ferjany *et al*. (2009) indicated that the foliar application of Spinosad at the higher rate was more effective against the whitefly *B. tabaci* immature stages, the pest adults and the eggs deposition than at the lower one. Also, Kim *et al*. (2011) studied the effect of many different insecticides including Spinosad, where they recorded a great efficacy of this compound on the whitefly, *B. tabaci* populations.

2- A- The effect of Spinosad on the Population Density of the Cabbage Aphid, *B. brassicae* Infesting the Red Cabbage Plants.

Data presented in Table (2) and Fig. (4) indicated the effect of spraying the natural compound Spinosad on the population density of the cabbage aphid, *B. brassicae,* by comparing the treated area with that of the untreated control, on the red cabbage plants during 2017/2018 season. In the untreated control, the population density of the cabbage aphid, *B. brassicae* began to appear with a few numbers (7 individuals, at 18.09C° and 68.01 %R.H.) in the first week of December 2017. Then, they reached the highest total number (1880 individuals at 15.87C° and 53.96%R.H.), during the third week of February 2018. Finally, it ended was (with a total number of 359 individuals, at 25.56 C° and 40.43%R.H.) during the third week of April. While, the corresponding for the treated area by the natural compound Spinosad was; (one individual only, at 18.09C° and 68.01%R.H.) during the first week of December, 2017 (1591 individuals, at 16.50C° and 60.83%R.H.), during the second week of February, 2018 and (3 individuals at 25.56C°and 40.43%R.H.), in the third week of April, 2018. The month of February, 2018 represented the month, that has the highest population density of the cabbage aphid *B. brassicae* (5769 and 2545 individuals) for both the untreated control and the treatment, respectively. The mean total numbers of the cabbage aphid, *B. brassicae* per the season were; 559.49±134.07 &167.05±82.35 individuals, for the untreated control and the treated area by the natural compound Spinosad, respectively. The percentage of reduction in the population density of the cabbage aphid, *B. brassicae* was 70.14% (Table, 2). However, Wagh *et al.* (2017) recorded Spinosad as the most effective treated compound among many tested ones to reduce the aphidś population (the men total numbers were 2.09, 1.31 and 3.07 aphids/3 leaves/plant) compared with the untreated control (19.73, 17.47 and 18.20 aphids/3 leaves/plant) at three, seven and ten days after spraying this compound, respectively and it gave highest marketable yield. While, Salem *et al.* (2018) reported that, Spinosad reduced the cereal aphid complex infesting the wheat plants by 97.05%. Also, Henry and Vijay (2020) revealed that Spinosad was found to be effective against the cabbage aphid, *B. brassicae* (with 114.33, 98.32, 88.95 and 102.67 aphids per plant) compared with the untreated control (231.67, 238.31, 250.56 and 260.19), i.e., 49.14, 57.48, 63.42 and 59.34 percentages of the aphid population density reduction in comparing with the untreated control) at 3, 7, 11 and 15 days after spraying this compound, respectively.

2- B-The Effect of Spinosad on the Formation of the Aphid Mummies of the Parasitoid, *D. rapae* Parasitizing the Cabbage Aphid, *B. brassicae* on the Red Cabbage Plants.

Data presented in Table (2) and Fig. (4) revealed the effect of spraying the natural compound Spinosad on the formation of the mummies of the parasitoid *D. rapae* parasitizing the cabbage aphid *B. brassicae*, by comparing the treated area with that of the untreated control, on the red cabbage plants, during 2017/2018 season. In the untreated control, the total numbers of the aphid mummies of the parasitoid *D. rapae* parasitizing the

cabbage aphid *B. brassicae* began to appear with a few numbers only one mummy during the third week of January, 2018 (at 15.87C° and 53.96 %R.H.). Then, they reached the highest total number of parasitoid mummies (164 mummies at 23.36C° and 44.73%R.H.), during the first week of March, 2018. Finally, it was 84 parasitoid mummies (at 25.56C° and 40.43%R.H.) at the end of the season. While, the corresponding for the treated area by the natural compound Spinosad was; 16 mummies (at 14.76C° and 64.63%R.H.), during the last week of January, 2018, 56 individuals (at 15.87C° and 53.96% R.H.), during the third week of February, 2018 and only one individual (at 25.56 C° and 40.43%R.H.) at the end of the season, respectively. The mean total numbers of the aphid mummies of the parasitoid *D. rapae* parasitizing the cabbage aphid *B. brassicae* per the season were; 54.00±13.01&12.07±4.01, for the untreated control and the treated area by the natural compound Spinosad, respectively. The percentage of reduction in the total numbers of the formed mummies of the aphid parasitoid *D. rapae* parasitizing of the cabbage aphid.

Table 2: The weekly total numbers of the cabbage aphid, *B. brassicae* (adults & nymphs) and its parasitoid *D. rapae* mummies, that occurred on the red cabbage plants, in comparing the untreated control with that sprayed by Spinosad during the growing season 2017/2018, in the Greenhouses located in Giza Governorate.

No.	Dates of sampling	Total no. of the cabbage aphid, *B. brassicae* (A + N)		Total no. of *D. rapae* parasitoid mummies	
		Untreated control	Treatment	Untreated control	Treatment
1	Last week of November, 2017	0	0	0	0
2	1st week of December	7	1	0	0
3	2nd week	18	6	0	0
4	3rd week	37	29	0	0
5	Last week	42	34	0	0
6	1st week of January, 2018	50	47	0	0
7	2nd week	55	51	0	0
8	3rd week	82	76	1	0
9	Last week	351	327	18	16
10	1st week of February	772	647	36	31
11	2nd week •	1635	1591	59	52
12	3rd week	1880	176	147	56
13	Last week	1482	131	158	38
14	1st week of March	1290	119	164	21
15	2nd week	973	48	128	14
16	3rd week	682	24	86	11
17	Last week	596	13	72	8
18	1st week of April	491	11	63	4
19	2nd week	387	7	64	2
20	3rd week	359	3	84	1
Total/season (range)		11189 (0-1880)	3341 (0-1591)	1080 (0-164)	254 (0-56)
Mean / season				54.00±13.01	12.07±4.01
% of formation of *D. rapae* mummies		559.45±134.07	167.05±82.35	% of formation of *D. rapae* mummies 9.65%	% of formation of *D. rapae* mummies 7.60%
- % Reduction in the population density of the cabbage aphid, *B. brassicae* 70.14%. - % Reduction in the formation of the mummies of the parasitoid *D. rapae* parasitizing the cabbage aphid *B. brassicae* 21.24%.					
- Statistical analysis: - A highly significant difference was recorded in case of comparing the untreated control with the treatment of the red cabbage plants (infested by the cabbage aphid *B. brassicae*), in-season 2017/2018 (r-value =0.846*** & sign. =0.000). - A moderate significant difference was recorded in the case of comparing the formation of the aphid mummies. - In case of the untreated control with the treatment of the red cabbage plants (that was infested by the cabbage aphid *B. brassicae*), in season 2017/2018 (r-value =0.616** & sign. =0.004).					

• = (Date of spray) - (A + N) =Adults + Nymphs - *Significant (0.500-0.600) **Moderate significant (0.600-0.800) ***Highly significant (0.800-0.900) ****Very highly significant>0.900.

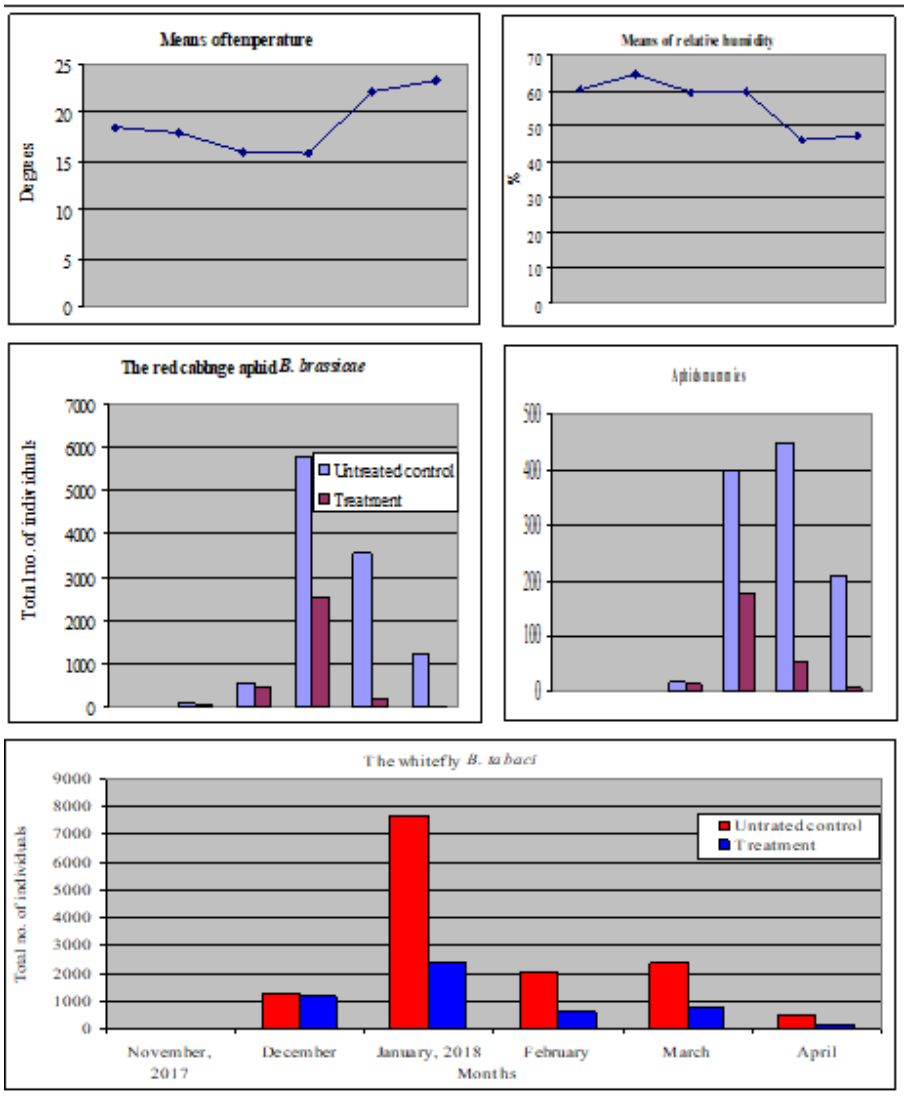


Fig. (4): The weekly total numbers of the whitefly, *B. tabaci* individuals (adults & nymphs), the cabbage aphid, *B. brassicae* (adults & nymphs) and its parasitoid *D. rapae* mummies, that occurred on the red cabbage plants, in comparing the untreated control with that sprayed by Spinosad, during the growing season 2017/2018, in the Greenhouses located in Giza Governorate.

B. brassicae was 21.24%**.** However, Stark & Acheampong (2007); Duchovskien & Raudonis (2008); Abdel-Galil (2019), and Verma *et al.* (2019) showed the aphid parasitoid *D. rapae* as a common parasitoid of the cabbage aphid, *B. brassicae*. However, Abdel-Galil *et al.* (2019) indicated that the mean percentage of *B. brassicae* parasitism by the parasitoid *D. rapae* increased until the end of both two studied seasons, although, the pest populations decreased at mid-March where, the seasonal mean percentage of parasitism recorded was 34.76%. A simultaneous decrease of the pest numbers was observed with the increase of the parasitoid populations. Similar to the obtained results concerning the effect of Spinosad on the parasitoid *D. rapae*, Williams *et al.* (2003) reported that the use of Spinosad-based products should be carefully evaluated with respect to the need for biological control by augmentative releases and/or conservation of the parasitoids. However, the natural components such as Spinosad was shown to have a unique mode of action, coupled with the high degree of the activity against the targeted pests considered to have low activity against most of the beneficial insects and are useful in I.P.M. programs (Eger & Lindenberg. 1998)

and was classified as reduced-risk product due to the low toxicity to the mammals, the fish, the birds, the wildlife and the human beings, and of course, the beneficial arthropods and may be used as an alternative to the conventional insecticides in I.P.M. programs (Cisneros *et al.*, 2002) finally, Spinosad was considered in the context of resistance management (Thomas *et al.*, 2006).

3- The Relationships Between Many Tested Factors and the Weather Factors Concerning the Means of Temperature and the Relative Humidity, During Season 2017/2018, in Giza Governorate.

The relationships between mean total numbers of the whitefly, *B. tabaci*, the mean total numbers of the cabbage aphid, *B. brassicae*, the mean total numbers of the aphid mummies of the parasitoid *D. rapae*, with the means of the temperature and the relative humidity in season 2017/2018, were shown in Table (3). Where the R-values were recorded to represent such obtained relationships that were recorded as follows:

1-There was no significant difference between mean total numbers of the whitefly *B. tabaci* individuals and the means of temperature (r-values=-0.489&-0.340), in case of comparing the untreated control & the treatment with Sipnosad.

2- There was no significant difference between the mean total numbers of the whitefly *B. tabaci* individuals and the means of the relative humidity (r-values=0.166&0.187), in case of comparing the untreated control & the treatment with Sipnosad.

3-There was no significant difference between the mean total numbers of the cabbage aphids *B. brassicae* individuals and the means of temperature (r-values=-0.036&-0.323), in case of comparing the untreated control & the treatment with Sipnosad.

Table 3: The relationships between many tested factors and the means of the weather factors concerning the means of temperature and the relative humidity, that occurred on the red cabbage plants, in comparing the untreated control with that sprayed by Spinosad, during the growing season 2017/2018, in the greenhouses located in Giza Governorate.

Tested factors	Values	The means of the weather factors			
		The means of temperature		The means of relative humidity	
		Untreated control	Treatment	Untreated control	Treatment
- The mean total numbers of the whitefly *B. tabaci*	r-value	-0.489	-0.340	0.166	0.187
	Sig.	0.029	0.143	0.483	0.429
- The mean total numbers of the cabbage aphid *B. brassicae*	r-value	-0.036	-0.323	0.219	0.194
	Sig.	0.881	0.165	0.354	0.411
- The mean total numbers of the aphid mummies of the parasitoid *D. rapae*	r-value	0.338	-0.325	-0.503*	0.040
	Sig.	0.145	0.162	0.024	0.867

Note: Significant (0.500-0.600) **Moderate significant (0.600-0.800) ***Highly significant (0.800-0.900) ****Very highly significant>0.900.

4- There was no significant difference between the mean total numbers of the cabbage aphid *B. brassicae* individuals and the means of the relative humidity (r-values=0.219&0.194), in case of comparing the untreated control & the treatment with Sipnosad.

5-There was no significant difference between the mean total numbers of the aphid mummies of the parasitoid *D. rapae* individuals parasitizing the cabbage aphid *B. brassicae* and the means of temperature (r-values=0.338&-0.325), in case of comparing the untreated control & the treatment with Sipnosad.

6- There was a significant difference between the mean total numbers of the aphid mummies of the parasitoid *D. rapae* and the means of the relative humidity (where, r-values=0.503*&0.0.040), in case of comparing the untreated control & the treatment with Sipnosad.

Conclusion

1- In the untreated control, the population density of the whitefly, *B. tabaci* began to appear with a few numbers in the last week of November, 2017, then, they reached the highest total number during the third week of January, 2018 and finally, it ended in the third of week of April, 2018. While, the corresponding for the treated area by the natural compound Spinosad against the whitefly, *B. tabaci* were; in the last week of November, 2017, during the first week of January, 2018 and ended in the third of week of April, 2018, respectively. The month of January, 2018 represented the month having the highest population density of the whitefly *B. tabaci* (7712 and 2409 individuals) for both the untreated control and treatment, respectively. The mean total numbers of the whitefly, *B. tabaci* individuals per the season were; 699.05±152.23 & 261.95±71.86 individuals, for the untreated control and the treatment by the natural compound Spinosad, respectively. The percentage of reduction in the population density of the whitefly, *B. tabaci* was 62.53%.

2- In the untreated control, the population density of the cabbage aphid, *B. brassicae* began to appear with a few numbers in the first week of December, 2017, then, they reached the highest total number during the third week of February, 2018, finally, it ended during the third week of April. While, the corresponding for the treated area by the natural compound Spinosad was during the first week of December, 2017, during the second week of February, 2018 and ended in the third week of April, 2018, respectively. The month of February, 2018 represented the month, that has the highest population density of the cabbage aphid *B. brassicae* (5769 and 2545 individuals) for both the untreated control and the treatment, respectively. The mean total numbers of the cabbage aphid, *B. brassicae* per the season were; 559.45±134.07 &167.05±82.35 individuals, for the untreated control and the treated area by the natural compound Spinosad, respectively. The percentage of reduction in the population density of the cabbage aphid, *B. brassicae* was 70.14%.

3- In the untreated control, the total numbers of the aphid mummies of the parasitoid *D. rapae* parasitizing the cabbage aphid, *B. brassicae* began to appear with a few numbers during the third week of January, 2018, then, they reached the highest total number of parasitoid mummies during the first week of March, 2018 and finally, it ended in the third of week of April, 2018. While, the corresponding for the treated area by the natural compound Spinosad was; during the last week of January, 2018, during the third week of February, 2018 and ended in the third week of April, 2018. The mean total numbers of the aphid mummies of the parasitoid *D. rapae* parasitizing the cabbage aphid, *B. brassicae* per the season were; 54.00±13.01 & 12.07±4.01, for the untreated control and the treated area by the natural compound Spinosad, respectively. The percentage of reduction in the total numbers of the formed mummies of the aphid parasitoid *D. rapae* parasitizing the cabbage aphid, *B. brassicae* was 21.24%**.**

4- Thus, the natural compound Spinosad can be used as an effective natural insecticide against both the whitefly, *B. tabaci,* and the cabbage aphid, *B. brassicae* in the red cabbage fields that are cultivated in the Greenhouses or open fields (that are subjected to attack by these two-common piercing-sucking insects pests). Also, the use of such compounds was less harmful to the formation of the mummies of the aphid parasitoid *D. rapae*. Therefore, this natural compound and the parasitoid *D. rapae* can be used when planning I.P.M. programs against the two previous pests' species, side by side with other safe control methods, for giving less pollution to the surrounding environment. However, Williams *et al*., (2003) stated that the use of Spinosad-based products should be carefully evaluated with respect to the need for biological control by augmentative release and/or conservation of parasitoids.

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ARABIC SUMMARY

تأثيراستخدام المبيد الطبيعى Spinosad على كلاً من الذبابة البيضاء (the whitefly, *Bemisia tabaci* (Genn.))، ومن الكرنب ((the cabbage aphid, *Brevicoryne brassicae* (L.)) المهاجمان لنباتات الكرنب الأحمر، مع تقدير تأثيره على مومياوات طفيل المن ((the aphid parasitoid *Diaeretiella rapae* (Mclntoch)) ، فى الصوبات الزراعية بمحافظة الجيزة.

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يعتبر الكرنب الأحمر *Brassica oleracea* var. *capitata* (التابع للعائلة الصليبية) أحد محاصيل الخضر الهامة فى مصر. حيث يتعرض للاصابة بالعديد من الآفات الثاقبة الماصة الشائعة: مثل الذبابة البيضاء (the whitefly, *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae)، ومن الكرنب (the cabbage aphid, *Brevicoryne brassicae* (L.) (Hemiptera: Aphididae).

ولذا، فقد أجريت هذه الدراسة لتقييم وتقدير التأثير الحادث بواسطة المبيد الطبيعى Spinosad لمكافحة وتقليل تعداد تلك الآفتين، وكذلك طفيل المن (the aphid parasitoid *Diaeretiella rapae* (Mclntoch)) المسجل على من الكرنب. حيث أجريت هذة الدراسة خلال موسم 2018/2017 فى منطقة الصوبات الزراعية بمحافظة الجيزة، مصر.

أظهرت النتائج ان فترة التواجد للذبابة البيضاء (the whitefly, *B. tabaci*) قد امتدت على مدار موسم زراعة الكرنب الأحمر (من نوفمبر 2017 حتى أبريل 2018). حيث سجل أعلى تعداد للذبابة البيضاء (the whitefly, *B. tabaci*) (2139, 1469 فرداً) خلال الأسبوعين الثالث والأول من شهر يناير 2018 لكلاً من الكنترول الغير معامل والمعاملة بالمبيد الطبيعى Spinosad، على الترتيب. وكان متوسط التعداد على مدار الموسم 699.05±152.23، 261.95±71.86 فرداً، لكلاً من الكنترول الغير معامل والمعاملة بالمبيد الطبيعى Spinosad. وسجل أقصى تعداد شهرى خلال شهر يناير (7712, 2409 فرداً) لكلاً من الكنترول الغير معامل والمعاملة بالمبيد الطبيعى Spinosad، على الترتيب. واوضحت النتائج أن نسبة الخفض فى تعداد الذبابة البيضاء (the whitefly, *B. tabaci*) *على* مدار الموسم كانت 62.53% نتيجة المعاملة بالمبيد الطبيعىSpinosad ، يالمقارنة بالكنترول الغير معامل.

وبالنسبة لمن الكرنب (the cabbage aphid, *B. brassicae*) ، فقد أمتدت فترة التواجد طوال الموسم فيما عدا الأسبوع الأخير من شهر نوفمبر2017. وسجل أعلى تعداد لمن الكرنب (the cabbage aphid, *B. brassicae*) (1880, 1591 فرداً) خلال الأسبوعين الثالث والثانى من شهر فبراير 2018 لكلاً من الكنترول الغير معامل والمعاملة بالمبيد الطبيعى Spinosad، على الترتيب. وسجل أقصى تعداد شهرى لمن الكرنب *B. brassicae* *خلال* شهر فبراير (5769, 2545 فرداً) لكلاً من الكنترول الغير معامل والمعاملة بالمبيد الطبيعى Spinosad، على الترتيب. وكان متوسط التعداد لمن الكرنب (the cabbage aphid, *B. brassicae*) على مدار الموسم 559.45±134.07، 167.05±82.35 فرداً ، لكلاً من الكنترول الغير معامل والمعاملة بالمبيد الطبيعىSpinosad ، على الترتيب. واوضحت النتائج أن نسبة الخفض فى تعداد المن على مدار الموسم كانت 70.14% نتيجة المعاملة بالمبيد الطبيعى Spinosad، يالمقارنة بالكنترول الغير معامل.

وسجل فقط تواجد لطفيل المن *D. rapae* المرتبط بمن الكرنب (the cabbage aphid, *B. brassicae*) وكان أعلى تعداد لمومياوات الطفيل (164, 56 مومياء طفيل) خلال الأسبوع الأول من مارس 2018 والثالث من شهر فبراير لكلاً من الكنترول الغير معامل والمعاملة بالمبيد الطبيعى Spinosad، على الترتيب. وكان متوسط التعداد لمومياوات الطفيل على مدار الموسم 54.00±13.01، 12.07±4.01 لكلا من الكنترول الغير معامل والمعاملة بالمبيد الطبيعى Spinosad، على الترتيب. وسجل أقصى تعداد شهرى للمومياوات (450, 177 مومياء طفيل) خلال شهرى مارس 2018 وفبراير 2018 لكلاً من الكنترول غير المعامل والمعاملة بالمبيد الطبيعى Spinosad ، على الترتيب. وبلغت نسبة الخفض فى التعداد لمومياوات الطفيل *D. rapae* على من الكرنب (the cabbage aphid, *B. brassicae*) 21.24% نتيجة للمعاملة بالمبيد الطبيعى Spinosad ، يالمقارنة بالكنترول الغير معامل.

عموماً يمكن أن نستنتج مما سبق، بأنه يمكن إستخدام المبيد الطبيعى Spinosad لخفض تعداد الذبابة البيضاء(the whitely, *B. tabaci*) ومن الكرنب (the cabbage aphid, *B. brassicae*) ، على نباتات الكرنب الأحمر أو النباتات الأخرى التى تصاب بالآفتين. بجانب امكانية إستخدام طفيل المن the parasitoid *D. rapae* فى وجود المبيد الطبيعى Spinosad، حيث انه قليل التأثير على مومياوات طفيل المن المتكونة. ويكون ذلك فى إطار منظومة برنامج المكافحة المتكاملة للأفات (I.P.M.) ، جنباً الى جنب مع إستخدام باقى الطرق الأخرى الآمنة لتقليل التلوث البيئى للوسط المحيط.