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Biological control of sesame moth and tobacco whitefly in Antalya sesame fields

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ABSTRACT

Sesame moth and tobacco whitefly cause significant damage to sesame plants, especially in the second-period sesame cultivation areas, if early intervention is not implemented. This greatly reduces efficiency. Chemical control is generally preferred for these pests in Türkiye. Today, the use of chemical control creates many harmful results. Therefore, in our study, the aim is to use biological control agents and preparations as an alternative to chemical control. In this study, applications of Nostalgist Bl biological insecticide containing 1.5% *Beauveria bassiana* strain Bb-1 1x10^{8} CFU mil^{-1} spores, Nimbecidine biological insecticide containing 0.3 g L^{-1} Azadirachtin active ingredient, and *Trichogramma evanescens* Westwood (Hymenoptera: Trichogrammatidae) an egg parasitoid and activities were determined. The application area (2 da) was divided into 3 blocks; each block was named with the letters A, B, and C. Each block was divided into four parcels. The above applicatios and biological insecticides were applied separately in each parcel, including the control parcels in each block. In the counts made according to the application results, there was a significant decrease in whitefly eggs and nymphs on the leaf surface. A very significant decrease was observed in the populations per plant in the sesame moth larvae counts. The highest efficiency was obtained with Nimbecidine and Nostalgist applications. The yield was moderate in the plots with parasitoid application.

1. Introduction

Sesame is an important oil plant with high nutritional and economic value, and so it is used as a raw material in many sectors. Sesame [*Sesamum indicum* (Lamiales: Pedaliaceae)] is native to Africa and a secondary crop in Türkiye. It is grown in hot regions both around the world and in Türkiye. Sesame capsules contain a large number of seeds, which are used as a spice and as ingredients in products such as bagels, bread, cakes, buns, and pies. It is the raw material for the production of tahini, and helva. According to Atakisi (1991), after oil extraction from sesame, the pulp remains. Sesame meal is used as an important animal feed as it is also mixed with bread.

Sesame is cultivated as a second crop after cereal harvests in coastal areas of Türkiye (Tan 2015). Second sowing is done in June, July, and August.

In Türkiye, sesame was cultivated on an area of 254862 da in 2021, while this number was 53910 da in 2020, and 56598 da in 2021 just in Antalya. The yield of 84 kg da^{-1} was obtained in both years (TUIK 2022).

In Manavgat, 2400 tons of sesame are harvested on a production area of 41000 da. Approximately 20% of the sesame produced in Türkiye is produced in Antalya and approximately 80 % of the sesame produced in Antalya is produced in Manavgat district. Approximately 17% of the sesame grown in Türkiye is in Manavgat; in other words, three-quarters of the sesame cultivated in Antalya is grown in Manavgat. Manavgat sesame is known as Golden sesame and has a 60% oil content (MATSO 2020).

Since sesame is a plant that is used in many areas, it is necessary to increase the yield per unit area. The most important pests in sesame plants are whitefly and sesame moth. If they are not controlled, they cause high yield losses.

Bodenheimer (1958) stated in a study that the larvae of *Antigastra catalaunalis* Dup. (Lepidoptera: Pyralidae), which colonize sesame plants, cause significant damage during the seedling and flower phases. In a study carried out in the province of Antalya, it was reported that a 74.7 kg da^{-1} sesame yield was obtained in 1938, but then it decreased to 34.4 kg da^{-1} in 1939.

Larval damage usually occurs by twisting sesame leaves transversely, spinning webs, and feeding on leaves. In addition, at flower formation time, they weave the flower buds with nets and then eat them before the plant's entire flowering. For this reason, the sesame plant cannot develop and form capsules at all. At the time when sesame capsules emerge, the larvae can eat both the seeds by making holes in the capsules and the capsules as well by chewing them.

The whitefly, *Bemisia tabaci* Genn. (Homoptera: Aleyrodidae), another sesame pest causes damage by sucking and producing fumagine, especially during the flowering period. In addition, it facilitates fungal and viral diseases by vectoring them. Ashley (1993) mentioned that *Phyllody* virus and *Nicotiana* virus can be transmitted by whitefly in sesame.

In 1983-1984, 26 pest species were detected on sesame plants in the second growth of sesame in Aydın, İzmir, and Manisa provinces, and the most abundant species in terms of total number of individuals in all samples was *B. tabaci* (Genn.) (Hemiptera: Aleyrodidae) (Zümreoğlu and Akbulut 1988).

In this study, the aim was the control of pest populations by using biological control agents and bioinsecticides (*Beauveria bassiana, Trichogramma evanescens* and Azadiractin) without using chemical insecticides in the control of tobacco whitefly and sesame moth pests, which cause significant damage to sesame plants.

2. Materials and Method

2.1. The trial site

The trial was established in a field with an area of 2000 m^2 in the Çavuşköy zone of the Manavgat district in Antalya province. The heirloom seeds known as Manavgat sesame were sown in the field. The field was divided into three blocks as replications. The blocks were named A, B, and C. Each block was equally divided into four plots and were marked with numbers. The 4^{th} plots of each block were used as a control plots. In the 3^{rd} plot blocks, *Trichogramma evanescens*, the subject parasitoid wasp was released one by one. The 3^{rd} plot were isolated with 75% net curtains. Biological insecticides were used sequentially in the remaining blocks.

2.2. The origin of applied parasitoids and biological insecticides

Trichogramma evanescens as 20000 pieces were provided from Trimail Biological Agriculture of Ankara University's Teknokent. Nostalgist Bl biological insecticide containing 1.5% *B. bassiana* strain Bb-1 1×10^8 CFU mil^{-1} min spores and Nimbecidine biological insecticide containing 0.3 g L^{-1} Azadirachtin active ingredient were procured from Agrobest Agriculture Group. Yellow, blue, and black sticky traps were provided and then randomly hung in the plots according to the plant size in order to identify the adult individual's emergence of the subject pests and other pest types.

2.3. Identification of pest populations

The fight against the sesame moth, *Antigastra catalaunalis* Dup. (Lepidoptera: Pyralidae), was started with 50 sesame plants, which were randomly selected from each block based on the information stated on the page of the Ministry of Agriculture and Forestry that the application was started when the plant infestation rate was 20%. After an estimation of the infestation rate, the application was initiated.

For the tobacco whitefly population (Anonymous 2008), based on information data from the Ministry of Agriculture and Forestry stating that the control should be initiated when 60 leaves are counted, 1 each from the lower, common and upper parts of at least 20 randomly selected plants and when an average of 5 larvae or pupae per leaf are counted, the population densities were determined in the field as follows: 50 plants were randomly selected and tobacco whitefly eggs and nymphs were counted on the lower, middle, and upper leaves. Sesame moth larvae were counted in 50 randomly selected sesame plants, and infected plants were identified. In order to asses its effectiveness, the trial field scouting was carried out on 4 different dates (July 30, August 10, August 22, and August 31, 2021). taking into account the economic damage threshold.

2.4. Determination of trial plots and application

The 2000 m^2 trial field was divided into 3 blocks equally, and the blocks were lettered A, B, and C. Each block was equally divided into 4 plots marked with numbers. In each block plots, biological insecticide applications and parasitoid release were conducted in the 3 replications as shown in Figure 1. The 4^{th} plot was left as a control plot.

A1 Nimbecidine	B1 Nostalgist	C1 Nimbecidine
A2 Nostalgist	B2 Nimbecidine	C2 Nostalgist
A3 *Trichogramma evanescens*	B3 *Trichogramma evanescens*	C3 *Trichogramma evanescens*
A4 Control	B4 Control	C4 Control

Figure 1. Schematic of applications in the study plots.

Biological insecticides were applied by spraying on the plants with the help of a 16-liter knapsack sprayer, so the upper and underneath of the leaves were all well covered. Each plot was 165 m^2. Nimbecidine at a dosage of 40 mL and Nostalgist at a dosage of 42 mL (250 ml ha^{-1}) were applied to the plots except the 3^{rd} and 4^{th} plots of the blocks, which were treated with 8 L of water. The first application was conducted on September 1, 2021, and the second application was conducted on September 9, 2021.

On August 31, 2021, a total of 20000 *Trichogramma evanescens* parasitoids, 2000 in each box, were released separately within equal boxes in the 3^{rd} blocks by hanging the boxes on the plants.

2.5. Post-application counts

Similarly, for the counts carried out to determine population density, on September 1, 2021 (a week after the first application) 50 plants were randomly selected from each plot and counted for infested tobacco whitefly larvae and nymphs on the lower, middle and upper leaves. For sesame moth larvae, 50 plants that were randomly selected from each plot were observed and along with the previous. For sesame moth larvae, 50 plants that were randomly selected from each plot were observed, counted and then monitored by comparing with the previous situation. In a similar way, on September 9, 2021 (a week after the second application) counting was carried out again, and the effectivity graphs of all the pesticide types were drawn.

2.6. Evaluation of trials and statistical analysis

The effect of the treatments on yield as assigned in different plots was calculated after weighing the product obtained in the plots at harvest time. For this purpose, the plants in each treatment were harvested separately, and their biomass was weighed. Afterwards, the results were subjected to statistical analysis.

A one-way analysis of variance (One-Way ANOVA) was applied to the trial field that was designed as a completely randomized block. Then Tukey's multiple comparison test (Tukey 1949) was employed to determine the source of differences. Statistical analyses were carried out using IBM SPSS® Statistics (IBM SPSS 2008).

3. Results and Discussion

As a result of the experiment the number of insects caught in the traps before the treatment is shown in Table 1.

As can be seen in the table, varied numbers of insects were caught in differently colored traps in the two pre-treatment counts. The number of insects caught in the second count was higher than in the first count. Before application, thrips were not caught in the yellow sticky traps, and whitefly was not caught in the blue sticky traps and *Empoasca* sp. was caught in all three colored traps. *Macrolophus pygmaeus* Rambur (Hemiptera: Miridae), a polyphagous predatory species that feeds on pests such as whiteflies, mites, aphids, and gallery flies, was caught only in the black-colored sticky traps. As seen in Table 2, *Empoasca* sp. was caught equally in the yellow and black-colored traps, while it was caught less in blue traps. The sesame moth was not caught in any of the traps.

The number of insects caught in the traps after parceling and treatments is shown in Table 2.

As shown in Table 2, it was found that although there were numerical differences between the insects caught in traps, but for the post-treatment application, there was no statistical difference.

Although there was no difference between the treatments, there was a difference between the traps depending on the treatments. Whitefly individuals were not caught in the blue sticky traps but they were caught in the yellow traps in quite varied amounts as compared to the black traps. Thrips were caught only in the blue traps while *Empoasca* species were caught in all three colors of traps with the highest number caught in the yellow traps, followed by the black traps and the lowest number found in the blue traps. The predatory insect *M. phymaeus* was caught only in the black traps, although in small numbers.

A comparison between Table 1 and Table 2 leads to the conclusion that the yellow sticky traps can be used in sesame-growing areas for catching whiteflies, the blue sticky traps for thrips and the yellow and black sticky traps for *Empoasca* species.

The graphs showing the results of the direct counts conducted on 50 plants in the field but outside the traps are presented in Figures 2-6.

As can be seen in Figure 2, Nimbecidine was applied to the study plots on September 1 and 9, 2021, and it was determined that it was highly effective against whitefly in the subsequent monitoring. In a similar way to Nimbecidin, the applied Nostalgist was found to be highly effective against whitefly eggs and nymphs (Figure 3).

As presented in the Figures 4 and 5, Nimbecidine and Nostalgist were applied to the study plots on September 1 and 9, 2021. On the next counting dates, it was found highly effective against sesame and similarly for the whitefly.

Figure 6 shows the graph of sesame moth population change after the monitoring of sesame moth and the field releases of the parasitoid *Trichogramma evanescens* in the study plots. As can be seen in Figure 6, there was a significant decrease in the number of moths immediately after the release.

In this case, all figures are evaluated together, very significant effects of the biological insecticides on both whitefly and sesame moth were found.

It was also found that the parasiticide used was also effective in terms of reducing the population of Sesame moth.

The yield results obtained in the study plots in their treatments during the harvest period are presented in Table 3.

The presentation in Table 3 shows that the yield was also different in the plots with different treatments and the differences were statistically significant. However, all treatments were found statistically different from the control treatment. The highest yield was obtained in Nimbecidine and Nostalgist treatments and both treatments were statistically in the same group. The yield in plots treated with *Trichogramma evanescens* was in the moderate group and statistically different from the other groups.

Coşkuntuncel (1995), on the egg of *Ostrinia nubilalis* Hübner (Lepidoptera: Pyralidae), the maize worm, in the secondcrop corn production areas of Çukurova University, Faculty of Agriculture Research and Application Farm, on a 5 decare are a twice (40 thousand + 40 thousand) twice a week (40 thousand + 440 thousand) produced a mass release activity by releasing one thousand egg parasitoids *Trichogramma evanescens* Westwood (Hymenoptera: Trichogrammatidae). Success rates were 81.25% and 56.66% in 1993 and 1994, respectively.

Ferizli (1997) applied Azadirachtin to *Spodoptera littoralis* Boisd (Lepidoptera: Noctuidae) and stated that depending on the applied doses, it reduced the weight of the larvae, prolonged the larval period and caused larval death.

Çeribaşı (2001) investigated the effectiveness of azadirachtin at different concentrations on *Bemisia tabaci* and stated that azadirachtin was effective in the adult and pre-adult periods.

Kılıç (2006) applied the entomopathogenic fungus *Beauveria bassiana* to tobacco whiteflies. On the sixth day, 36% nymphal death and 48% adult death were observed.

Table 1. Number of insects caught in differently colored traps (number of insects/trap)

Date of Counting	Yellow sticky trap		Blue sticky trap		Black sticky trap		
	Whitefly	Cicadellid	Thrips	Cicadellid	Whitefly	Cicadellid	*Macrolophus pygmaeus*
25.7.2021	108.33	93.89	100.00	43.33	10.33	88.33	10.56
7.8.2021	213.89	201.11	193.89	51.67	5.00	173.89	10.89

Table 2. Number of insects caught in differently colored traps (number of insects/trap)

Insects	Whitefly		Thrips	Empoasca			*Macrolophus pygmaeus*
Trap	Yellow	Black	Blue	Yellow	Blue	Black	Black
Nimbecidine	134.0±24.58	16.6±1.66	131.6±10.92	180.00±21.24	19.00±3.78	116.67±41.76	9.33±3.84
Nostalgist	125.33±12.45	15.33±4.25	173.00±28.00	226.67±3.47	13.33±1.66	172.33±126.38	9.67±3.71
Trichogramma evanescens	110.67±9.82	27.33±2.84	260.67±57.52	153.33±23.95	4.33±4.33	95.00±22.81	6.00±0.57
Control	123.67±18.22	18.33±4.37	158.33±14.52	124.00±31.60	19.33±6.22	99.67±6.11	16.67±6.88

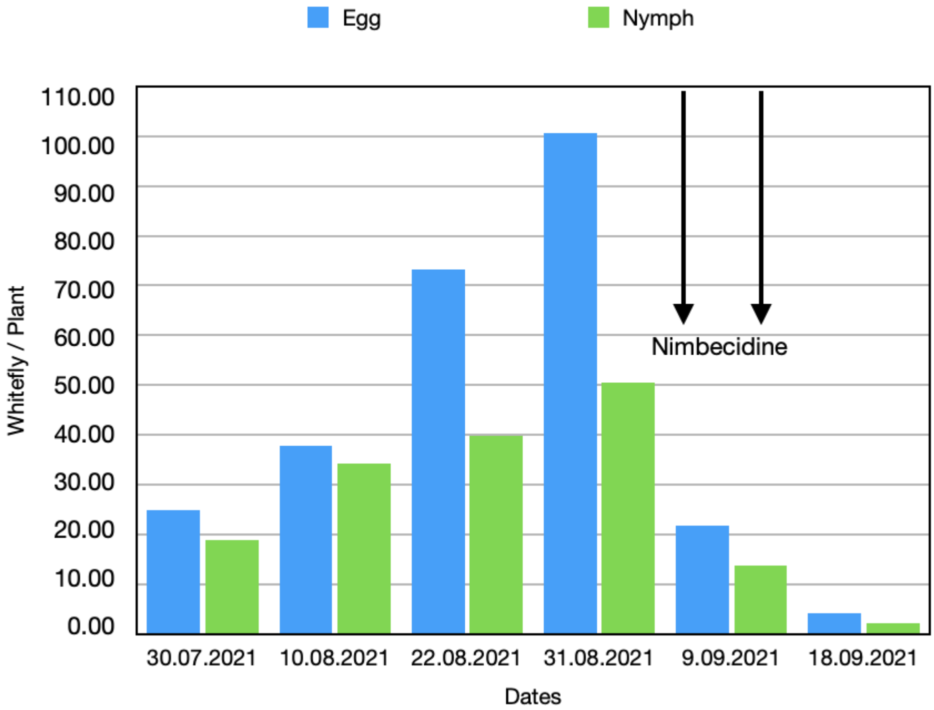

Figure 2. Whitefly numbers/plant.

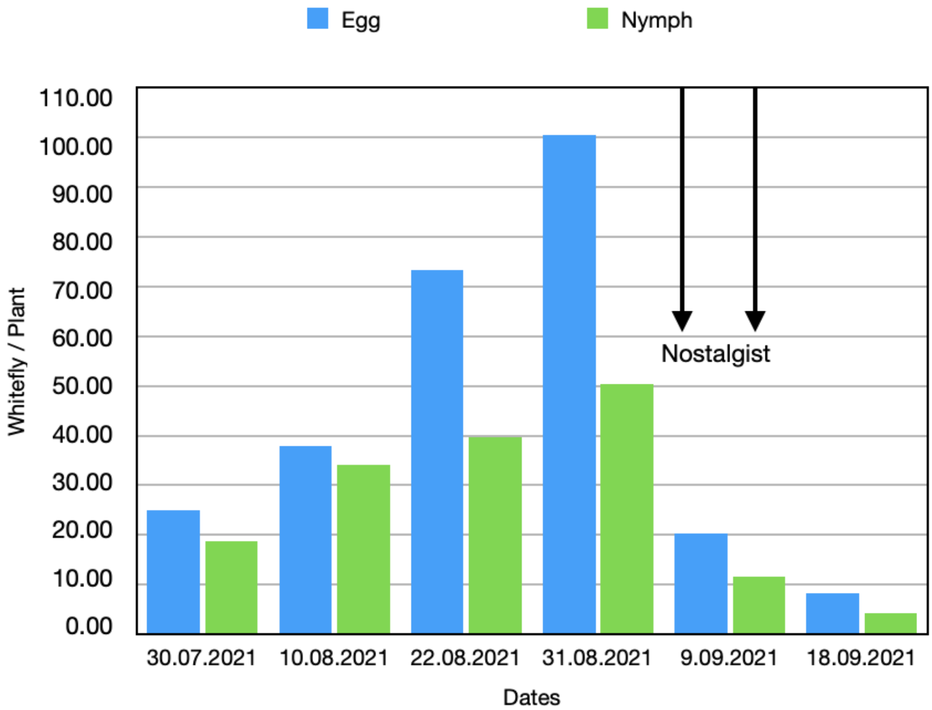

Figure 3. Whitefly numbers/plant.

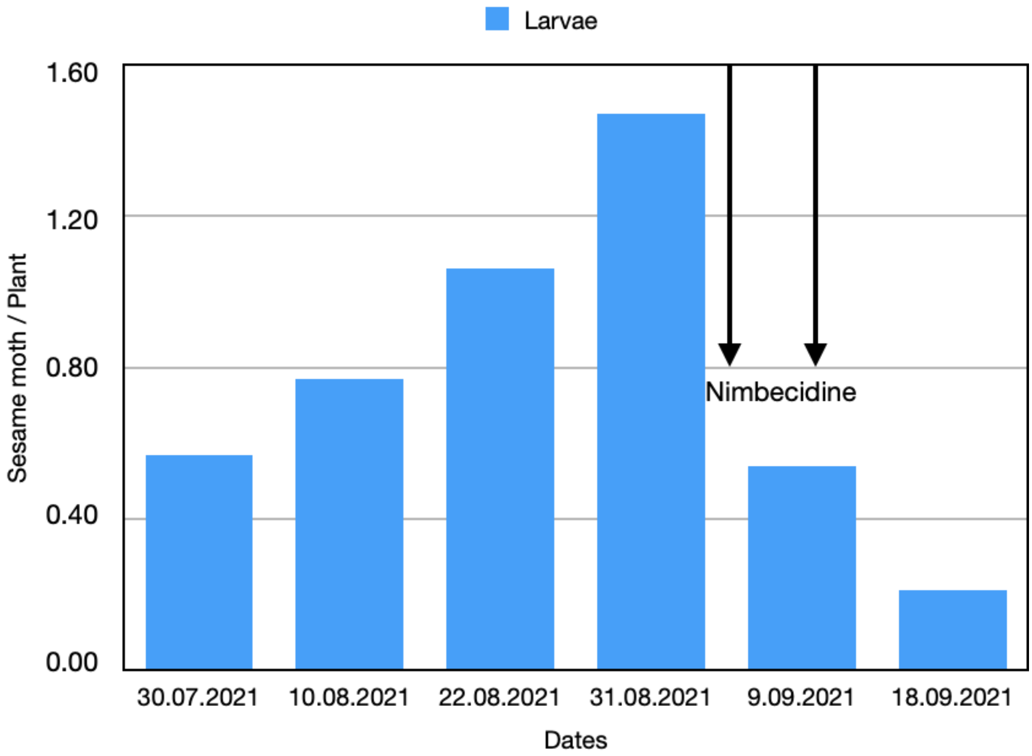

Figure 4. Sesame moths' number/plant.

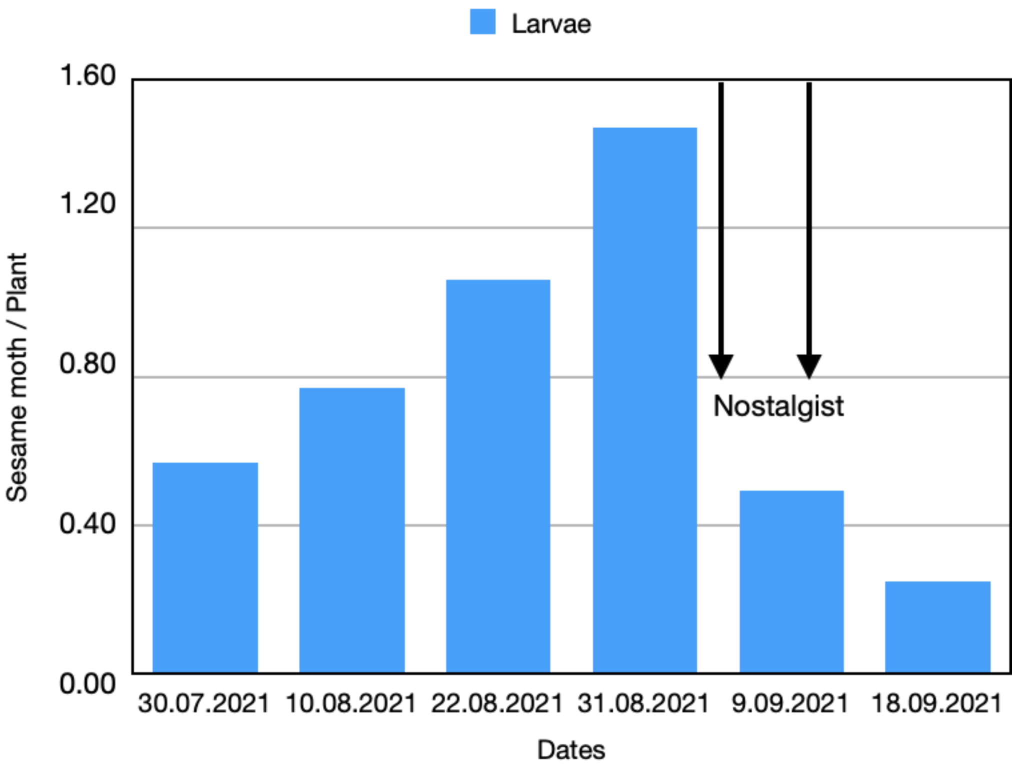

Figure 5. Sesame moths' number/plant.

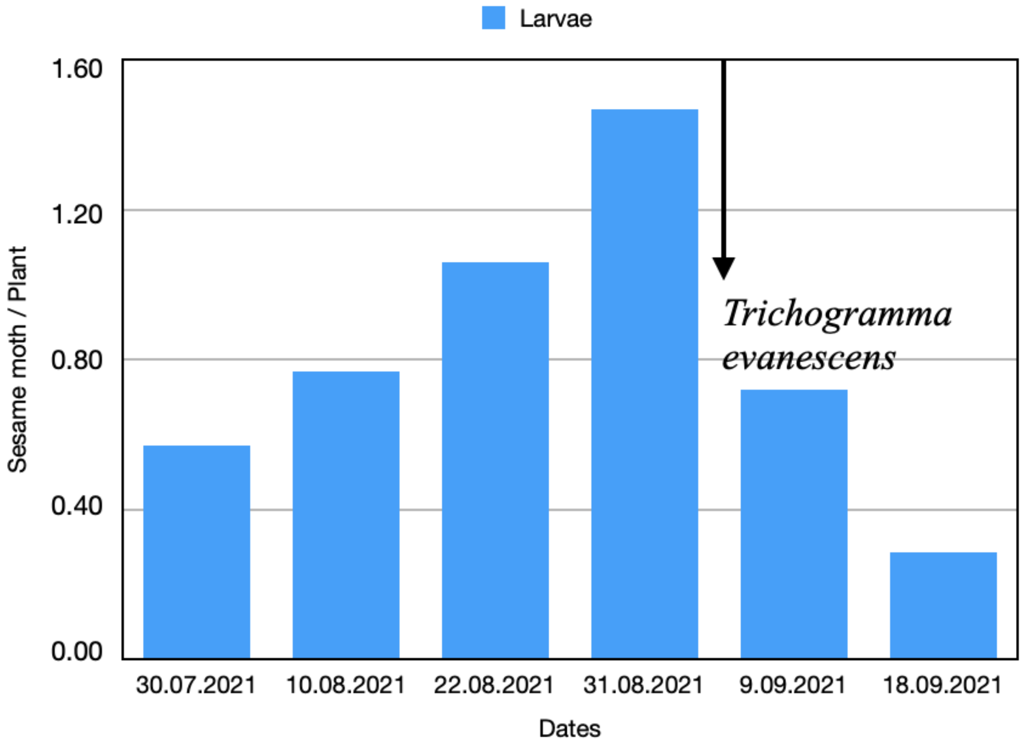

Figure 6. Sesame moths' number/plant.

Table 3. Effect of different treatments on yield (kg/treatment)

Treatments	Yield
Nimbecidine	15.88±0.44 a
Nostalgist	15.33±0.88 a
Trichogramma evanescens	12.50±0.28 b
Control	2.58±0.30 c

Ulusoy (2016) in his study, applied the entomopathogenic fungus containing *Beauveria bassiana* 1x107 spores to *Leptinotarsa decemlineta* larvae by the spraying method and observed 86.6% larval death on the 7th day.

Cırbın et al. (2017) applied *B. bassiana* isolates to *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) and found it quite effective. The LT_{50} values for BMAUM-E2003, BMAUM-E6001, and BMAUM-M6001 were calculated as 2.76, 3.97, and 4.23 days, respectively. He stated that BMAUM-E2003, and BMAUM-E6001 isolates have the potential to be used in future studies.

Akdaş et al. (2020) observed the activity of 12 subcultures of *Beauveria bassiana* BMAUM-E2003, and BMAUM-E6001 isolates, isolated from the soils of Isparta province and its districts in 2014 on mycelium development and *Spodoptera littoralis* larvae, which cause significant economic losses in agricultural products. It was determined that it caused 100% death on the 5th day.

4. Conclusion

So far, the biological pest control method has become very important. Based on the literature, it was found that there are very few biological control studies on the sesame plant. In fact, the results obtained from this study proved that biological control of the main pests in the sesame crop can be achieved effectively.

Parasitoid *Trichogramma evanescens* applied against sesame moth eggs in the study was effective and significantly reduced larval emergence.

An application of a bioinsecticide with an AZA active ingredient against sesame moth larvae resulted in a high efficacy.

The bioinsecticides AZA, and *B. bassiana*, that were applied to *B. tabaci*, decreased the population densities through out the successive post-treatment 7- days counts and it was later observed that those bioinsecticides were highly effective.

This study's data evaluation revealed that biological insecticides are effective on both whitefly and sesame moth and this effect is very important. Another remarkable result is that the parasiticide used was also effective in reducing the population of the sesame moth.

Moreover, when the results are evaluated in terms of the reflection of treatments on yield, it was found that higher yields were obtained from the two entomopathogens: Nimbecidine and Nostalgist. As a conclusion, the use of these agents for subject pests' control in sesame production is recommended.

References

Akdaş A, Kalkar Güven Ö, Karaca İ (2020) Efficacy of *Beauveria bassiana* Isolates Made from Subculture on *Spodoptera littoralis*. Turkish Journal of Biological Control 11(2): 175-187.

Anonymous (2008) Ministry of Agriculture and Forestry, Agricultural Struggle Technical Instructions. https://www.tarimorman.gov.tr/TAGEM/Belgeler/Teknik%20tal%C4%B1matlar%202008/C%C4%B0LT%202.pdf. 200-202 Accessed 07 December, 2022.

Ashley J (1993) Oil Seeds. In Dry Land Farming in Africa. J.R.J. Rowland (eds.), pp. 240-242.

Atakisi İK (1991) Oil Crops Cultivation and Breeding Trakya University. Tekirdağ Faculty of Agriculture. Lesson Book 10, Puplication 11, Publication No 148, pp. 181.

Bodenheimer FS (1958) A Study on Insects Harm ful to Agriculture and Trees in Türkiye and Combating Them. Bayur Printing House. https://kutuphane.tarimorman.gov.tr/pdf_goster?file=9d14b062069 bc02ddfafaa2889cb1511#book/217. Accessed 07 December, 2022.

Cırbın İ, Güven Ö, Karaca İ (2017) Some entomopathogenic fungi have *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) Determination of their effect on their larvae. Journal of Agricultural Faculty of Gaziosmanpasa University 34(3): 159-165.

Coşkuntuncel S (1995) Determination of Mass Release Activity and Natural Parasitization Rate of Egg parasitoid (*Trichogramma evanescens* Westwood, Hymenoptera: Trichogrammatidae) in Biological Control of Corn worm (*Ostrinia nubilalis* Hübner, Lepidoptera: Pyralidae) in Çukurova. Master Thesis, Çukurova University, Institute of Science and Technology, Adana.

Çeribaşı N (2001) Research on the effectiveness of Azadirachtin against some vegetable pests. Master's Thesis, Akdeniz University, Institute of Science and Technology, Department of Plant Protection, Antalya.

Ferizli AG (1997) *Azadirachta indica* A. Juss and *Melia azedarach* L. (Meliaceae) *Spodoptera littoralis* Boisd of Sdrains. (Lep: Noctuidae) Investigations on Some Plants. Ph.D. Thesis, Ankara University, Institute of Natural and Applied Sciences, Department of Plant Protection, Ankara.

Kılıç E (2006) Determination of the potentials of the isolates of *Beauveria bassiana* (Balsamo) Vuillemin, 1826 (Hyphomycetes: Deuteromycotina) in biological control with tobacco whitefly [*Bemisia tabaci* Gennedius, 1936 (Homoptera: Aleyrodidae)]. Ph.D. Thesis, Atatürk University, Graduate School of Natural and Applied Sciences, Erzurum.

MATSO (2020) Manavgat Golden Sesame is Registered With Geographical Indication. https://www.matso.org.tr/haberler/gungor-manavgat-altin-susami-cografi-isaret-ile-tescillendi.html. Accessed 07 December, 2022.

IBM SPSS (2008) Base 10.0 Application Guide. SPSS, Chicago, IL, USA.

Tan AŞ (2015) Sesame Farming. Republic of Türkiye Ministry of Food, Agriculture and Livestock. Aegean Agricultural Research Institute Publications.https://arastirma.tarimorman.gov.tr/etae/Belgeler/Egiti mBrosur/135-ciftcibro.pdf. Accessed 07 December, 2022.

TUIK (2022) Crop Production Statistics.https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr. Cereals and Other Plant Products, Select Breakdown, Breakdowns, Sesame. Accessed 07 December, 2022.

Tukey JW (1949) Comparing Individual Means in the Analysis of Variance. Biometrics 5(2): 99-114.

Ulusoy M (2016) Investigation of the Effect of Entomopathogenic Fungus *Beauveria bassiana* (bals.-criv.) vuill spores on Some Harmful Insects. Master's Thesis, Hacettepe University, Department of Biology, Ankara.

Zümreoğlu S, Akbulut N (1988) Research on pests seen in the second crop sesame plantations of the Aegean Region. Turkish Journal of Entomology 12(1): 39-48.