NTU Journal of Agriculture and Veterinary Sciences (NTU-JAVS)
P. ISSN: 2788-9890 e. ISSN: 2788- 9904

Efficiency of Some Vegetative Powders and Storage Method in Controlling the Great Wax Moth Galleria Melloella L.

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Received: 8-9-2021, **Accepted:** 27-9-2021, **Published online:** 29-9-2021

Abstract. The studies were conducted in the apiary laboratory, apiary store and the external shed of the Plant Protection Department/Department of Plant Protection/College of Agriculture and Forestry/Mosul University during the year 2019-2020. Before using plant powders (black arum, oleander, and cinnamon) to control the wax moth, the effect of the powders on honeybee colonies was tested. The results did not show any negative effect of the powders under study on bees, and bees mortality as a result of treating frames with powders were not recorded. As for the effect of plant powders on the wax-moth, the results showed the lethal effect of plant powders (black arum, oleander and cinnamon) on the Wax moth larvae stage in the laboratory. All plant powders led to satisfactory mortality rates after a week of treatment, especially the black arum powder treatment which differed from the other treatments, and recorded the highest mortality rate of 83.3%, followed by oleander powder with a mortality rate of 63.3%, then cinnamon powder treatment which resulted in the lowest mortality rate of 50.0% during the same period. It was noted that mortality rates differed among treatments for different dates. Interaction treatment of black arum powder and outdoor storage method with leaving a space between frames after a week of treatment recorded the highest mortality rate which was. The rates of larval mortality varied according to the method of storage, arranging the frames and the dates of data recording. Natural mortality rates of insect larvae were recorded in the control treatment, especially in outdoor storing frames, when leaving a space between frames. The control treatment did not record any natural mortality for larvae when using the storage method inside the store, regardless of the distance between frames or the dates of data recording.

Keywords: Black arum, oleander, large wax-moth, storage, plants powders.

Introduction

Honey bee keepers suffer from the infestation of bees inside and outside the hives with many insect and non-insect pests, and the Great Wax Moth *Galleria mellonella* L is one of these important economic pests and destructive to beehives due to its high reproductive efficiency, voracious feeding of the larvae ، The insect attacks the wax comb and pollen inside the beehives or in the store (Hood, 2010). Larvae prefer to feed on old, and dark waxy discs that are stored because of their protein content. The larvae inside the weak honey bee colonies feed on all the contents of the frame from the wax, pollen and brood, causing bald brood, which reveals the pupae and the removal of the wax cover from the hexagonal eye, and sabotaging the installation of the comb by creating long tunnels connected to each other (Ellis, 2013).

The pest larvae secrete thick silk threads that fill the infected frame, which in turn hinders the movement of worker bees and their movement between frames, which affects their performance in raising and feeding brood. As a result, infection leads to weakening of the cell and starvation of the brood and its death due to lack of food by the phenomenon of Galleriasis. Before pupation, the larvae burrow to settle in the wood of the beehive and damage the beehive. Adults and larvae of moths cause the transfer of pathogens to beehives by feces of larvae containing spores of *paeni bacillus* and Nosema spores (Sulborska et al., 2019). The wax moth also transmits Israeli Acute paralysis Virus IAPV and Black Queen cell Virus BQCV among honey bee colonies (Kwadha et al., 2017). This insect spreads widely in Iraq with an infection rate of 26.5%, and the infection rate in Maysan apiaries in southern Iraq in general was 22% and in stores 56% (Al-Mutalibi, 2016).

The use of pesticides often leads to the emergence of resistance in the insect and poisoning of non-target organisms. This requires reducing the use of chemical pesticides and adopting alternative control methods with modern and advanced techniques according to a safe mechanism for bees and the environment within integrated management programs to combat the great wax moth (Imran et al., 2019). In general, pesticides of plant origin are safe and low-risk pesticides. Studies have indicated the possibility of using powders and plant extracts to combat all stages of the wax moth. Among these materials is the powder of the plant Eminium spiculatum, Nerium olrander, and Cinnamomum zeylanicum), which were characterized by containing biologically active compounds and substances effective in expelling and killing pest larvae, similar to the effect of chemical pesticides (Mahmoud and Daoud, 2014, Abu-Reidah et al., 2015, and Fawzy et al., 2017). and Baker and Grant, 2020). On the other hand, arranging the wax frames while storing them requires special care and attention to reduce the injury of the bee hives of the wax mission. It was found that storing combs and placing them in a shed that is open from the sides so that it allows sunlight and air to reach the combs reduces the attraction of wax moth adults and reduces infestation (Hood, 2010; llis et al., 2013 and Kwadha et al., 2017). Therefore, it is preferable to store bee tires in rooms that contain ventilation fans and constant lighting with a low temperature. Therefore, the study aimed to test the effectiveness of vegetative powders (black arum, oleander and cinnamon) in controlling the major wax moth, testing different methods of storing bee combs and their impact on the infection rate of the great wax moth population and evaluate some control methods individually or integrated in reducing the injury by this pest.

Materials and Methods

Collection of plant samples and identification

The black arum plants were collected in April 2020 from areas north of Nineveh, and the plant was diagnosed by Prof. Dr. Ahmed Sultan, Professor of Weed Science, Department of Field Crops / College of Agriculture and Forestry. The leaves of oleander plant were collected from the gardens of the University of Mosul, while the cinnamon plant was obtained in a ready-made powder from the local markets in Nineveh Governorate.

Preparation of vegetable powders

The plant parts of black arum and oleander plants were taken and cleaned of dust by wiping with a peice of cloth, then spread on the cloth and dried for 10 days with continuous flipping until complete dryness. The dry plant parts were ground separately using an electric grinder. The powder was placed in sterilized glass bottles, labeled and stored until use (Al Douri, 2019)

Testing the effect of vegetative powders on honey bees

The effect of the plant powders was tested on honey bee colonies, as empty wax frames were sprayed with 10 g of each powder with 3 replicates for each type of powder. The frames were transferred to the hives and the behavior of the bees was monitored on the treated frames after 48, 96 and 168 hours.

After confirming the efficacy of the plant powders used in the study against the larvae of the Great Wax Moth in vitro, the test was carried out under different storage conditions: the internal storage in the apiary store and the external storage under an open-sided shed (representing the storage in the open). The frames were stored on iron stages with a length of 3.5 m, a width of 50 cm and a height of 1.5 m, divided into 3 replicates for storage internally in the warehouse and externally under the shed. Frames were divided and arranged over the traps with 5 frames for each treatment, which was repeated 3 times. The experiment was designed according to the complete random design in a factorial experiment. treatments included arranging the frames without leaving a distance, leaving a distance of 3 cm between frames within a treatment and leaving a distance of 25 cm between different treatments. Before starting artificial infection, the frames were treated with the used plant powders at a concentration of 10 g/frame. While the control treatment was left without adding any powder. Artificial infection was induced for all cell frames by adding 5 larvae of different ages to each frame. After making sure that all the larvae had descended into the combs, the combs were arranged over the iron stages. The data were recorded after 24, 48 and 168 hours to calculate the death rate and correct it in the treatments according to the Abbott equation 1925: (Al-Mallah and Al-Jubouri, 2012).

Corrected percentage of death = (comparison in death % - treatment in death %)/(comparison in death %-100%) 100 x%.

The data were analyzed according to the analysis of variance ANOVA using the computer SAS program. Means were compared using Duncan's multible range test at 5% probability level.

Results and discussion

Generally, the results showed that there was no any negative effect of plant powders under study on bees, and no death occurred as a result of treating frames with the powders used in the study.

Effect of plant powders (black arum , oleander and cinnamon) on mortality rate of the great wax moth larvae under laboratory conditions

The results of table (1) showed significant difference in the wax moth larvae mortality rate according to the interaction between the type of plant powder and the time period of the control. All powders led to a disguised mortality rate after a week of control. The treatment of black arum plant powder was significantly superior recording the highest mortality rate of 83,33%, followed by oleander powder with a rate of 63,33%, while the treatment of cinnamon plant powder recorded the lowest rate of 50.00% and in the same time period.

It was noted that mortality rates varied between the treatments according to the different dates of data recording (the time period after the treatment). The cinnamon powder treatment recorded the lowest mortality rate in wax moths (1.00%) after two days of treatment compared to the control treatment that did not record any larvae mortality.

The results of the statistical analysis showed the significant difference in the rates of larval mortality. The third period, one week after the treatment, recorded the highest mortality rate (49.16%), which differed significantly from all the average mortality rates for the other periods, while the lowest mortality average (13.58%) was on the first date, two days after the treatment.

As for plant powders efficiency, there was a significant superiority of black arum powder treatment appeared in recording the highest mortality rate among all the treatments. The lowest mortality rate was recorded in the cinnamon powder treatment which differed significantly from the control treatment. The different mortality rates for larvae due to plant powders may be due to the nature of the chemicals and elements in the composition of each powder, which differs from the powder of another plant. Afifi and Abu Dahab (2012) and Boukeria et al.(2020) stated that the chemical composition and biological properties of the chemicals present in the plant, represented by flavonoids, directly affect the total proteins and enzymatic systems present in the insect. Mahmoud and Daoud Awad (2014) confirmed that oleander leaves powder had a repellent and lethal effect on adults and larvae of the capillary beetle, and that the size and concentration of the plant powder had a significant and clear effect on the mortality rate of adults and larvae. This confirms the results of the study of the possibility of using plant powders in the control as alternatives to chemical pesticides.

Rathi and Al-Zubaidi (2020) confirmed that different concentrations of crude alkaloid extracts from oleander leaves affected the mortality rates of the whitefly phases. The death rates increased in the first and second stages of the life cycle compared to the third stage of the life cycle. The death rate also increased by increasing the concentration and the time period of exposure. On the other hand, Baker and Grant (2020) clarified the role of the active substances in cinnamon powder such as cinnamaldehyde and eugenol as effective substances in the control of the insects of Lepidoptera and Coleoptera. And that its main effect is as a repellent at low concentrations and as a biocidal at high concentrations.

Table1. Effect of plant powders (Black arum, oleander and cinnamon) on mortality rate of the great wax moth larvae.

Treatments (Plant powder at 10g/frame)	Mortality (%) at days post treatment (DPT)			Average
	2DPT	4DPT	7DPT	
Control	0.00 G	0.00 g	0.00 g	0.00 g
Black arum	23.33 F	43.33 d	63.33 b	43.33 b
Oleander	30.00 E	53.33 c	83.33 a	55.55 a
Cinnamon	1.00 G	2.00 g	50.00 c	17.66 c
Averge	13.58 C	24.66 b	49.16 a	

Values followed by the same letter are not significantly different according to Duncan's multiple range tests ($P \leq 0.05$)

Effect of storage and treatment with plant powders (black arum, oleander and cinnamon) on mortality rate of wax-moth larvae

The results of the laboratory study agreed with the results of the field study in achieving satisfactory mortality rates in the insect larvae. The results showed that the use of the storage method outside the store (in the open) with the treatment of black arum powder led to the highest larval mortality rate after a week of treatment, which was 72,900% (Table2). Having a space between the wax combs while they are stored outside the store has helped other natural factors such as heat, humidity, ventilation and lighting in increasing the mortality rate of larvae. Whereas, the same plant powder during the same period of time by storage method inside the store led to a

lower larval mortality rate of 57,333% than outside the store. Oleander plant powder killed the larvae by 54,380% under the same conditions outside the store and during the same period, and this percentage decreased during the treatment conditions inside the store for the same plant and time period where the percentage was 42.667%. Similar effect was also recorded in case of cinnamon leaf powder during the treatment outside the store and for the same period, which resulted in mortality of 30.797%, which differed significantly from inside the store, which recorded a rate of 36,000%. The results confirmed that the natural factors had a positive effect in increasing the efficiency of the powders by increasing mortality percentage. The control treatment when storing combs outside the store warehouse after two days of treatment recorded mortality rate of 17.333%. This percentage increased gradually and naturally after a week to be 26.667% in the case of leaving a space between frames during storage, compared to not leaving a distance that reduced the larval mortality rate to 5.333%, during same time period. These results are in agreement with Kwadha et al. (2017) that storing bee wax comb in dry, well-lit and ventilated places outside the store at a temperature of 45C° prevents infection with wax moth, and leads to death of insect stages in the infected frames. Another study indicated that one of the most important preventive and curative methods for controlling the Great Wax-moth is the use of open-sided external stores (sheds) and storing combs in boxes on stages made of iron or wood in open areas with good ventilation and lighting (Anonymous, 2018). These conditions are not favorable for the wax moth. Breeding boxes with dry frames can also be stored vertically on top of each other, with their ends kept open without covering. This helps with good ventilation and light penetration inside the boxes and thus reduces infestation.

Table 2. Effect of storage method and plant powders (black arum, oleander and cinnamon) treatments on mortality rate of wax-moth larvae.

Storage method	Treatments plant powder 10g/frame	Wax moth larvae mortality (%) Combs stored with spacing			Combs stored with no spacing			Average
		Day 1	Day 2	Day 7	Day 1	Day 2	Day 7	
In the open	Control	0,000 R	17,333 No	26,667 l - n	0,000 r	0,000 r	5,333 q	30,385 a
	Oleander	37,333 e – h	35,473 f- i	54,380 b c	26,667 in	42,667 d-f	40,877 d-g	
	Black arum	42,667 d-f	45,233 De	72,900 a	32,000 g-k	37,333 e-h	49,167 b-d	
	Cinnamon	30,667 h-k	22,537 k-o	30,797 c-k	18,667 m-o	25,333 e-n	35,200 f-i	
Inside the wear-house	Control	0,000 r	0,000 R	0,000 r	0,000 r	0,000 r	0,000 r	22,778 b
	Oleander	25,333 j-n	29,333 h-l	42,667 d-f	14,667 op	28,000 h-m	41,333 d-g	
	Black arum	29,333 h-l	42,667 d-f	57,333 b	20,000 l-o	33,333 f-j	48,000 cd	
	Cinnamon	18,667 m-o	25,333 j-n	36,000 e-i	8,000 pq	20,000 l-o	26,667 i-n	
Total average		30,1106 a			23,0518 b			
Total average		19,000 c		25,286 b		35,458 a		

Values followed by the same letter for each parameter are not significantly different according to Duncan's multiple range tests ($P \leq 0.05$)

Conclusions

1- Black arum powder recorded the highest mortality rate for the larvae of the major wax moth, followed by oleander plant powder and finally cinnamon plant powder. The mortality rate was directly proportional to the time period for taking data.

2- The superiority of the black arum plant powder in recording the highest mortality rates may be due to the nature of the materials and chemical compounds contained in this plant. Which often differ from the components of oleander and cinnamon powder.

3- The treatment of black arum powder when used by storage method outside the store and leaving a space between combs after a week of treatment

recorded the highest mortality rate. The rates of larval mortality varied according to the method of storage, arranging the combs and the dates of data recording.

Natural mortality rates of insect larvae were recorded in the control treatment, especially in outdoor storing combs, especially when leaving a space between frames after two days of data recording. The control treatment did not record any natural mortality for larvae when using the storage method inside the store, regardless of the distance between combs or the dates of data recording.

The results confirmed that the weather conditions such as temperature and lighting have a role in the mortality rate of wax moth larvae. The mortality rate in the larvae increased gradually with the increase in the length of the storage period, especially when the combs were stored outdoor and leaving a space between the frames.

Recommendations

1- Using the powder of the black arum plant, oleander and cinnamon to dust the wax comb to prevent infection or during the wax expedition.

2- Storing the wax combs outside the stores and arranging them under sheds on raised iron or wooden stages, leaving a space between the combs during storage.

Acknowledgements

The authors are very grateful to the University of Mosul / College of Agriculture and Forestry for their provided improve the quality of this work.

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