

Effect of deltamethrin on the cement surface of different stages of *Trogoderma granarium* (Coleoptera: Dermestida) at laboratory

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ABSTRACT

The study examined the effects of all concentrations of deltamethrin pesticide concentrations (750, 1000, 1500 and 2000) ppm on indirect treatment (cement) and exposure periods (5,7,8,9,10) days, respectively, with the highest percentage larvae inhibition rates at 2000 ppm and 7-day exposure periods, and the lowest at 750 ppm, and 7-day exposure periods. The study found that deltamethrin concentrations significantly affected adults mortality rates with the highest percentages observed at concentration 2000 ppm and 8-day exposure, and lowest at 750 ppm. The study examined the effects of different concentrations of deltamethrin on mortality rates in the adult phase, with the highest mortality rates at concentration 2000 and exposure period of the first day. while the lowest percentages were at concentration 750 ppm.

Keywords: Pesticide, Indirect effect, Khapra beetle, Control, Cement treatment.

Introduction

Wheat (*Triticum aestivum* L.) is the staple food for a large part of the world's population worldwide, including Pakistan. It is also the third most important cereal after rice and Corn (Guo et al., 2018). Global wheat production is estimated at 779.03 The yield of this crop per unit area rose at the start of this century due to the adoption of enhanced genotypes, diverse pesticides, advancements in fertilizers, and widespread agricultural mechanization (Al-latif, 2022). Million tons, with an average yield of 3.510 tons per hectare (USDA, 2022). At present, there are 25 cultivars suitable for irrigation and 65 for dryland cultivation, with 12 of these cultivars being particularly adapted to the Mediterranean climate of the Western Cape (ARC-SGI, 2009). *T. aestivum* (wheat) contains dietary fiber, resistant starch, phenolic acids, alkylresorcinols, lignans, and antioxidants like carotenoids, tocopherols, and tocotrienols. These components provide various health benefits, including anticancer, antimicrobial, antidiabetic, hypolipidemic, antioxidant, laxative, and moisturizing effects (Moshawih et al., 2022; ammar et al., 2023). Stored grains are seriously affected by various insect pests. These pests invade

stored grains to meet their food and shelter needs, resulting in both qualitative and quantitative losses (*T. granarium* Everts (Coleoptera: Dermestidae), is one of the most destructive pests of cereal products worldwide (Banks, 1977) specially wheat This beetle is polyphagous, causing significant damage, emitting an unpleasant odor, and imparting a foul, undesirable taste due to contamination from its molted exoskeletons. (Kteo and mohammed, 2019). *T. granarium* Everts as a quarantine species by organizations such as the European and Mediterranean Plant Protection Organization (EPPO) (Myers et al., 2012) and others. Native to India, the beetle has spread to nearby regions over recent centuries due to human travel, despite the fact that adults are unable to fly. Like many pests that affect stored goods, (EMERY et al., 2008) Protection of stored grains from insect damage relies primarily on synthetic insecticides, including fumigants with phosphine or methyl bromide, as well as dusting with compounds such as primiphos-methyl and permethrin (Price and mills, 1988; Pruthi and Singh, 1950). In areas with a high concentration of *T. granarium* larvae, grain quality and quantity decrease due to feeding, and contamination from

larvae skins and barbed hairs can pose health risks to humans (Hosseiniaveh et al., 2007; Ahmedani et al., 2009). Pesticide residues are considered a significant risk factor in society. Most countries have strict legislation and regulations regarding pesticide residues in food, with stringent rules aimed at reducing the use of these harmful chemicals (Jawad et al., 2018). Over the past 40 years, pyrethroids and pyrethrins have emerged as the leading class of insecticides used to control pests in agricultural fields, Deltamethrin (DMT) is a man-made pyrethroid pesticide that eliminates insects through skin contact and ingestion, Pyrethroids significantly prolong and enhance sodium tail currents in voltage-clamped nerve axons.

The aim of this study was to determine the effect of deltamethrin on the cement surface of different stages of *Trogoderma granarium* (Coleoptera: Dermestida) at laboratory.

Materials and Methods

Preparing the insect culture: The experiment took place at the College of Agricultural Sciences and Engineering at the University of Baghdad the Khabra grain beetle *T. granarium* (coleoptera: dermestidae) was collected raised at laboratory conditions and put in plastic boxes with grain wheat. A total of 20 pairs of the insect (male and female) (the main culture) were placed in sterilized sealed containers of 500 ml capacity with 250 g of wheat (*T. aestivum* L). They were sterilized by exposing them to a temperature of (-10 Celsius for 14 days) to get rid of all deferent infections (Abdul Rahman and Jazem, 2005). Then they were placed in (Binder) incubators at a temperature of 30-35 Celsius and a humidity of 65 ± 5%. The culture remained in order to obtain the different insect roles in order to do the mentioned treatments for the indirect treatment.

preparing the deltamethrin pesticide: Deltamethrin pesticide was prepared at concentrations (750, 1000, 1500, 2000 ppm) ml per 100 liters of distilled water for the purpose of preparing pesticide dilutions for (cement treatment) on the Khabra beetle *T. granarium*. The pesticide was spread on the surface of the block with making sure to cover all the area of the block and waiting till the pesticide to dry and placing the stages of the insect (eggs, larvae, pupa and adult) to the surface of the block.

Preparation of cement blocks: Cement block was made with dimensions 25 x 25 x 2 cm were prepared for the various treatments of deltamethrin, they were constructed using dry concrete (Ghimire et al., 2017) and there were covered with paper in all sides to prevent the insects (adults and larvae) from escaping the treatment area.

1-The effect of deltamethrin pesticide treatment indirect (cement surfaces) in eggs of the khapra insect (*T. granarium*): The results of (Table 1) showed the effect of all concentrations of deltamethrin pesticide (2000, 1500, 1000, 750) ppm and exposure periods (5, 7, 8, 9 and 10) days respectively, except for the 5-day period, with inhibition rates reaching (49.26, 55.71, 60.46 and 58.10) respectively, and at all concentrations, with inhibition rates reaching (0.00, 21.38, 73.83, 86.24 and 97.96) for all exposure periods respectively. The highest percentage inhibition rates were 100% at the concentration of 2000 ppm and the exposure period of 10 days, while the lowest percentage inhibition rates were at the concentration of 750 ppm and the exposure period of 7 days. The results of the statistical analysis also indicated that the concentration of 2000 gave the highest rate of 60.46 and did not differ. Morally, the concentrations 1500 and 1000, which had an average of 58.10 and 55.71 respectively, while it differed from the concentration 750, which recorded the lowest average of 49.26. The time period of day 10 had a significant effect on day 9, as well as on day 8 and 7. The results of the statistical analysis indicated the significance of the results of egg inhibition between the concentrations 750, 1500 and 2000, each separately. The results of the statistical analysis also indicated the significance of the results of egg inhibition at all exposure periods. The L.S.D value for the interaction was significant except for the period of 9 days and the concentration 750 ppm. Deltamethrin indirectly impacts egg hatching but is more effective at killing larvae after they emerge, especially when there is no food available. Consequently, maintaining cleanliness by eliminating food sources in storage areas improves the insecticide's effectiveness against both eggs and larvae stages. (Boukouvala and Kavallieratos, 2020).

Table (1): Effect of deltamethrin on *T. granarium* eggs on cement surfaces

Concentrations (ppm)	Kill percentage					Average
	Time (Days)					
	5	7	8	9	10	
750	0.0	11.0	64.33	77.66	93.33	49.26
1000	0.0	22.2	70.0	87.67	98.66	55.71
1500	0.0	23.33	77.66	89.66	99.86	58.10
2000	0.0	28.99	83.33	90.0	100.0	60.46
Average	0.00	21.38	73.83	86.24	97.96	---
Interference: 13.94*, Concentration: 7.25*, Time: 9.62*, LSD: (P<0.05)*						

2-The effect of deltamethrin pesticide treatment indirect (cement surfaces) in larvae of the khapra insect (*T. granarium*): The results of (Table 2) showed the effect of all concentrations of deltamethrin pesticide (750, 1000, 1500 and 2000) ppm on the indirect treatment (cement) and exposure periods (7, 8, 9, 10) days, respectively, with inhibition rates reaching (66.65, 81.54, 85.50, 89.72) respectively, and at all concentrations, with inhibition rates reaching (63.88, 71.10, 81.93, 91.32, 96.10) for all exposure periods, respectively, and the highest percentage inhibition rates were 100% at the concentration of 2000 ppm and the exposure period of 9 days, while the lowest percentage inhibition rates were 11% at the concentration of 750 ppm.

The results of the statistical analysis also indicated that the concentration of 2000 gave the highest rate of 89.72. It differs significantly from the concentration 1500, which had an average of 85.50, and differs significantly from the concentration 1000, which had an average of 81.54. At the concentration 750, there is a large significant difference at the concentration 750, which had an average of 66.65. The time period for day 10 has no significant effect on day 9, but it has a significant effect on day 8, as well as day 7 and day 5. These results were significant and consistent with (Boukouvala and Kavallieratos, 2020) the indirect treatment of larvae on cement surfaces.

Table (2): Effect of deltamethrin on *T. granarium* larvae on cement surfaces

Concentrations (ppm)	Kill percentage					Average
	Time (Days)					
	5	7	8	9	10	
750	45.53	57.76	65.53	77.76	86.67	66.65
1000	66.66	71.11	80.0	92.2	97.76	81.54
1500	70.0	75.53	86.66	95.33	100.0	85.50
2000	73.33	80.0	95.53	100.0	100.0	89.72
Average	63.88	71.10	81.93	91.32	96.10	---
Interference: 13.44*, Concentration: 7.19*, Time: 9.24*, LSD: (P<0.05)*						

3-The effect of deltamethrin pesticide treatment indirect (cement surfaces) in adult of the khapra insect (*T. granarium*): The results of (Table 3) showed the effect of all concentrations of deltamethrin pesticide (750, 1000, 1500 and 2000) ppm on the indirect treatment (cement) and for exposure periods (7, 8, 9, 10) days, respectively, with inhibition rates reaching (100, 100, 94.67, 86.39) respectively, and at all concentrations, with inhibition rates reaching (84.67, 93.33, 98.88, 99.44,

100) for all exposure periods, respectively, and the highest percentage inhibition rates were 100% at the concentration of 2000 ppm and from the first day, while the lowest percentage inhibition rates were 11% at the concentration of 750 ppm. The results of the statistical analysis also indicated that the concentration of 2000 gave the highest rate of 100, which did not differ significantly from the concentration of 1500, which had a rate of 100. It did not differ significantly from the concentration of

1000, which had an average of 94.67, while at the concentration of 750 there was a significant difference, which had an average of 86.39. The time period for day 10 had no significant effect on day 9, day 8, and also had no significant effect on day 7, but had a significant effect on day 5. Most of the studies shown Adults are generally less vulnerable than larvae, but considerable mortality can still occur. Additionally, deltamethrin may interfere with adult

reproductive behavior, which can indirectly slow population growth over time, and were significant and consistent with the studies shown that the adults had more high sensitivity to deltamethrin than larvae, larvae and adults have a variety of resistance and may enter diapause depends on the dose of the pesticide. This means that while direct contact with treated surfaces can cause immediate knockdown and death (Arthur et al., 2019).

Table (3): Effect of deltamethrin on *T. granarium* adult on cement surfaces

Concentrations (ppm)	Kill percentage					Average
	Time (Days)					
	5	7	8	9	10	
750	65.33	73.33	95.53	97.76	100.0	86.39
1000	73.37	100.0	100.0	100.0	100.0	94.67
1500	100.0	100.0	100.0	100.0	100.0	100
2000	100.0	100.0	100.0	100.0	100.0	100
Average	84.67	93.33	98.88	99.44	100	---
Interference: 12.96*, Concentration: 7.26*, Time: 8.72*, LSD: (P<0.05)*						

4-The effect of deltamethrin pesticide treatment indirect (cement surfaces) in pupa of the khapra insect (*T. granarium*): The results of (Table 4) showed the effect of all concentrations of deltamethrin pesticide (750, 1000, 1500 and 2000) ppm on the indirect treatment (cement) and for exposure periods (7, 8, 9, 10) days, respectively, with inhibition rates reaching (34.06, 42.65, 49.75, 63.27) respectively, and at all concentrations, with inhibition rates reaching (19.96, 37.29, 50.49, 60.53, 68.87) for all exposure periods, respectively, and the highest inhibition rates were at the concentration of 2000 ppm, while the lowest inhibition rates were at the concentration of 750 ppm. The results of the

statistical analysis also indicated that the concentration of 2000 gave the highest rate of 63.27 and differed significantly from the concentration of 1500, which had a rate of 49.75 and also significantly different from the concentration of 1000, which had an average of 42.65, while at the concentration of 750 there is a highly significant difference, which had an average of 34.06. The time period for day 10 has no significant effect on day 9, but it had a significant effect on day 8, as well as on day 7 and 5. The results of the statistical analysis indicated the significance of the results of egg inhibition between the concentrations of 750, 1500 and 2000, each separately.

Table (4): Effect of deltamethrin on *T. granarium* pupa on cement surfaces

Concentrations (ppm)	Kill percentage					Average
	Time (Days)					
	5	7	8	9	10	
750	10	23.66	33.33	45.53	57.76	34.06
1000	16.66	30.0	46.66	55.53	64.43	42.65
1500	21.0	36.66	56.66	63.33	71.11	49.75
2000	32.20	58.86	65.33	77.76	82.2	63.27
Average	19.96	37.29	50.49	60.53	68.87	---
Interference: 15.74*, Concentration: 8.53*, Time: 10.04*, LSD: (P<0.05)*						

Conclusion

The effect of increasing the time period and concentration of deltamethrin pesticide on the different stages of the hairy grain beetle (Khabra) (Coleoptera: Dermestidae) *T. granarium* was proven. It was also proven that the stage of the adult was the weakest stage for resistance, as the killing rate was high in it, and the egg-laying rate in it was non-existent, and the role was more resistant to the pupae. These findings indicate that although deltamethrin is initially effective against all stages of the khapra beetle on cement, frequent reapplication might be required for sustained control, particularly in areas with severe infestations. The indirect effects on khapra beetle stages are likely to follow similar patterns, with early-stage larvae being particularly vulnerable due to their higher susceptibility to toxins, while later stages, such as adults, might exhibit more resistance over time. Cement's porous nature allows deltamethrin to persist longer compared to other surfaces, enhancing its initial efficacy (Vatandoost et al., 2009). These findings highlight the need for high-dose applications and sustained exposure, especially in areas where Khapra beetle infestations are present, to achieve effective, long-lasting control across all stages of development.

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