

COMPARATIVE TOXICITY AND RESIDUAL EFFECT OF *ALOE VERA* AND DELTAMETHRIN ON *TROGODERMA GRANARIUM*

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ABSTRACT

This study aimed to evaluate the efficacy of *Aloe vera* gel extract and Deltamethrin against *Trogoderma granarium* (Everts), commonly known as the Khapra beetle—a major quarantine pest of stored grains. Given the adverse health and environmental impacts associated with conventional pesticides, *Aloe vera*, a plant-based material, was investigated as a safer and eco-friendly alternative. The insecticidal activity, including mortality and residual toxicity, was assessed using the filter paper impregnation method for both treatments. The LC₅₀ values recorded after 24 hours were 1.05% for *Aloe vera* and 0.185% for Deltamethrin, indicating significant toxicity. In terms of residual effect, *Aloe vera* caused 40% mortality at a 2.5% concentration after 5 days, and 60% mortality by Deltamethrin at a 0.125% concentration after 4 days, though its effectiveness declined over time. Overall, *Aloe vera* demonstrated potential as a safe and effective phyto-pesticide under laboratory conditions. However, further studies are needed to evaluate its practical application under storage (godown) conditions.

Keywords: Comparison, Residual, Toxicity, *Aloe vera*, Deltamethrin, *Trogoderma granarium*

INTRODUCTION

Stored grains are highly vulnerable to infestation by various insect pests during storage, primarily due to suboptimal storage conditions, which contribute significantly to quantitative and qualitative grain losses (Chattha, 2015; Ahmed *et al.*, 2008; Kumar and Kalita, 2017). Among these pests, *Trogoderma granarium* (Khapra beetle) is recognized as one of the most destructive and economically significant quarantine pests of stored grains. The predominantly hot and dry climate in Pakistan creates favorable conditions for the rapid development and proliferation of this pest, both in storage facilities and during grain export processes (Ahmedani *et al.*, 2011; Honey *et al.*, 2017). Although chemical fumigants such as Methyl Bromide and Phosphine are commonly used for pest control, their application raises serious environmental concerns, including Ozone layer depletion and residual toxicity in food products (MBTOC, 2010; Riaz *et al.*, 2022).

In alternatives plant materials are best, safe and environment friendly. Many researches explained the pesticide abilities of plants against pest insect's management (Sultan *et al.*, 2015, Khan *et al.*, 2013, Ahmed *et al.*, 2025) and especially against *Trogoderma granarium* (Elamin and Satti, 2013, Sagheer *et al.*, 2013, Hassan *et al.*, 2006, Arivudainambi and Singh, 2003). Plant materials are economical, environment friendly and are more susceptible to insects' management.

This study focused on evaluating and comparing the toxicity and residual effects of different treatments against *Trogoderma granarium*. The findings contribute to the ongoing research on alternative, eco-friendly pest control options for managing stored grain pests, highlighting the potential of plant-based compounds as safer substitutes for conventional chemical pesticides.

MATERIALS AND METHODS

Insects were reared in wheat in the glass jars in the incubator under controlled conditions $65 \pm 5\%$ relative humidity, 30°C-35°C temperature, at the insects rearing laboratory in the Food Quality and Safety Research Institute (FQSRI), Pakistan Agricultural Research Council (PARC), Southern Zone Agricultural Research Centre (SARC), University of Karachi.

Aloe vera leaves were collected from the field of Karachi University. Fresh *Aloe vera* leaves were washed thoroughly with distilled water and dried and peeled off and 50gram *Aloe vera* gel was collected and blended in

250mL Ethyl Alcohol (50% concentrated) and left for 4 to 5 days than 20% *Aloe vera* gel extract (because solvent is 5 times greater than solute) was filtered (Sultan *et. al.*, 2015). Deltamethrin was purchased from a pesticide store.

Toxicity was tested by Contact method/Filter paper impregnation method (Sultan *et. al.*, 2015). For this experiment, glass Petri dishes were thoroughly washed and then dried and sterilized in the oven and used for toxicity assessment. Different concentrations of *Aloe vera* (0.16%, 0.31%, 0.63%, 1.25% and 2.5%) in 50% Ethanol and Deltamethrin (0.06%, 0.125%, 0.25%, 0.50%, and 1%) in distilled water were prepared and tested against *Trogoderma granarium* adult stage. Filter paper was placed in glass Petri dishes and concentrations of *Aloe vera* and Deltamethrin were applied on filter paper with 1mL pipette and left for few minutes to evaporate solvent then 10 insects were placed on filter paper in the Petri dishes then Petri dishes were closed and placed in the dark. Mortality data was recorded after 1, 2 and 3 days treatment and data were analyzed (Chaubey, 2016).

LC50 was calculated by making graphs of concentration versus mortality. For this purpose, computer software Minitab and Microsoft Excel were used. Regression line was drawn according to data points. On the regression line, a line is drawn (from the point at which 50% insects were killed on the y-axis) downward toward the concentration values on the x-axis to find out the LC50 value (Sultan *et. al.*, 2015, Suseela *et. al.*, 2015, Finney, 1971).

For residual toxicity evaluation the same procedure was followed as for toxicity. Except, mortality was noted and dead insects were replaced with new live insects, until mortality was reduced to 0%. Data was noted and residual toxicity was analyzed for 10 days (Sultan *et. al.*, 2015).

RESULTS AND DISCUSSION

Toxicity and residual effects analyzed against *Trogoderma granarium* were evaluated in this study. It was found that *Aloe vera* is less toxic than Deltamethrin. *Aloe vera* has LC50 values 1.05%, 0.99% and 0.84% and Deltamethrin has 0.185%, 0.21% and 0.16% in 24, 48 and 72 hours after treatment, respectively.

Residual toxicity of *Aloe vera* and Deltamethrin was studied till 10 days and found *Aloe vera* has effective toxicity in the first three days and has a high residual effect at higher concentration. However, a very low residual effect was found from 7th day to 10th day. During 10 days of residual toxicity study the residual effect of Deltamethrin was high during the first 6 days and it was 30% to 93% at different concentrations respectively. After that it reduces although it has higher residual effect during the whole tested period of 10 days.

The present investigation proves the insecticidal activity of *Aloe vera* and Deltamethrin and also verifies previous investigations about plant activities against stored grain pests. Riaz *et. al.*, (2014) studied and found 35°C is the most favorable temperature at which *Trogoderma granarium* flourish and shows its maximum activities. The weather of our country hot and dry most of the time favors *Trogoderma granarium* infestation adding an important point in its control as temperature is also a factor kept in view during exports of grains.

Many previous findings explained the insecticidal activity of plants. Odeyemi and Ashamo (2005) and Arivudainambi and Singh (2003) studied and found Neem toxicity for *Trogoderma granarium* management. Ayub *et. al.*, (2005) evaluated effectiveness of plant materials for *Sitophilus oryzae*. Although, in our investigation *Aloe vera* was found more toxic showing higher insecticidal abilities. In the earlier findings, Sagheer *et. al.*, (2013) and Jakher and Jat (2010) also gave importance to Citrus plants and plant oils for *Trogoderma granarium*. Even though variations exist because different plant materials were tested. The repetition in the research is the effectiveness of plant material against pest insects.

Similar results of *Aloe vera* and Deltamethrin were reported against *Sitophilus oryzae* by Sultan *et. al.*, (2015). Even though, there is variation in the results. Kausar *et. al.*, (2021) and Ali *et. al.*, (2021) also found plant materials effectiveness and favors our study. Although pesticides have greater toxicity but plant materials are safer than pesticides.

Further studies incorporating Kucuktopu and Saruhan (2024), Hassan *et. al.*, (2006) and Abbas *et. al.*, (2024) reported residual toxicity of plant materials from days to months which matches with our research as found residual toxicity of *Aloe vera* till 10 days. Related research on fungi (Riaz *et. al.*, 2022) and plants (El-Shourbagy *et. al.*, 2023) found mortality increased with increase in concentrations and time of exposure which is also found in our research.

We concluded, the current and earlier research verifies that plant materials also including *Aloe vera* are better solutions for pest insects' management. Although *Aloe vera* was analyzed in the laboratory. It was not examined in the godowns, so more investigation is needed to check its effectiveness on large scale applications.

Table 1. Shows mortality data of *Trogoderma granarium* by application of different concentrations of *Aloe vera* and Deltamethrin after 24, 48 and 72 hours of treatment.

<i>Aloe vera</i> Conc.	Mean Mortalities			<i>Deltamethrin</i> Conc.	Mean Mortalities		
	1 Day	2 Day	3 Day		1 Day	2 Day	3 Day
0.16%	6.67	6.7	6.67	0.06%	20	13.33	26.67
0.31%	13.33	13.33	20	0.13%	40	40	43.33
0.63%	23.33	30	46.67	0.25%	80	73.33	80
1.25%	60	63.33	70	0.50%	93.33	93.33	100

Table 2 shows Residual Toxicity Data of *Trogoderma granarium* by application of different concentrations of *Aloe vera* (*HAT: Hours after Treatment).

S. No.	<i>Aloe vera</i>	24 HAT	48 HAT	72 HAT	96 HAT	120 HAT	144 HAT	168 HAT	192 HAT	216 HAT	240 HAT
1	Control	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0.15%	3.33%	3.33%	0%	6.66%	0%	0%	0%	0%	3.33%	3.33%
3	0.31%	10%	6.66%	10%	13.33%	10%	13.33%	6.66%	0%	0%	0%
4	0.63%	30%	20%	13.33%	20%	20%	20%	6.66%	0%	6.66%	0%
5	1.25%	40%	30%	30%	20%	6.66%	0%	0%	6.66%	0%	0%
6	2.50%	20%	40%	40%	33.33%	40%	20%	0%	0%	0%	6.67%
7	5.00%	20%	40%	20%	10%	20%	0%	0%	13.33%	0%	0%

Table 2. Shows Residual Toxicity data of *Trogoderma granarium* by application of different concentrations of Deltamethrin (*HAT: Hours after Treatment).

S. No.	Deltamethrin	24 HAT	48 HAT	72 HAT	96 HAT	120 HAT	144 HAT	168 HAT	192 HAT	216 HAT	240 HAT
1	Control	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0.03%	30%	20%	10%	10%	20%	6.66%	10%	6.66%	3.33%	3.33%
3	0.06%	40%	30%	30%	40%	30%	20%	23.33%	20%	10%	6.66%
4	0.13%	60%	40%	10%	60%	20%	40%	26.66%	10%	13.33%	10%
5	0.25%	80%	70%	40%	20%	30%	30%	20%	10%	16.66%	10%
6	0.50%	93.33%	60%	43.33%	20%	40%	20%	30%	40%	30%	26.66%

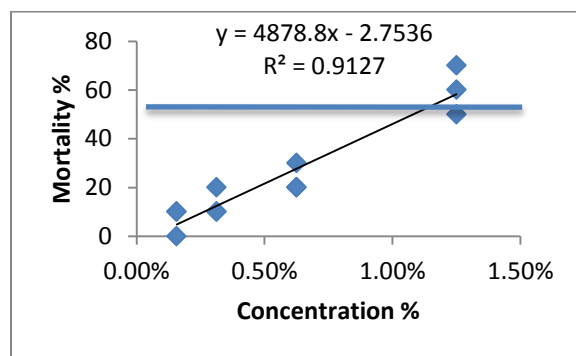


Fig. 1. Showing regression analysis for *Aloe vera* against Khapra beetle after 1 day of treatment.

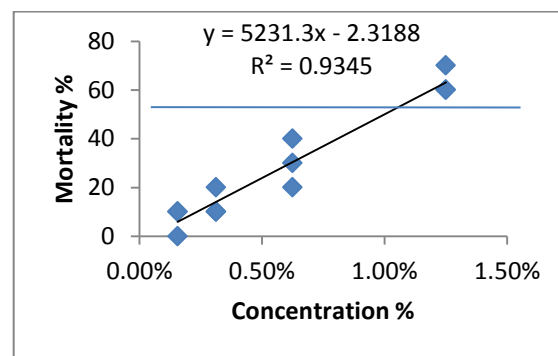


Fig.2. Showing regression analysis for *Aloe vera* against Khapra beetle after 2 days of treatment.

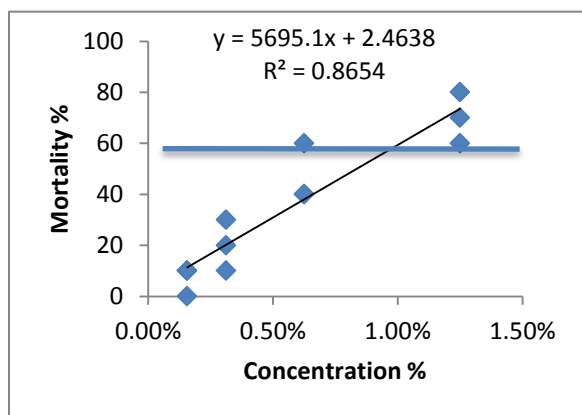


Fig. 3. Showing regression analysis for *Aloe vera* against Khapra beetle after 3 days of treatment.

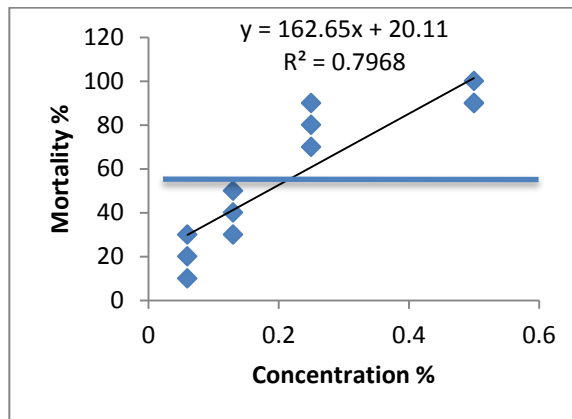


Fig. 4. Showing regression analysis for Deltamethrin against Khapra beetle after 1 day of treatment.

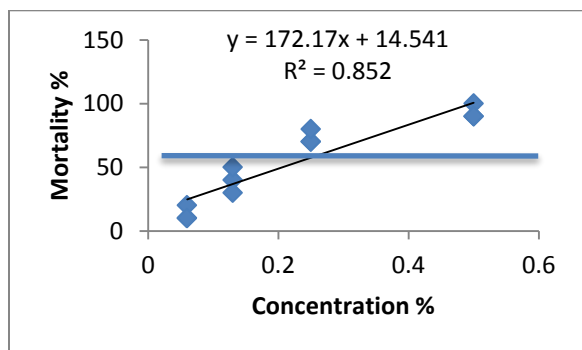


Fig. 5. Showing regression analysis for Deltamethrin against Khapra beetle after 2 days of treatment.

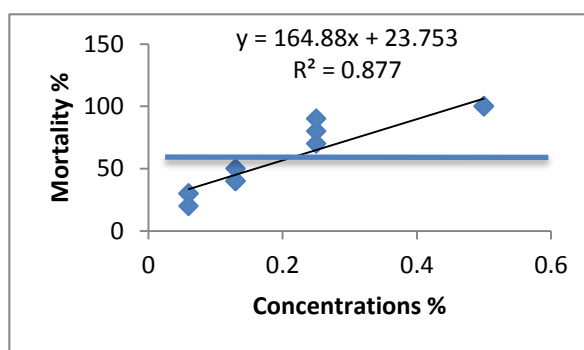


Fig. 6. Showing regression analysis for Deltamethrin against Khapra beetle after 3 days of treatment.

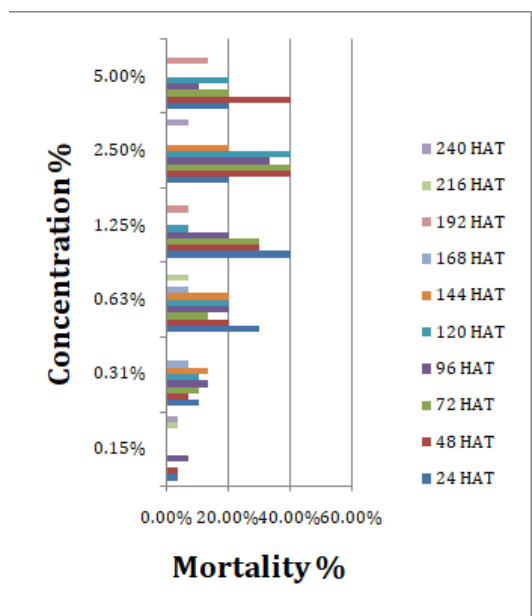


Fig. 7. Residual toxic activity of *Aloe vera* for Khapra beetle. (*HAT means hours after treatment)

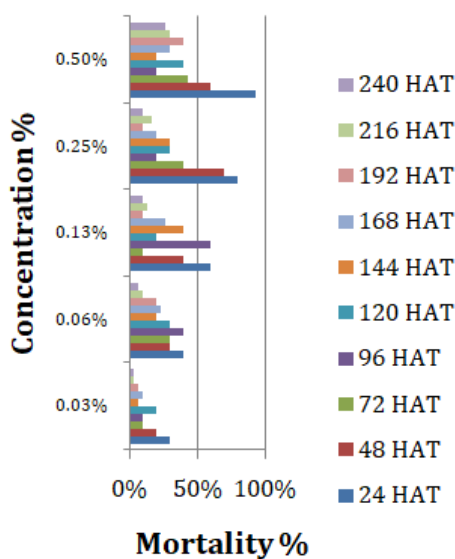


Fig. 8. Residual toxicity of Deltamethrin against *Trogoderma granarium*.

Limitations:

The current study was done in laboratory conditions. It did not prove its applicability in field conditions (godown). So further research is needed to check its applicability on large scale applications.

Conclusion:

Aloe vera is found effective in the controlled environment of the laboratory. The study proves the effectiveness of *Aloe vera* against *Trogoderma granarium* in laboratory conditions. So further research is needed to analyze its field (godown) applicability.

Recommendations for Future Research:

Toxicity analysis of *Aloe vera* on a large scale in the field (godown) conditions and storage areas is recommended. Its long-term effectiveness can be analyzed. Further work can be done on its formulation for better performance and usefulness.

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