**BIORATIONAL INSECTICIDES AS SEED PROTECTANTS ON *Tribolium castaneum* (HERBST) IN STORED SESAME**

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ABSTRACT

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| **Aim:** To evaluate the efficacy of essential oils (EOs) and insect growth regulators (IGRs) against *Tribolium castaneum* (Herbst) infesting stored sesame seeds.  **Study design:** Completely Randomised Design.  **Place and Duration of Study:** ICAR-Indian Institute of Oilseeds Research, Division of Crop Protection, Rajendranagar; During January to June 2024.  **Methodology:** The study involved six treatments *viz.,* clove oil (5 mL Kg⁻¹), peppermint oil (5 mL Kg⁻¹), pyriproxyfen 10 EC (5 ppm Kg⁻¹), azadirachtin 1500 ppm (5 ml kg⁻¹), deltamethrin 2.8 EC (1 ppm per?) and an untreated control. One hundred grams of treated seeds were infested with ten pairs of freshly emerged *Tribolium castaneum* adults and incubated at 25°C and 55% RH. Adult mortality was assessed at 1, 3, 5, 7, and 14 days after treatment (DAT) using Abbott’s mortality correction? formula.  **Results:** Results revealed that all treatments caused significantly higher mortality than in the control. Among the treatments, peppermint oil recorded the highest adult mortality of 62.33 per cent at 14 DAT, which was on par with the standard chemical, deltamethrin and botanical insecticide, azadirachtin checks. Clove oil and pyriproxyfen showed moderate efficacy. The insecticidal activity of peppermint oil was attributed to its major bioactive compounds-menthol, menthone, limonene, carvone, and pulegone which disrupt insect nervous, respiratory and hormonal systems.  **Conclusion:** This study highlights the potential of EOs and IGRs as eco-friendly alternatives to synthetic insecticides in storage pest management. Their multiple modes of action also reduce the risk of resistance development, making them suitable alternatives for sustainable pest control strategies. However, further studies are required to increase their persistence and efficacy under long term storage conditions. |

*Keywords: Essential oils, Insect Growth Regulators, peppermint oil, sesame, bioactive compounds.*

1. INTRODUCTION

Sesame, *Sesamum indicum* L., commonly known as til is the oldest indigenous oilseed crop. Red flour beetle, *Tribolium castaneum* (Herbst) is a cosmopolitan and serious primary pest of sesame. The average loss estimated due to *T. castaneum* was 6.8 per cent in non-cereal crops (Ahir *et al.,* 2018). A study on storage pest management in sesame is relatively less compared to cereals and pulses. Though chemical fumigants are used for storage pest control, they pose risks to the environment, human health, and seed quality. Pesticide and chemical residues are chief causes of concern for Indian agricultural exports. Indian food exports including sesame are sometimes rejected due to crossing the Maximum Residue Limit (MRL) for pesticides of importing nations (IOPEPC, 2020). Therefore, this study assessed biorational insecticides *viz.*, two essential oils (EOs),clove oil @ 5mLKg-1 and peppermint oil @ 5mLKg-1 and insect growth regulator (IGR)Pyriproxyfen 10 EC @ 5 ppm against *T. castaneum.*

2. material and methods

The experiment was carried out with six treatments with three replications in a Completely Randomised Design at ICAR- Indian Institute of Oilseeds Research, Division of crop protection, Rajendranagar from January to June, 2024. The treatments included Clove oil @ 5mLKg-1, peppermint oil @ 5mLKg-1, pyriproxyfen 10 EC @ 5ppm, azadirachtin 1500 ppm @ 5mL Kg-1 and deltamethrin 2.8 EC @ 1ppm. Deltamethrin 2.8 EC and azadirachtin 1500 ppm were used as standard chemical and botanical checks, respectively. A100 grams of sesame seeds were used for each treatment and were transferred to plastic containers. Ten pairs of freshly emerged *T. castaneum* adults were released into each plastic container and covered with aluminum foil having pores on it. Later, plastic containers were placed in incubator at 25°C and 55% RH. Beetle mortality per cent was calculated at 1, 3, 5, 7 and 14 days of exposure by using Abbott's corrected mortality formula (Abbott, 1925).

3. results and discussion

At 1 DAT, there was significant difference observed in the adult mortality compared to untreated control (Table 1). Deltamethrin recorded highest adult mortality of25 per cent followed by peppermint oil (23.33 %) and were on par with each other. Azadirachtin recorded 20 per cent mortality followed by clove oil (18.33%) whilepyriproxyfen recorded only 13.33 per cent mortality. However, untreated control recorded no adult mortality. The adult mortality increased in all treatments gradually. At 3, 5 and 7 DAT, the highest adult mortality was recorded in peppermint oil with 35.67, 44.66 and 56 per cent, respectively showing same efficacy as that of standard checks and deltamethrin wasfound to be on par with the peppermint oil.

In conclusion, EOs and IGRs are showing similar results to that of standard checks. The use of EOs and IGRs proved to be one of the best alternative insecticides against storage pests. The EOs and IGRs present a promising alternative to conventional insecticides for storage pest management as these have multiple level of mode of actions, thus the possibility of resistance development is also less. The findings of this study contribute to the development of new EO and IGR based formulations for improved efficacy and pest control even under change in optimal conditions.

Peppermint oil contains several bioactive components *viz*., menthol, menthone, limonene, carvone and pulegone which exhibit insecticidal properties (Khani *et al.,* 2012). Each bioactive component has varied mode of actions, for example , menthol, menthone, and pulegone disrupt the nervous system of insects, leading to paralysis and mortality. Limonene affects insect respiratory systems and has strong repellent properties. Carvone and Pulegone interfere with hormonal regulation in insects, reducing larval development. All these bioactive compounds are monoterpenes. Monoterpenes, which are often volatile and relatively lipophilic substances that can quickly enter insects *via* cuticle (contact), the respiratory system (fumigation) and the digestive system (ingestion) (Prates *et al.,* 1998). and impede their physiological processes, are primarily responsible for the insecticidal properties of many essential oils. The management of storage insects through essential oils is due to their diverse range of effects, including their insecticidal, antifeeding, repellent and ovicidal properties (Weaver and Subramanayam, 2000).

The results of peppermint oil are in line with Alshaibani *et al*. (2024) who reported that 10% mint oil caused 70 per cent adult mortality of *T. castaneum* after 7 days of treatment. The results are also in accordance with Panezai *et al*. 2019 who found that peppermint oil caused 70% adult mortality of *Trogoderma granarium*. Kaviya *et al*. (2021) reported that 6% peppermint oil resulted in 76 per cent adult mortality of *T. castaneum* in stored sesame. The essential oil of *Mentha piperita* (peppermint) has the potential to control two important stored product pests, *T. castaneum* and *Sitophilus granaries* (Atay *et al.,* 2024). The results of clove oil @ 5mL Kg-1 are in line with Arora *et al.* (2018) who found that clove oil 25% recorded 100% mortality after 48h of exposure against *T. castaneum*. Elnabawy *et al.* (2022) reported that clove oil 5% recorded 86.66 Per cent against *T. castaneum* at 180 minutes of exposure.

**Table 1. Effect of treatments on *Tribolium castaneum* in sesame**

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| --- | --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Treatments** | **1 DAT** | **3 DAT** | **5 DAT** | **7 DAT** | **14 DAT** |
| 1 | Clove oil @ 5ml kg-1 | 18.33±1.67bc | 28.00±0.00b | 39.66±1.67c | 45.33±1.67c | 53.66±1.67b |
| 2 | Peppermint oil 5ml kg-1 | 23.33±1.67ab | 35.67±1.67a | 44.66±1.67a | 56.00±0.00a | 63.33±1.67a |
| 3 | Pyriproxyfen 10 EC @ 5 ppm | 13.33±1.67cd | 20.00±2.89c | 27.33±1.67d | 32.33±3.33d | 37.00±2.89c |
| 4 | Azadirachtin 1500 ppm (Standard botanical check) @ 5ml kg-1 | 20.00±2.89b | 33.33±1.67ab | 41.00±2.89ab | 54.33±3.33ab | 62.33±4.41a |
| 5 | Deltamethrin 2.8 EC (Standard chemical check) @1 ppm | 25.00±2.89a | 34.33±3.33a | 42.33±3.33a | 52.66±1.67bc | 62.00±2.89a |
| 6 | Untreated control | 0.00±0.00e | 0.00±0.00e | 0.00±0.00e | 0.00±0.00e | 0.00±0.00d |
|  | F value | 18.40 | 13.95 | 13.90 | 33.60 | 21.47 |

*\*Mean±SE mortality of three replicates; means followed by same small letters are not significantly different according to DMRT.*

4. Conclusion

In our study, we used 100% pure essential oils and insect growth regulators on sesame seeds. They showed promising results based on their respective insecticidal properties. The peppermint oil results were found to be on par with that of neem oil and deltamethrin. In case of IGRs, pyriproxyfen provided adequate control, however, it can be further evaluated in combination with other biorational insecticides for complete control of stored grain pests. The results suggest that peppermint oil can be used as an alternative to synthetic insecticides for the management of *T. castaneum* in the storage of sesame seeds. Maintaining optimal conditions is necessary for improving the insecticidal performance and to obtain better results. However, further research is needed to enhance their toxicity for long term storage through slow-release, carrier-based technologies, to ensure complete control, residue-free products for safe storage and export etc.

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