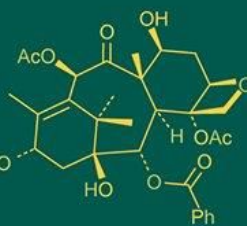
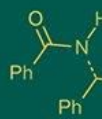
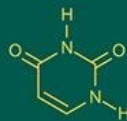
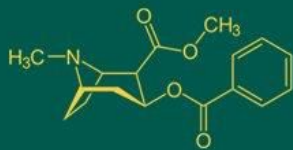


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(8): 1256-1261
www.biochemjournal.com
Received: 19-05-2025
Accepted: 22-06-2025

Alok Singh

M.Sc. Scholar, Department of Entomology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Usha Yadav

Assistant Professor, Naini Agricultural Institute Department of Entomology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:**Alok Singh**

M.Sc. Scholar, Department of Entomology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Efficacy of different plant-derived smoke on the adult mortality of rice weevil, (*Sitophilus oryzae* L.) at different time intervals

Alok Singh and Usha Yadav

DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i8Sr.5370>

Abstract

Rice weevil (*Sitophilus oryzae* L.) is a major pest responsible for substantial losses in stored wheat. Although synthetic pesticides are commonly used to manage these pests, their application poses serious environmental hazards and potential risks to human and animal health. In light of these concerns, the present study was conducted to assess the effectiveness of natural, plant-based smoke treatments in controlling rice weevil infestations in stored wheat. The plant materials tested included neem leaves, eucalyptus leaves, curry leaves, orange peel, bay leaves, and a combination of clove and camphor. These materials were burned to generate smoke, and their impact on adult rice weevil mortality was evaluated. The experiment was carried out in 2024 at the Department of Entomology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, using a Completely Randomized Design (CRD). The experiments conducted on the effect of smoke generated by burning plant leaves and extracts on percent mortality of adults of *S. oryzae* at 24, 48, 72, and 96 h exposure to smoke under airtight conditions resulted in (55.57%) after 48h of exposure to (T₆) Clove & Camphor followed by (T₁) Neem leaves, (T₂) Eucalyptus leaves, (T₃) Bay leaves, (T₄) Orange peel, (T₃) Curry leaves and (T₇) Coragen 10 mg smoke. The order of effectiveness of botanicals is ranked as Clove & Camphor>Neem leaves>Eucalyptus>Bay leaves>Orange peel>Curry leaves respectively. Finally, these findings demonstrated that certain plant smokes possess strong insecticidal properties against rice weevils, indicating their potential as effective and eco-friendly alternatives to synthetic fumigants for stored wheat grain protection.

Keywords: Efficacy, percent mortality, rice weevil, plant extracts, botanicals, smoking, stored grain pest management, coragen 10 mg

Introduction

Wheat (*Triticum aestivum* L.) holds the position of being the second most vital cereal crop in India, following rice. It plays a crucial role in the human diet, serving as a significant source of protein—surpassing maize, rice, and several other staple grains in protein content. However, during storage, agricultural products, including wheat, are vulnerable to infestation by a wide range of pests—over 600 species of beetles, 70 species of moths, and approximately 355 mite species. These infestations result in considerable quantitative and qualitative losses. In India alone, insect damage to stored grains is estimated to account for about 6.5% of total stored produce. Among the various pests that infest stored wheat, the rice weevil (*Sitophilus oryzae* L.) is considered one of the most destructive. Belonging to the family Curculionidae (order: Coleoptera), the rice weevil attacks key cereal crops such as wheat, rice, sorghum, barley, and maize—both in the field and during storage.

The reddish-brown adult rice weevils and their white, legless grubs are internal feeders that cause significant damage to stored cereal grains, both in terms of quantity and quality. In recent years, the use of smoke from various plant leaves has been explored as a potential method for managing stored grain pests. This traditional approach is gaining renewed interest, especially given the limitations of chemical insecticides, which include environmental pollution, development of pest resistance, high toxicity to mammals, and rising application costs. These challenges have driven the search for safer, more cost-effective alternatives. Plant-based products, particularly those containing bioactive compounds or secondary metabolites, show promise as natural insecticides. In fact, more

than 2, 000 plant species worldwide have been identified to possess insecticidal properties, offering a rich resource for developing environmentally friendly pest management solutions.

Materials and Methods

The current study was conducted in the research laboratory of the Department of Entomology at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India.

Insect culture, *Sitophilus oryzae* L.

Adult *Sitophilus oryzae* specimens used in the study were collected locally from wheat grains that had been naturally infested during storage. For rearing purposes, plastic containers with a capacity of 1 kilogram were used. The openings of these containers were covered with muslin cloth to allow proper ventilation. Healthy, disinfected wheat grains were used as the rearing medium. Approximately 500 grams of wheat grains were placed in each container, and around 100 adult weevils were introduced. The muslin cloth was then secured with a rubber band to keep the containers

sealed while still permitting airflow. These containers were maintained under controlled conditions at 32 ± 2 °C and $70 \pm 5\%$ relative humidity to promote weevil development. After 45 days, newly emerged adult weevils (2-3 days old from the F1 generation) were collected and used to artificially infest the experimental wheat samples for further study.

Collection of plants leaves

The fresh leaves of plants i.e. Neem, eucalyptus, curry, bay leaves, orange peel and clove & camphor were collected from the SHUATS campus, the 250 gm of all leaves were dried naturally at room temperature ($32-35$ °C), to avoid sun light for induce damage of active compound by Uv-ray.

Treatments

The experiments were conducted on susceptible wheat variety SHUATS-W10 under laboratory conditions. The treatments were consist of dried neem leaves, eucalyptus, curry leaves, orange peel, bay leaves, clove & camphor along with chemical, Coragen (100 mg/kg wheat grains) and control (untreated) seeds.



Fig 1: Treatments used in the management of Rice weevil in stored wheat grains

Methodology:

The experiments were conducted by taking storage receptacles such as plastic containers. The treated wheat grains (100g) were kept in the receptacles in three replications, separately at ambient temperature.

Effect of smoke on the mortality of Rice weevil

The study was designed to evaluate the impact of smoke from various plant materials on the mortality of adult rice weevils (*Sitophilus oryzae*) under controlled laboratory conditions. Treatments included smoke generated from burning (T₁) neem leaves, (T₂) eucalyptus leaves, (T₃) curry leaves, (T₄) orange peel, (T₅) bay leaves, (T₆) a mixture of clove and camphor, and (T₇) a chemical control using Coragen at 10 mg. Smoke from each plant material was produced using a smoke-generating device.

Freshly emerged adult rice weevils were used for the experiment, with 50 insects introduced into each conical

flask containing 100 grams of wheat grains. Each treatment was replicated three times. After releasing the insects, smoke was introduced into the flasks using the smoker. The flask openings were then sealed tightly with cotton plugs and covered with aluminum foil to retain the smoke.

Separate sets of flasks were prepared for different exposure durations—24, 48, 72, and 96 hours—to assess the effect of smoke over time. This setup helped determine how varying exposure periods influenced the mortality rate of *S. oryzae*.

$$\text{Percent mortality} = \frac{\text{Number of dead insects}}{\text{Total number of insect release}} \times 100$$

Statistical Analysis

The data collected during the experiment were analyzed statistically using the Analysis of Variance (ANOVA) method, following a Completely Randomized Design

(CRD). Wherever necessary, data transformations were applied to meet the assumptions of ANOVA. The standard error of the mean (SEm) was calculated for each treatment, and the critical difference (CD) at the 5% level of significance was computed to compare treatment means where significant differences were observed.

Results and Discussion

1. Effect of plant-based smoke on mortality of Rice weevil, *Sitophilus oryzae* in wheat grains during the month of November

The data obtained on the effect of smoke on insect mortality in stored wheat is presented in table-1 and figure-1. It was evaluated from the data that smoke of (T₆) Clove & Camphor with mortality percentage 32.67% was found to be superior which was followed by neem leaves smoke. Data was observed after 24hour of exposure of Clove & Camphor (32.67%), Neem leaves (31.33%), Eucalyptus leaves (29.33%), Bay leaves (26.67%), Orange peel (26.33%),

Curry leaves (25.33%), Coragen 10 mg (24.67%) and respectively. Resulted as the insect mortality was increased with the increase in the exposure period of various smoke under airtight conditions.

Insect mortality observed after 48 hour exposure where Clove & Camphor (T₆) showed the highest mortality at 35.33% over other treatments Neem leaves (34.67), Eucalyptus leaves (33.33), Bay leaves (32.67), Orange peel (32.00) and Curry leaves (32.00), Coragen (31.33) smoke insect mortality recorded was significantly percentage and similarly after 72 hours exposure insect mortality percent recorded was Clove & Camphor (20.00) Neem leaves (19.33), Coragen 10 mg (18.67), Eucalyptus leaves (18.00), Bay leaves (17.33), Orange peel (16.67) and Curry leaves (16.00) similarly after 96 hours exposure to smoke of Clove & Camphor (14.67), Neem leaves (14.33), Coragen 10 mg (14.00), Bay leaves (13.33) Eucalyptus leaves (12.67), Curry leaves (11.33) and Orange peel (10.67) was recorded.

Table 1: Effect of smoke on% mortality of Rice weevil on stored wheat during the month of November

S. No.	Treatments	Percent mortality of adult rice weevil at different time intervals of exposure of smoke			
		24h	48h	72h	96h
T ₀	Untreated	0.00	1.33	1.33	0.67
T ₁	Neem leaves	31.33	34.67	19.33	14.33
T ₂	Eucalyptus leaves	29.33	33.33	18.00	12.67
T ₃	Curry leaves	25.33	32.00	16.00	11.33
T ₄	Orange peel	26.33	32.00	16.67	10.67
T ₅	Bay leaves	26.67	32.67	17.33	13.33
T ₆	Clove & Camphor	32.67	35.33	20.00	14.67
T ₇	Rynaxypyr (Coragen 10 mg)	24.67	31.33	18.67	14.00
SEm±		0.62	0.70	0.57	0.58
CD (5%)		1.87	2.12	1.73	1.76
CV percent		4.37	4.21	6.25	8.90

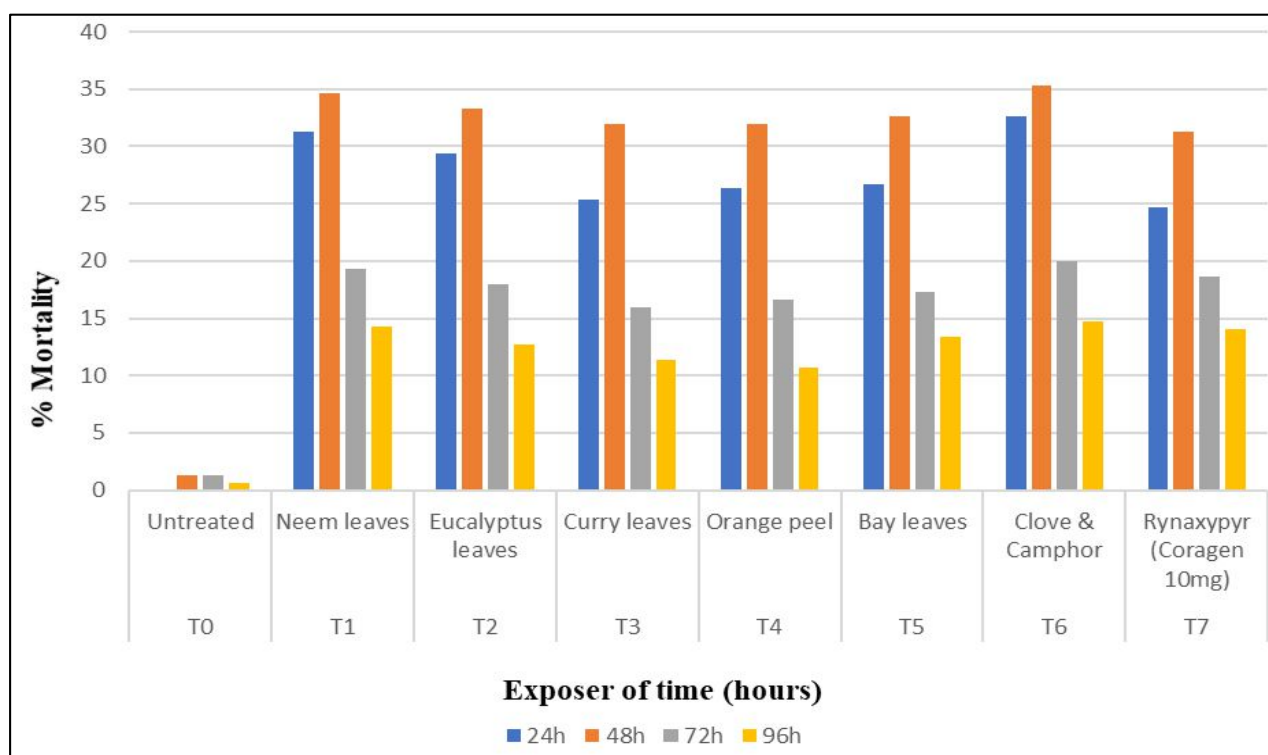


Fig 1: Effect of smoke on% mortality of rice weevil on wheat, during the month of November

2. Effect of smoke on mortality of Rice weevil, *Sitophilus oryzae* L. on stored wheat grains during the month of February

The data obtained on the effect of smoke on insect mortality in wheat grain is presented in table-2 and graph-2. It was found that from the data that smoke of (T₆) Clove & Camphor (34.67), was found significantly higher which was followed Neem leaves smoke. data was observed after 24 hours of exposure where percent mortality was founded as Neem leaves (32.67), Eucalyptus leaves (32.00), Bay leaves (31.33), Coragen 10 mg (30.00), Orange peel (28.67), and Curry leaves (28.00) was percent respectively. The insect mortality was decreased with the increase in the exposure period of various smoke under airtight conditions. Insect mortality observed after 48 hours of exposure where Clove & Camphor (T₆) again showed the highest mortality at 30.67 over other treatments Neem leaves (29.33), Coragen (28.67), Eucalyptus leaves (27.33), Bay leaves (26.67), Orange peel (26.00) and Curry leaves (24.67) smoke insect mortality recorded was percent and similarly after 72 hours

exposure insect mortality percent recorded was C & C (19.33), Neem leaves (18.67), Co (18.00), Eu (16.67), Orange (16.67), Bay (15.33) and Curry (14.67) and similarly after 96 hours exposure to smoke of Clove & Camphor (14.67), Neem leaves (14.67), Coragen 10 mg (13.33), Orange peel (13.00), Eucalyptus leaves (12.67), Bay leaves (12.00) and Curry leaves (11.33) was recorded as percent.

3. Percent mortality of Rice weevil, *Sitophilus oryzae* without smoke under air tight conditions in wheat grain

The mortality of adult Rice weevil, *Sitophilus oryzae* was observed without passing any smoke under air tight conditions at different interval of time period and the data obtained is presented in table-2 and figure-2 The data showed that without smoke, no any insect mortality was occurred after 24 hours whereas 1.33 and 1.33 percent mortality at 48 hours and 72 hours and 0.67 percent mortality after 96 hours without smoke under air tight conditions on wheat grains.

Table 2: Effect of smoke on % mortality of Rice weevil on stored wheat, during the month of February

S. No.	Treatments	% Mortality of adult rice weevil at different time intervals of exposure of smoke			
		24h	48h	72h	96h
T ₀	Untreated	6.67	8.67	6.67	5.33
T ₁	Neem leaves	32.67	29.33	18.67	14.67
T ₂	Eucalyptus leaves	32.00	27.33	16.67	12.67
T ₃	Curry leaves	28.00	24.67	14.67	11.33
T ₄	Orange peel	28.67	26.00	16.67	13.00
T ₅	Bay leaves	31.33	26.67	15.33	12.00
T ₆	Clove & Camphor	34.67	30.67	19.33	14.67
T ₇	Rynaxypyr (Coragen 10 mg)	30.00	28.67	18.00	13.33
	SEM±	0.52	0.74	0.62	0.61
	CD (5%)	1.58	2.23	1.87	1.83
	CV percent	3.26	5.11	6.85	8.74

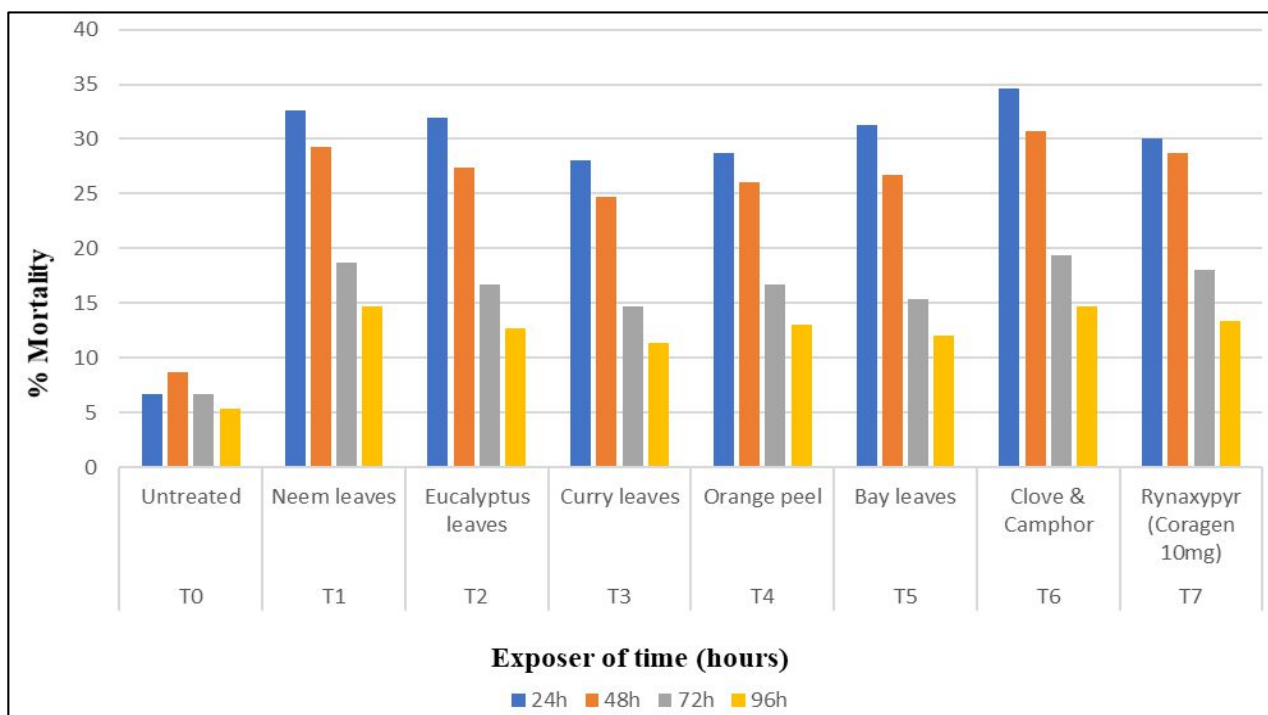


Fig 2: Effect of smoke on % mortality of rice weevil on wheat, during the month of February

Discussion

The findings of the present study clearly demonstrate the significant insecticidal effects of plant-derived smokes on

the mortality of adult *Sitophilus oryzae* in stored wheat grains. Among all the treatments, the smoke generated from Clove and Camphor (T₆) consistently exhibited the highest

mortality rates across both November and February trials, indicating its superior efficacy. This may be attributed to the presence of bioactive compounds such as eugenol in clove and camphor, which are known for their strong fumigant and insecticidal properties. The mortality of rice weevils increased notably with prolonged exposure to smoke in both months. In the November trial, Clove & Camphor smoke achieved a mortality rate of 35.33% after 48 hours of exposure, followed by Neem (34.67%) and Eucalyptus (33.33%). Similar trends were observed in February, with Clove & Camphor again leading at 30.67% after 48 hours, followed by Neem (29.33%) and Coragen (28.67%). These results affirm that natural plant smokes can perform comparably, and in some cases more effectively, than the synthetic insecticide Coragen. Interestingly, Neem leaf smoke consistently ranked second in efficacy. Neem contains azadirachtin and other limonoids, which disrupt insect growth and feeding behavior. Eucalyptus and Bay leaves also showed substantial mortality, indicating the presence of volatile compounds like eucalyptol and other terpenes that likely act as natural fumigants. Orange peel and Curry leaves were relatively less effective, though still significantly higher in mortality compared to the control.

The decline in mortality observed at the 72 and 96-hour intervals in both trials could be due to reduced fumigant activity over time or adaptation responses by the weevils. Nonetheless, even with this decline, treated samples still exhibited notably higher mortality than untreated controls. Furthermore, the negligible mortality observed under airtight conditions without smoke reinforces the fact that the observed effects were due to the action of plant smokes rather than oxygen depletion or container conditions alone. These findings support the hypothesis that smoke from certain plant materials possesses strong bioactivity against storage pests and can serve as a low-cost, eco-friendly alternative to chemical fumigants. Plant-based smokes offer the added benefits of low toxicity to humans, minimal environmental impact, and ease of application in rural settings. However, further research is needed to understand the exact mechanisms of toxicity, residual effects on grain quality, and the potential for scaling up these practices under field or warehouse conditions.

Conclusion

The primary aim of this study was to evaluate the effectiveness of natural, plant-based smoke treatments in controlling rice weevil (*Sitophilus oryzae*) populations in stored wheat. The results demonstrated that smoke derived from certain plant materials possesses notable insecticidal properties against the weevils. Among all treatments, smoke from clove and camphor consistently produced the highest mortality rates in both the November and February trials, followed by neem and eucalyptus leaf smoke. Mortality increased with longer exposure times in sealed conditions, highlighting the cumulative toxic effects of the smoke on adult insects.

These findings indicate that botanical smokes—particularly those from clove & camphor and neem leaves—can offer an effective and environmentally friendly alternative to synthetic fumigants such as Coragen. This method provides a more sustainable approach to managing rice weevil infestations, with reduced risks to human health and the environment compared to conventional chemical pesticides.

References

- Asawalam EF, Ebere UE, Emeasor KC. Effect of some plant products on the control of rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). J Med Plants Res. 2012;6(33):4811-4814.
- Bhupender, Yadav U, Kumari A, Sachin. Efficacy of various storage treatments on wheat (*Triticum aestivum*) preservation and rice weevil (*Sitophilus oryzae*) control. Int J Adv Biochem Res. 2024;8(7):611-616.
- Chahal KK, Bansal R, Kaur R. Chemistry and insecticidal potential of bay leaf essential oil against stored grain pest of wheat. J Appl Nat Sci. 2016;8(4):2049-2054.
- Chauhan P, Jakhmola SS, Bhaduria NS, Dwivedi US. Influence of wheat varieties on biological activities of rice weevil, *Sitophilus oryzae*. Indian J Entomol. 2005;67(4):366-368.
- Don-Pedro KN. Fumigant toxicity of citrus peel oils against adult and immature stages of storage insect pests. Pestic Sci. 1996;47:213-223.
- Estalle E, Riudavets J. The rice weevil, *Sitophilus oryzae*: Data on its biology and methods of control. Catalunya Rural I Agraria. 1995;56:29-31.
- Jayakumar M, Arivoli S, Raveen R, Tennyson S. Repellent activity and fumigant toxicity of a few plant oils against the adult rice weevil *Sitophilus oryzae* L. 1763 (Coleoptera: Curculionidae). J Entomol Zool Stud. 2017;5(2):324-335.
- Kumari R, Harshlata, Sharma N, Dhatwalia B, Bharti V. The efficacy of natural plant extracts in controlling rice weevil (*Sitophilus oryzae*). J Entomol Zool Stud. 2024. [Page numbers not provided].
- Mehta V, Kumar S. Influence of different plant powders as grain protectants on *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) in stored wheat. J Food Prot. 2020;83(12):2167-2172.
- Mesbahm HA, Mahomed AA, Aajel MS. Eco-friendly tools for controlling of the rice weevil *Sitophilus oryzae* (Coleoptera: Curculionidae). Alex Sci Exch J. 2018;39(3):476-481.
- Mishra BB, Tripathi SP. Repellent activity of plant-derived essential oils against *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst). Singap J Sci Res. 2011;1:173-178.
- Opiyo SA. A review of insecticidal plant extracts and compounds for stored maize protection. IOSR J Appl Chem. 2021;14(10):23-37.
- Padmasri A, Srinivas V, Lakshmi KV, Pradeep T, Rameash K, Anuradha C, Anil B. Management of rice weevil (*Sitophilus oryzae* L.) in maize by botanical seed treatments. Int J Curr Microbiol Appl Sci. 2017;6(12):3543-3555.
- Pal M, Tiwari S, Regmi R, Ali F. Efficacy of plant-powders against rice weevil, *Sitophilus oryzae* (L.) (Curculionidae: Coleoptera) at laboratory condition. SAARC J Agric. 2022;19:331-338.
- Paranagama PA, Abeysekera KHT, Nugaliyadde L, Abeywickrama K. Bioactivity of leaf volatiles of *Azadirachta indica* A. Juss. and *Murraya koenigii* Spreng. against *Sitophilus oryzae* L. (Coleoptera: Curculionidae). Trop Agric Res Ext. 2002;5:17-21.
- Rajashekara S, Kiran R, Bhavya V, Chithrashree C, Chaitra V, Joshi DR, Venkatesha MG. Screening of

- botanicals against the adults of rice weevil, *Sitophilus oryzae* L. Int J Ind Entomol. 2023;47(1):12-24.
17. Rajendran S, Sriranjini V. Plant products as fumigants for stored-product insect control. J Stored Prod Res. 2008;44(2):126-135.
 18. Rathore M, Pravalika Y, Kumar R, Tutlani A, Aggarwal N. Enhancing seed quality and insect management in wheat (*Triticum aestivum* L.) through optimization of storage treatments with natural and chemical compounds. Plant Arch. 2024;24(1):26-33.
 19. Roy N. Green management of rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae) by new botanicals. J Entomol Res. 2020;44(4):565-574.
 20. Saljoqi AUR, Afridi MK, Khan SA, Rehman S. Effects of six plant extracts on rice weevil *Sitophilus oryzae* L. in the stored wheat grains. J Agric Biol Sci. 2006;1(4):61-65.
 21. Sharma K, Meshram NM, Sharma RK. Bioactivity of essential oil from leaves of *Murraya koenigii* against rice weevil, *Sitophilus oryzae* in stored wheat. Indian J Plant Prot. 2015;43(3):284-289.
 22. Soujanya PL, Sekhar J, Kumar P. Efficacy of plant extracts against rice weevil *Sitophilus oryzae* (L.) in stored maize. Indian J Entomol. 2016;78(4):342-345.
 23. Srivastava [Initials]. Toxicity of leaf extract of *Azadirachta indica* on the fecundity and hatchability of the rice moth. Neem Newsl. 1994. [Page numbers not provided].
 24. Opiyo SA. Utilization of plant extractives and compounds for *Sitophilus oryzae* (rice weevil) management. IOSR J Biotechnol Biochem. 2024. [Page numbers not provided].
 25. Tayeb NAAE-S, *et al.* Biological performance of certain botanical fine dusts, ash and sulfur powders against the rice weevil *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). Plant Prot Dep. 2011. [Page numbers not provided].
 26. Trivedi A, Nayak N, Kumar J. Recent advances and review on use of botanicals from medicinal and aromatic plants in stored grain pest management. J Entomol Zool Stud. 2018;6(3):295-300.
 27. Vidhya SA, Jesudasan RWA. Repellency of four spices against the rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). J Appl Zool Res. 2012;23(2):125-129.
 28. Yadav U, Tiwari R. Ecofriendly management of *Sitophilus oryzae* and *Rhyzopertha dominica* in stored wheat at Pantnagar, Uttarakhand. J Appl Nat Sci. 2017;9(2):736-743.