



**SEETHALAKSHMI RAMASWAMI COLLEGE**  
(AUTONOMOUS)  
AFFILIATED TO BHARATHIDASAN UNIVERSITY  
TIRUCHIRAPPALLI

*Accredited with A+ by NAAC (4<sup>th</sup> Cycle)*



**CONFERENCE PROCEEDINGS ON**  
**SUSTAIN LIFE 2026 :**  
**EXPLORING BIOLOGICAL FRONTIERS FOR A GREENER PLANET**  
**VOLUME - I**

**National Conference on**  
**SUSTAIN LIFE 2026 :**  
**EXPLORING BIOLOGICAL FRONTIERS FOR A GREENER PLANET**  
**(EBFGP 2026)**

**Editors**

**Dr. A. S. Maheswari**

**Dr. J. Viji**

**Dr. M. Isai**

**Editorial Committee Members**

**Dr. R. Prabhavathy**

**Dr. P. Anitha**

**RESEARCH DEPARTMENT OF ZOOLOGY**

**2026**

**CONFERENCE PROCEEDINGS ON SUSTAIN LIFE 2026: EXPLORING  
BIOLOGICAL FRONTIERS FOR A GREENER PLANET - VOLUME I**

© Dr. A. S. Maheswari, Dr. J. Viji, Dr. M. Isai

**First Edition: March, 2026**

**ISBN: 978-93-49618-28-2**



*Copyright*

All rights reserved. No part of this book may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, mechanical, photocopying, recording or otherwise, without prior written permission of the Editor.

*Publishers*

Thanuj International Publishers,  
Tamil Nadu,  
India

# BOTANICAL ESSENTIAL OILS AS A BIOFUMIGANTS AGAINST PULSE BEETLE

Aaron Arputharaj.A1, Anandhabhairavi.N2\*, Durgesh.M3, Mahima .S4, kumar .J5

Phone No – 9342484432 , email id - aaronaaron40333@gmail.com

1School of Agriculture, VELS Institute of Science, Technology & Advanced Studies(VISTAS),  
VelanNagar ,Chennai-600 117, Tamil Nadu, India

2\* Department of Agricultural Entomology, School of Agriculture VELS Institute of Science, Technology  
& Advanced Studies (VISTAS) Velan Nagar, Chennai-600 117, Tamil Nadu, India

(\*Corresponding author mail Id: [anandhabhairavi03@gmail.com](mailto:anandhabhairavi03@gmail.com))

## Abstract

To replace the usage of synthetic fumigants against pulse beetle in storage ecosystem. In this chapter focus on the highly potential botanical essential oil as biofumigants against pulse beetle. The biofumigants botanical essential oil, are extracted from Selected botanicals being highly volatile from extract plant-derived secondary metabolites, they exhibit multi-targeted bioactivity including fumigant toxicity, neurotoxic effects ( nerve system), enzyme inhibition, oviposition deterrence, ovicidal action( egg hatchability )and disruption of larval development reducing the complete life cycle. Oils are extracted from Selected plants due to high resistant capacity plant such as *Syzygium aromaticum*, *Cinnamomum verum*, *Ocimum tenuiflorum*, *Eucalyptus globulus*, *Chenopodium ambrosioides*, and *Cymbopogon nardus* demonstrate promising huge insecticidal properties. Their major active compounds in that plant are eugenol, cinnamaldehyde, 1,8-cineole, ascaridole, and citronellal play a crucial role in mortality induction and behavioral interference in adult beetles and immature stages to control the infestation. When Comparative result from the each botanicals indicate that clove and cinnamon oils show superior high fumigant efficacy against pest, while citronella and basil oils effectively suppress oviposition and population growth. their effectiveness are numerous advantages using these botanical biofumigants are biodegradable, leave minimal harmful residues, and IPM (integrated pest management strategies). Their integration into modern storage systems can substantially reduce dependence on chemical

## 1.INTRODUCTION

Pulses constitute a specified role of global nutritional security, serving as an necessary source of plant-based protein, minerals , vitamins and fibre . In spite of their agronomic And Economic

importance significantly post – harvest losses occur in storage, majorly infestation due to by bruchid beetles . especially these pulse beetles belonging to the genus *callosobruchus* , are among the most devastating pest of stored pulses .their infestation severely affected seed quality, germination percentage,market value .While studying important pulse beetles infesting stored pulses in India Raina (1970) reported that out of five known species of *Callosobruchus* from India, three are commonly found in stored pulses. These are *Callosobruchus. Chinensis* (Linnaeus), *Callosobruchus. Maculatus*(Fabricius) and *Callosobruchus.analis* (Fabricius). Dwivedi et al. (1991) evaluated the weight Losses in pulses Maximum infestation of weight loss is 8.7 per cent .the grub completely feed the endosperm , leaving only the seed coat it's not for human consumption. Both the adult and grub have a potential damage to the crop .At present, pest control depend on the use of insecticide and fumigants .The indiscriminate use of insecticides in the storage, Causes insect resistance, toxic residues in food grains (Fishwick1988), Environmental pollution and increasing costs of application. problem safe alternative conventional insecticides and fumigants to conserve stored grains from insect infestation is essential oil and biorational approaches, plant oil have scientifically Proven most effective and in properly managing the pest. Additionally, a lesser no toxicity effect Is fitted for human consumption. the control methods of against the pulse beetle this are mostly based using synthetic chemicals and fumigants to reduce by using botanicals

Environmental Protection Agency, 2001). But chemical control measures have suffer serious Deficiencies (Luckman & Metcalf) Essential oil are promising alternative to synthetic insecticides .Many formulation are being used against stored product pests and their selection is most important to control such target pest . Selecting the need for environment friendly, safe, economically feasible and also more effective insecticide to control the insect pest of stored products, the present study was taken is to identify the best fumigant toxicity of selected essential oil against stored product pest namely *c.chinensis* and inflicting damage to stored. these concerns have to accelerated the search for environmentally safe, bio degradable and sustainable. essential oil have emerged as a high viable bio fumigants owing to their high volatility, mulit target activity like disturb growth , reduce ovidicial and comparatively low human toxicity

## **2.BIOLOGY AND ECONOMIC SIGNIFICANCE OF PULSE BEETLE:**

Pulse beetle undergo complete metamorphosis, progressing through egg, larval ,pupal and adult stages. female deposit eggs on seed Upper layer of the seeds .upon the hatching Larvae goes into the seed coat and feed the endosperm internally, rendering the grain hollow And unfit for human consumption. Only Pupation occur within inner of the seed, and young one emerge by forming distinctive circular exit holes by damaging the seed by only the favourable controlled environmental conditions , And their full growth complete life cycle completed within 21- 28 days, leading to rapid population multiplication.

And the identification of male and female of the pest on the basis of their Antennae .Males are having pectinate antenna and pygidium without any single dark patches .while female are having strongly serrate antennae and pygidium with two dark patches,one on each side of the line . Generally female is slightly larger than male (Howe and Curie (1964))

The internal feeding habit of larvae leads into progressive damaging and contamination of stored pulses. Losses include reduction in seed weight, decreased germination percentage, nutritional deterioration and unfit for market . Post harvest losses due to bruchids may reach 30 – 60% in poorly managed the storage systems. Their high adaptability and reproductive rate make control particularly challenging . In that poorly managed storage systems, damage may escalate to alarming levels , emphasizing the urgency (odos Santos et al., 2021, Morris et al., 2020).f effective control management strategies

### **3.BIOFUMIGATION IN STORED GRAIN PROTECTION**

Bio fumigation refers to the maximum utilization Of naturally derived volatile compounds to suppress insect pests and pathogens reduce the infestation. In condition of grain storage, essential oil act as biofumigants by emitting vapours that exert toxic and repellent effects on target pest .this eco compatible strategy aligns with sustainable agriculture and IPM (integrated pest management) frameworks , reducing dependence on synthetic Chemicals.

This process involves the incorporation of plant biomass into the soil , where tissue decomposition release chemical compounds like **isothiocyanates** , which are highly effective in suppressing harmful microorganisms (dos Santos et al., 2021, Morris et al., 2020).Further more, biofumigants species also function as cover crops , providing soil protection against soil erosion, maintaining organic matter balance, improving soil structure And reducing nutrient leaching .

**EXAMPLE** – clove oil , basil oil , eucalyptus oil

### **4.ESSENTIAL OILS : CHARACTERISTICS AND PHYTOCHEMICAL PROFILE :**

Essential oils are highly concentrated, volatile, aromatic phytochemicals synthesized as secondary metabolites in numerous plant species and have a unique chemical composition . They are typically extracted through from steam distillation or hydro distillation from various plant parts such as roots , leaves, seed , bark and flowers . They also may attract some insect to favour the dispersion of pollens and the seeds , or repel undesirable others these oils are chemically complex mixture composed of terpenes , trapezoids , phenylpropanoids, and other low molecular weight compounds used as a essential oil

In addition , certain phytochemicals and metabolites suppers detoxification enzymes, thereby impairing the insect capacity to metabolize toxicity compounds. Essential oil also demonstrated

oviposition deterrent effects by reducing reproduction discouraging egg laying and reducing egg hatch ability . some compounds interfere with larval development and pupation, acting as natural growth regulators.the multiplicity of modes of action significantly to reduce the probability of resistance development these essential oil that act as a insect growth regulators

## **5. MODE OF ACTION AGAINST PULSE BEETLES :**

Essential oils exert toxicity through multiple and interconnected mechanism against the pest . Owing to their high volatility, they function efficiently as fumigants within the storage environments . Inhalation of vapours disrupts respiratory functions and interfere with neural signal transmission is highly affected . Many constituents inhibit **acetylcholinesterase** activity, resulting due to the effect of nervous system impairment, hyperexcitation , paralysis , and eventual mortality

**Fumigant Toxicity** – Due to high volatility, essential oils act as through a vapour-phase toxicity. When insects inhale vapours inside sealed storage environments, that's damage the respiratory and nervous systems are affected, leading to mortality.

**Neurotoxic Effects** -Several studies have shown that essential oils inhibit acetylcholinesterase (AChE), an enzyme responsible for nerve impulse transmission. Inhibition results in damage of nervous system disruption, hyperactivity, paralysis, and leading to the death of insect.

**Enzyme Inhibition** – Essential oils may suppress detoxifying enzymes such as glutathione-S-transferase (GST), reducing the insect's ability to metabolize toxic substances Due to the inhalation of fumigants

**Oviposition Deterrence and Ovicidal Activity** – Certain oil constituents interfere with egg laying behaviour and reduce egg hatchability. This significantly limits population buildup over successive generations and also reduces the growth and development.

**Growth Disruption** – Some plant-based compounds act as insect growth regulators, disturbing larval development and adult emergence it's almost reduced the total insect population

## **6.. INTEGRATION INTO SUSTAINABLE STORAGE SYSTEM :**

Essential oil-based formulations can be integrated into hermetic storage technologies, improved sanitation practices, and community-level grain storage systems and also small holder friendly storage intervention. Such integration ensures prolonged protection while minimizing ecological disturbances. Synergistic adoption alongside traditional storage methods enhances resilience and sustainability.

**TABLE 1. DIFFERENCE EFFICACY OF ESSENTIAL OIL**

S.No	BOTANICAL	SCIENTIFIC NAME	ACTIVE COMPOUND	PRIMARY ACTION	REPELLENT ACTIVITY	Fumigant Strength
1	Clove	<i>Syzygium aromaticum</i>	Eugenol	Neurotoxic action, reduces oviposition	High	Very high
2.	Basil / Tulsi	<i>Ocimum tenuiflorum</i>	Eugenol, Methyl eugenol	Growth regulatory and repellent	High	Moderate
3.	Eucalyptus	<i>Eucalyptus globulus</i>	1,8-Cineole (Eucalyptol)	Respiratory and nervous disruption	Moderate	High
4.	Cinnamon	<i>Cinnamomum verum</i>	Cinnamaldehyde, Eugenol	Neurotoxic and enzyme inhibition	Moderate	Very high
5.	Citronella	<i>Cymbopogon nardus</i>	Citronellal, Citronellol, Geraniol	receptor disruption	Very High	Moderate
6.	Chenopodium	<i>Chenopodium ambrosioides</i>	Ascaridole	Strong fumigant toxicity	Moderate	High

Numerous plant- derived essential oils have demonstrated promising results against pulse beetles

These are all the botanicals will given the prominent result against pulse beetle. Clove oil exhibits pronounced fumigant and contact toxicity attributed to its high eugenol content as strong repellent against pulse beetle . Cinnamon oil, rich in **cinnamaldehyde**, toxicity with **LC<sub>50</sub> ≈ 23.16 μL** produce rapid knockdown and strong ovicidal effects. Citronella oil is recognized for its potent repellency and behavioral disruption activity act as repellent agent . Chenopodium oil displays substantial lethality even at lower concentrations very low **LD<sub>50</sub> values (~2.5–2.8 μL)** , while basil moderate fumigant action (**LC<sub>50</sub> ~278.6 μL/L** air at 1 hand eucalyptus oils provide moderate yet consistent fumigant and repellent action.

**Clove > cinnamon > citronella > chenopodium > basil**

Comparative investigations frequently rank clove and cinnamon oils among the most effective biofumigants, followed by citronella and other aromatic oils have moderate capacity. Their

efficacy across different life stages underscores their suitability for comprehensive pest suppression to control pulse beetle in storage ecosystem

## **7. ADVANTAGES OF BOTANICAL BIOFUMIGANTS :**

Botanical essential oils offer several distinct advantages over conventional fumigants against the pulse beetle. They are biodegradable, leave minimal residual toxicity, and exhibit lower environmental persistence and maintain ecosystem( Isman, 2015). Their comparatively reduced mammalian toxicity enhances safety for farmers, consumers, and storage workers. Furthermore, their broad-spectrum biological activity encompasses insecticidal, repellent, antifeedant, and growth-inhibitory effects and also reduce their growth and disturb the life cycle. The naturally occurring, Biologically active botanicals appear to have a prominent role for the development Of future commercial pesticides not only for increased productivity but for the Safety of the environment and public health.

Their compatibility with organic agriculture and integrated pest management programs further supports their adoption. Additionally, plant-based products are often locally available and economically feasible for smallholder farmers highly resistant against the pulse beetle by using the botanicals

## **8. CONCLUSION :**

Botanical essential oils represent a scientifically validated and environmentally sustainable alternative to synthetic fumigants for managing pulse beetle infestations from the storage systems. Their multifaceted mode of action, encompassing fumigant toxicity, repellency, ovicidal activity, and developmental interference, enables comprehensive suppression of storage pests. Increased exposure duration correlates positively with insect mortality, highlighting their practical effectiveness in enclosed storage systems.

Among the various oils evaluated, clove and cinnamon oils demonstrate superior high performance due to their strong fumigant toxicity, rapid knockdown effect, and remarkable ovicidal properties against pulse beetle. Citronella oil effectively disrupts insect behavior and deters egg laying and disturb the life cycle, while Chenopodium oil shows high lethality even at comparatively lower concentrations. Basil and eucalyptus oils, though moderate in toxicity, provide consistent repellent and developmental inhibitory effects, contributing to overall pest suppression. The synergistic action of their bioactive constituents reduces the likelihood of resistance development, which is a major limitation of synthetic pesticides.

In addition to their efficacy, essential oils offer significant environmental and health advantages against pest. They are biodegradable, leave minimal toxic residues, and pose comparatively lower risks to non-target organisms. Their compatibility with sustainable storage technologies and integrated pest management approaches further strengthens their practical applicability and also small holder farmers Easily handled.

## REFERENCE :

1. Aloke, S. (2024). A review on insecticidal efficacy of phytochemicals including essential oil constituents for stored grain pest management.
2. Arivoli, S., & Tennyson, S. (2025). Assessment of insecticidal efficacy of aromatic plant leaf oil extracts on stored grain insect pests. *Napere Journal*, 100171.
3. Bhavya, M. L., Obulaxmi, S., & Devi, S. S. (2021). Efficacy of *Ocimum tenuiflorum* essential oil as grain protectant against coleopteran beetle, infesting stored pulses. *Journal of Food Science and Technology*, 58(4), 1611–1616.
4. Chandrasekaran, K., Maline, A. S., & Sivasankari, S. (2020). Fumigant effect of essential oils against pulse beetle (*Callosobruchus chinensis* L.) and rice weevil (*Sitophilus oryzae* L.) in stored products. *Indian Journal of Science and Technology*, 13(25), 2575–2581.
5. Gostin, I. N. (2023). Evaluation of the essential oils used in biopesticide production: insecticidal and miticidal activity. *Agriculture*, 14(1), 81.
6. Jayaram, C. S., Chauhan, N., Dolma, S. K., & Reddy, S. G. E. (2022). Chemical composition and insecticidal activities of essential oils against pulse beetle. *Molecules*, 27(2), 568.
7. Kathirvelu C, Maline AS,Sivasankari S (2020) Fumigant Effect of essential oils against pulseBeetle (*Callosobruchus chinensis* L.)And rice weevil (*Sitophilus oryzae* L.) in stored products. *IndianJournal of Science and Technology* 13(25): 2575-2581.
8. Mssillou, I., Saghrouchni, H., Saber, M., Zannou, A. J., Balahbib, A., & Bouyahya, A. (2022). Efficacy and role of essential oils as bio-insecticide against the pulse beetle *Callosobruchus maculatus* (F.) in post-harvest crops. *Industrial Crops and Products*, 189, 115786.
9. Nikolaou, A. D., Lisi, A., & Zhang, Y. (2025). Chemical composition and bioefficacy of essential oils against stored-product beetles. *Journal of Stored Products Research*, 115, 102537
10. Revathy, V. S., Jacob, A. M., & Binu, N. (2025). Insecticidal efficiency of selected essential oils against stored pests *Sitophilus oryzae* and *Callosobruchus maculatus* by using GC–MS analysis. *Scientific Reports*, 15, 45477.