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**EXPLORING BIOLOGICAL FRONTIERS FOR A GREENER PLANET**  
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BIOLOGICAL FRONTIERS FOR A GREENER PLANET - VOLUME I**

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

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# **Biology, Damage potential and essential oil based management of pulse beetle**

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## **Introduction :**

The preservation of stored pulses is a critical component of global food security, as legumes serve as a primary source of protein for millions. Among the various post-harvest challenges, the pulse beetle, *Callosobruchus chinensis* L., remains one of the most formidable pests in storage environments. Known for its rapid life cycle and high reproductive potential, this insect can cause devastating quantitative and qualitative losses in a remarkably short period.

In traditional storage conditions, infestation levels can reach as high as 50–60% within just six months, with some bean varieties experiencing over 90% damage when stored in sacks. These losses are not merely physical; infestation leads to a significant decrease in calorific value and alterations in the biochemical properties of the grain. Initial presence of even a single pair of adults can lead to the complete destruction of pulse grains within two to four months, depending on the pulse variety and environmental conditions such as temperature and moisture.

Understanding the biological parameters of *C. chinensis*—including egg incubation, larval and pupal development, and adult longevity—is essential for developing effective control measures. Historically, management has relied heavily on synthetic fumigants and chemical insecticides.

This chapter explores the biology of the pulse beetle and evaluates the efficacy of various plant-based essential oils as seed protectants. By examining the impact of botanicals such as neem, lavender, citronella, and mint oils on oviposition, adult emergence, and grain damage, we can identify biodegradable and safe strategies for long-term pulse protection. Such botanical interventions not only minimize dependence on synthetic chemicals but also offer a practical, cost-effective approach for maintaining seed viability and nutritional quality during storage.

### **Biology of pulse beetle**

- Egg incubation period: Duration of time taken from egg laying to hatching which was recognized by turning of egg to opaque or creamish white colour due to accumulation of bored material inside the egg.
- Developmental period (larval and pupal): After hatching larva bore down in the seed making egg shell empty and passes its larval and pupal stages inside the seeds. The indication of pupal stage was formation of net or circular translucent exit hole on the surface of the seed but it is hard enough to record the exact larval and pupal period for the season that it was inside the seed. So, data was recorded as duration of time taken from hatching of egg to adult emergence.
- Total developmental period: From the day of oviposition to adult emergence.
- Adult longevity: It was recorded from the day of adult emergence to death of adult.
- Oviposition details: A period between the time of emergence of female and starting egg laying was considered as pre ovipositional period. Period between starting of egg laying and stopping of egg laying was noted as ovipositional period, while period between stopping of egg laying and death of female was considered as post ovipositional period.
- Fecundity: The grains containing eggs were replaced daily with healthy grains and total number of eggs laid by an individual was recorded till the female died, which shows the total egg laying capacity of female i.e. fecundity.

### **Damage Potential of Pulse Beetle**

Sharma et al. (2013) studied i.e. *C. chinensis* infesting stored pulses was reached its peak during September-October and the grain damage was rated the highest during January-February (13.75%) and lowest during June-July (3.05%).

Modgil and Mehta (1996) reported that decrease in calorific value in green gram and red gram infested with *C. chinensis*. Singh et al. (1995) observed the effects of various chemical characters of gram (chickpea) varieties on the growth and development of *C. chinensis* in the laboratory.

They found fecundity; F1 progeny and index of susceptibility were comparatively lower on the varieties of gram with characters such as high protein, and low oil and starch contents. The

varieties with high protein, and low oil and starch contents showed lower egg deposition, F1 progeny and index of susceptibility.

The resistant accessions had lower percentage of fats and starch but a higher percentage of protein than the susceptible accessions. Jay et al. (1973) reported that at the time of sample collection damage caused by *C. maculatus* was less than 1%, but after 120 days of sample storage in laboratory it rose to 44% in soyabean. Chopra and Khurab (1970) concluded in their laboratory experiments on extent of damage by *C. analis* that the beetles caused severe damage at high temperature and the pulses, therefore if stored at a temperature of 23.5 degree centigrade or less would be relatively safer. Lefevre (1950) in Belgium- Congo found that after harvest 48-70% of beans were damaged by bruchids during a period of 8 months. He also stated that 93% of beans stored in sacks, were found drilled by these insects in a period of 12 months causing enormous loss. In Nigeria Caswell (1973) estimated 50-60% of insect damage after 6 months of traditional storage.

### **Essential Oil Based Management of Pulse Beetle**

Different plant oils as seed protectants against the pulse beetle (*C. chinensis*), a laboratory experiment was conducted in completely randomized block design (CRD) with 10 treatments including control at Pulse Entomology Laboratory, Department of Entomology, G. B. Pant University of Agriculture & Technology, Pantnagar during 2014. Plant based oils like Camphor oil (*Cinnamomum camphora*), Citronella oil (*Cymbopogon citratus*), Mentha oil (*Mentha longifolia*), Lemongrass oil (*Cymbopogon flexuosus*), Lavender oil (*Lavandula agustifolia*), Neem oil (*Azadirachta indica*), Geranium oil (*Pelargonium graveolens*), Cardamom oil (*Elettaria cardamomum*) and Basil oil (*Ocimum basilicum*) procured from Medicinal Plant Research and Development Center (MRDC), Pantnagar were used as treatments @ 2.5 ml/ kg seeds. The used treatment oils are

<b>S. No.</b>	<b>Treatment (Plant Oil)</b>	<b>Scientific Name (Source)</b>	<b>Major Active Compounds</b>
1	Camphor oil	<i>Cinnamomum camphora</i>	Camphor, 1,8-Cineole, alpha-Pinene
2	Citronella oil	<i>Cymbopogon nardus</i>	Citronellal, Geraniol, Citronellol
3	Mentha oil	<i>Mentha arvensis</i>	Menthol, Menthone

4	Lemongrass oil	<i>Cymbopogon citratus</i>	Citral (Neral & Geranial), Myrcene
5	Lavender oil	<i>Lavandula angustifolia</i>	Linalool, Linalyl acetate
6	Neem oil	<i>Azadirachta indica</i>	Azadirachtin, Nimbin, Salannin
7	Geranium oil	<i>Pelargonium graveolens</i>	Geraniol, Citronellol, Linalool
8	Cardamom oil	<i>Elettaria cardamomum</i>	1,8-Cineole, alpha-Terpinyl acetate
9	Basil oil	<i>Ocimum basilicum</i>	Methyl chavicol, Linalool, Eugenol

### **Effect of Plant Oils on Extent of Oviposition and Adult Emergence of Pulse Beetle**

The superiority of neem oil over other plant oils tested in the present study was in agreement with Sharma et al. (2013) and Bhatnagar et al. (2001) who reported that neem oil was found to be most effective oviposition deterrent against *C. chinensis* in chickpea and cowpea, respectively. Rashmi et al. (2014) also reported that botanicals viz., neem oil, castor oil and mentha oil were found effective against pulse beetle in terms of ovicidal effect. Miah et al. (2013) also reported that the no eggs, larvae and pupae development of *C. maculatus* were found in neem oil, castor oil and camphor oil treated greengram due to toxic effect of these botanicals.

### **Effect of Plant Oils on Pulse Beetle Damage**

In case of 30 DAIR, the minimum grain infestation by number and seed content loss was recorded in neem oil (2.40 and 1.20%, respectively) followed by lavender oil (8.20 and 2.20%), citronella oil (8.80 and 3.40%) and camphor oil (9.40 and 5.40%). However, the maximum infestation and seed damage (16.00 and 19.60%) were recorded in basil oil as compared to untreated control (25.00 and 28.60%) which were statistically different from all other treatments.

Thus, it was found that among the different plant essential oils used, neem oil followed by lavender oil proved to be most effective against *C. chinensis*, up to four months of storage. Citronella, camphor and mentha oils also registered significantly less infestation and seed damage during the entire storage period.

The results in respect of use of neem oil as seed protectant corroborated with those of Ramangoudar et al. (2000) who observed no seed damage by *C. chinensis* in seeds of horse gram (*Macrotyloma uniflorum* Lam Verdc.) when treated with neem oil at 5 ml/kg seed. Singh (2003)

who reported that pigeonpea seeds coated with neem and castor oil gave significant protection against pulse beetle compared to the untreated control.

### **Effect of Plant Oils on Standard Germination of Greengram Seeds**

Amongst the different seed protectants, the standard germination ranged from 92.84 to 93.92%. Maximum standard germination in greengram seeds was found in treatment of citronella oil @ 2.5 ml/kg seeds, while the minimum was recorded in case of seeds treated with cardamom oil @ 2.5 ml/kg seeds in comparison to control (94.64%).

The present findings are in conformity with the findings of Bhardwaj and Verma (2013) in pea. Rajasri and Rao (2012) also found similar effect of different neem-based formulations against pulse beetle on chickpea seeds for a storage period of 12 months. Raghvani and Kapadia (2003) observed that the different oil treatments failed to exert any significant effect on germination of pigeonpea seeds, while Rajasri et al. (2014) found that blackgram seeds treated with crude neem oil had a very low germination of 58.4% as compared to untreated check (73.2%). In contrary, Sreeramaiah and Bommegouda (1992) in cowpea reported that neem oil at 0.5% maintained higher germination and seedling vigour during storage.

### **Conclusion :**

The present study on the biology and damage potential of the pulse beetle (*Callosobruchus chinensis*) revealed that the pest has a rapid life cycle, high reproductive potential, and strong adaptability to storage conditions, leading to severe infestation and significant quantitative and qualitative losses in stored pulses, particularly green gram. The biological observations indicated that the beetle completes its development quickly, allowing rapid population buildup and resulting in heavy seed damage within a short storage period.

Evaluation of plant essential oils demonstrated their potential as eco-friendly alternatives to chemical insecticides for managing pulse beetle infestation. Among the treatments tested, neem oil proved to be the most effective seed protectant, significantly reducing oviposition, adult emergence, seed infestation, and weight loss throughout the storage period.

Lavender and citronella oils also showed promising results, whereas basil and cardamom oils were comparatively less effective. The findings suggest that botanical oils, especially neem

oil, can serve as sustainable, biodegradable, and safe grain protectants. Adoption of such plant-based management strategies can reduce dependence on synthetic fumigants, minimize environmental hazards, and improve long-term storage protection of pulses. Further studies under large-scale storage conditions are recommended to enhance practical applicability and formulation development.

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