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# EVALUATION OF CERTAIN BOTANICALS AGAINST PULSE BEETLE, *CALLOSOBRUCHUS CHINENSIS* (L.) ON DIFFERENT PULSES

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## Abstract

Pulses are regarded as the second most significant crop category globally and in many underdeveloped nations, they represent a major source of plant protein. Pulses can be used as a meat substitute that suffer losses from insect pests in both field and storage conditions. Among other pests, the pulse beetle, *Callosobruchus chinensis* L., causes significant losses when stored. In this instance, the efficacy against *Callosobruchus chinensis* L. was assessed using five readily available natural ingredients found locally: Neem, Mint, Garlic and Onion in powder form and in different doses (0.1%, 0.2%, 0.3%, and 0.4%). On five distinct pulse seeds—Chickpea (*Cicer arietinum*), Kidneybean (*Phaseolus vulgaris*), Lentil (*Lens culinaris*), Soyabean (*Glycine max*) and Pigeon pea (*Cajanus cajan*). The results revealed that the lowest weight loss was recorded from the seeds treated with Neem leaf powder (0.4%) in Chickpea, Kidneybean, Lentil, Soyabean and Pigeonpea *i.e.*1.34%, 2.36%, 2.55%, 2.89% and 2.93%, respectively. Maximum was found in the seeds treated with Onion leaf powder (0.1%). Also, adult emergence was recorded minimum in seeds treated with Neem leaf powder (0.4%) in all pulses *i.e.* 26.22 % in Chickpea, 23.42% in Kidneybean, 19.24% in Lentil, 17.12% in Soyabean and 19.51% in Pigeonpea and maximum was recorded in seeds treated with Onion leaf powder (0.1%). Whereas, adult mortality was observed highest in the seeds treated with Neem leaf powder (0.4%) which was 81.23% in Chickpea, 77.24% in Kidneybean, 75.24% in Lentil, 71.23% in Soyabean and 68.34% in Pigeonpea while lowest was observed in the seeds treated with Onion leaf powder (0.1%).

***Keywords***: *Host preference, pulse beetle, Callosobruchus chinensis, botanicals, seed weight loss, adult emergence, adult mortality*

## Introduction

Pulses belongs to the family Leguminosae or Fabaceae that contributes in the economy of India. Tradition has that pulses are an essential part of the Indian diet. Pulses are significant in India where the majority of the population follows a vegetarian diet as they are good source of protein and a number of essential amino acids. They are also a good source of nutrients, vitamins and energy. With a production of 14.76 metric tonnes and production area of 23.63 million ha. India is the world's greatest producer of pulses (Anonymous, 2021- 2022). However, among the Indian states, Rajasthan stands at first position in pulse production. In Rajasthan, the total area under pulses was 3.87 mha with the annual production 1.55 MT. Production of pulses in Uttarakhand was 10,69,000 kg/ha in 2022.

Biotic and abiotic stress significantly impair the production of pulses around the world. Insect pest are the major challenge in the production of pulses as the pest causes damage in both field and storage conditions, restricting the yield and market value of pulses. Pulse beetles have been found to be responsible for up to 60% of the weight loss of stored seed (Golnaz *et al*., 2011). In India, there are around 200 species of insect pests known to infest pulses (Anonymous, 2017). *Callosobruchus chinensis* L., commonly known as the pulse beetle, is a highly damaging and widespread pest of legume storage. It lowers a seed's capacity to germinate in addition to causing both qualitative and quantitative losses. As a result of biochemical changes brought on by infection, seeds lose a variety of their basic parts. The bruchid spends its whole juvenile life in individual legume seeds, where it reduces the commodity's marketability and nutritional value while also causing weight loss, lower germination potential, and seed infection (Chakraborty and Mondal, 2016).

There are numerous techniques for managing pulse beetles in storage. These include the application of chemical, biological, mechanical, cultural, physical, and plant-based pesticides. Farmers and investors have made the use of synthetic insecticides to manage storage pests a routine practice. It is now well known that there are a number of issues with the chemical technique, including potential health risks for both users and grain consumers. It results in environmental contamination, persistent toxicity, and the emergence of pesticide resistance against bruchids. Given the significance of these plants, it is essential to investigate and assess certain plants that are present in commodities that have been preserved.

The study was conducted in that regard to assess a few environmentally friendly methods for *C. chinensis* management in various pulses

## Materials and Methods

The powder form of different botanicals *i.e.* Neem, Mint, Garlic and Onion was mixed up with pulses in different doses (0.1, 0.2, 0.3, and 0.4%) in the separate plastic container. Ten pairs of newly emerged adult beetles were released into each plastic container. Three replications were made for each treatment. The efficacy of powders against pulse beetle was estimated with three parameters *viz*, seed weight loss, adult emergence and adult mortality.

**Treatments and Details**

**Table 1. *In-vitro* conditions of botanicals against *C. chinensis* (Chickpea)**

| S.no. | Treatment | Concentrations (%) | | | |
|---|---|---|---|---|---|
| $T_1$ | Control | -- | -- | -- | -- |
| $T_2$ | Neem | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_3$ | Mint | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_4$ | Onion | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_5$ | Garlic | 0.1 | 0.2 | 0.3 | 0.4 |

**Table 2. *In-vitro* conditions of botanicals against *C. chinensis* (Kidneybeans)**

| S.no. | Treatment | Concentrations (%) | | | |
|---|---|---|---|---|---|
| $T_1$ | Control | -- | -- | -- | -- |
| $T_2$ | Neem | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_3$ | Mint | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_4$ | Onion | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_5$ | Garlic | 0.1 | 0.2 | 0.3 | 0.4 |

**Table 3. *In-vitro* conditions of botanicals against *C. chinensis* (Lentil)**

| S.no. | Treatment | Concentrations (%) | | | |
|---|---|---|---|---|---|
| $T_1$ | Control | -- | -- | -- | -- |
| $T_2$ | Neem | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_3$ | Mint | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_4$ | Onion | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_5$ | Garlic | 0.1 | 0.2 | 0.3 | 0.4 |

**Table 4. *In-vitro* conditions of botanicals against *C. chinensis* (Soyabean)**

| S.no. | Treatment | Concentrations (%) | | | |
|---|---|---|---|---|---|
| $T_1$ | Control | -- | -- | -- | -- |
| $T_2$ | Neem | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_3$ | Mint | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_4$ | Onion | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_5$ | Garlic | 0.1 | 0.2 | 0.3 | 0.4 |

**Table 5. *In-vitro* conditions of botanicals against *C. chinensis* (Pigeonpea)**

| S.no. | Treatment | Concentrations (%) | | | |
|---|---|---|---|---|---|
| $T_1$ | Control | -- | -- | -- | -- |
| $T_2$ | Neem | 0.1 | 0.2 | 0.3 | 0.4 |

| | | | | | |
|---|---|---|---|---|---|
| $T_3$ | Mint | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_4$ | Onion | 0.1 | 0.2 | 0.3 | 0.4 |
| $T_5$ | Garlic | 0.1 | 0.2 | 0.3 | 0.4 |

Following formulae were used during the study:-

**1. Seed damage %** :- For evaluating the effect of botanicals against the pulse beetle, *C. chinensis*, the number of damaged seed out of total number of seeds were taken for observation, 100 seeds were taken from each replication and per cent grain damage was calculated after 40 days of treatments by the formula given below:-

Seed damage % = $\frac{Number\ of\ damage\ seeds}{Total\ number\ of\ seeds\ counted} \times 100$

**2. Adult emergence (%) by Howe (1971)**:- The effect of botanicals against the pulse beetle, *C. chinensis* was measured by visual counting method. It was used to keep track of number of adult emergences at regular 24- hour intervals. At 40 days, there was no more adult emergences to be seen. Howe (1971) provided the following formula, which was used to calculate the percentage of adult emergence. The following formula was used for determination of mean damage as described.

Adult emergence (%) = $\frac{Number\ of\ adults\ emerged}{Number\ of\ egg\ laid} \times 100$

**3. Adult mortality (%)** :- For evaluation of botanicals against the pulse beetle, *C. chinensis,* for estimation of adult mortality, the numbers of dead adults of pulse beetle were counted in each container from different treatments after 10, 20, 30 and 40 days and mortality percentage was calculated by the following formula:

Adult mortality % = $\frac{Number\ of\ dead\ insects}{Total\ number\ of\ insects} \times 100$

**Statistical analysis**

All the experiments were kept under Completely Randomized Design (CRD) one way factor analysis with three replications with the help of OPSTAT under storage ambient conditions. The data obtained from various experiments were subjected to statistical analysis after necessary transformation was set as per given by book Statistical Procedures for Agricultural Research by Gomez and Gomez (1984).

**Results and Discussion**

**1. Seed weight loss**

All the treatments were found significantly superior over control in terms of reduction in the seed weight loss by pulse beetle, *C. chinensis* infesting chickpea, kidney bean, lentil, soybean and pigeon pea. The highest weight loss was recorded from untreated seeds. Among all the treatments the lowest weight loss was recorded from the seeds treated with Neem leaf powder @ 0.4 % dose, followed by Neem leaf powder @ 0.3%, Mint leaf powder @ 0.4% and Garlic leaf powder @ 0.4 %. Among the seeds treated with plant powder, the highest weight loss was recorded from the seeds treated with Onion leaf powder @ 0.1% which found to be less effective among all the treatments.

Tabu *et al*. (2012) found that the

treatment with neem seed powder @ 2 per cent dosage and mustard oil @ 5 ml /kg seed showed per cent weight loss of 1.45 and 0.31 per cent, respectively by *C. chinensis* in chickpea grains. Khan *et al.* (2015) reported that neem leaf powder @ 2.5 g per kg mung bean seed reduced the maximum per cent of grain damage by weight 41.72 per cent, respectively over control than other botanicals. Neem leaf powder @ 20 g/kg (8.01%) and custard apple leaf powder @ 20 g/kg (8.67%) were found moderately effective. The present findings are in conformity with the findings of Lakshmi and Venugopal (2007).

**2. Adult emergence**

The highest number of adult emergence of the pest were from seeds treated with Onion leaf powder @ 0.1 %. The lowest number of adults emerged from seeds treated with Neem leaf powder @ 0.4 % which was followed by Mint leaf powder @ 0.4 %, Neem leaf powder 0.3%, Garlic leaf powder @ 0.4 %, Onion leaf powder @ 0.4 %, the result suggests good potentiality for use of neem leaf powder. The current findings were in support with Jahan *et al*. (2020), he observed that lowest number of adult emergence was seen in Dhatura leaf powder which was followed by Neem leaf powder, Garlic tablet powder and Marigold leaf powder which was also supported by Latif *et al*. (2012) indicating the adult emergence was inhibited when the stored seeds were treated with indigenous plant powders like Neem and Mint.

**3. Adult mortality**

The lowest number of adult mortalities was seen in untreated pulse seeds. However, among the treated seeds, the highest number of adult mortalities was found from the seeds treated with neem leaf powder @ 0.4 % followed by Mint leaf powder @ 0.4 %. Whereas, the lowest number of adult mortalities was found from the seeds treated with onion leaf powder @ 0.1% followed by onion leaf powder @ 0.2 % doses.

The results were in support with Devi and Devi (2013), who reported that neem seed powder (5g/kg seed) was most effective protectant with an average of 85.71 per cent adult mortality of *C. chinensis* after 7 days of treatment. The current findings were also in agreement with those of Tabu *et al*. (2012), they reported that neem leaf powder @ 20 g/kg seed provide protection of stored chickpea with 80, 92 and 93.67 per cent adult mortality at 1, 3 and 4 days after treatment, respectively and also reported that mustard oil 5ml/kg seed was also effective botanical for management of pulse beetle with 40, 76.67 and 80 per cent adult mortality at 1, 3 and 4 days after treatment. The current finding shows conformity with the results of Sudhar and Bharpoda (2016) who observed that application of 5 g neem leaf powder per kg seed on chickpea was most effective and recorded adult mortality was 72.38 per cent of *C. chinensis*.

**Table 6. Effect of botanicals at various ratios on seed weight loss infested by pulse beetle *Callosobruchus chinensis* L. on 15th day.**

| Seed weight loss % | | | | | | |
|---|---|---|---|---|---|---|
| **Treatments** | **Doses %** | **Chickpea** | **Kidney bean** | **Lentil** | **Soybean** | **Pigeon pea** |
| **Control** | - | 9.43 ± 0.00 | 8.02±0.01 | 6.12± 0.01 | 5.03±0.01 | 4.06±0.01 |
| **Neem** | 0.1 | 2.38*± 0.01 | 2.94 *±0.01 | 2.97*±0.01 | 3.79*±0.01 | 3.82*±0.01 |
| | 0.2 | 2.31* ± 0.01 | 2.82*± 0.01 | 2.88*±0.01 | 3.52*±0.01 | 3.61*±0.01 |
| | 0.3 | 1.62*± 0.01 | 2.62*± 0.01 | 2.69*±0.01 | 3.12*±0.01 | 3.36*±0.01 |
| | 0.4 | 1.34* ±0.01 | 2.36* ±0.01 | 2.55*±0.01 | 2.89*±0.01 | 2.93*±0.01 |
| **Mint** | 0.1 | 3.14* ±0.01 | 3.34*±0.01 | 3.51*±0.01 | 3.66*±0.01 | 3.82*±0.01 |
| | 0.2 | 2.62 *±0.01 | 2.71*±0.01 | 2.75*±0.01 | 2.82*±0.01 | 3.70*±0.01 |
| | 0.3 | 2.55* ±0.01 | 2.64*±0.01 | 2.68*±0.01 | 2.75*±0.01 | 2.82*±0.01 |
| | 0.4 | 2.24* ±0.01 | 2.35*±0.01 | 2.44*±0.01 | 2.62*±0.01 | 2.75*±0.01 |
| **Garlic** | 0.1 | 3.34*±0.01 | 3.44*±0.01 | 3.64*±0.01 | 3.73*±0.01 | 3.94*±0.01 |
| | 0.2 | 2.74* ±0.01 | 2.82*±0.01 | 2.80*±0.01 | 2.92*±0.01 | 3.73*±0.01 |
| | 0.3 | 2.63*±0.01 | 2.72*±0.01 | 2.73*±0.01 | 2.82*±0.01 | 2.94*±0.01 |
| | 0.4 | 2.37* ±0.01 | 2.46*±0.01 | 2.62*±0.01 | 2.73*±0.01 | 2.82*±0.01 |
| **Onion** | 0.1 | 3.50*± 0.01 | 3.52*±0.01 | 3.76*±0.01 | 3.84*±0.01 | 3.96*±0.01 |
| | 0.2 | 2.83*± 0.01 | 2.94*±0.01 | 2.90*±0.01 | 3.12*±0.01 | 3.82*±0.01 |
| | 0.3 | 2.74*± 0.01 | 2.83*±0.01 | 2.84*±0.01 | 2.94*±0.01 | 3.12*±0.01 |
| | 0.4 | 2.52*± 0.01 | 2.58*±0.01 | 2.75*±0.01 | 2.85*±0.01 | 2.93*±0.01 |
| **S.E(d)** | - | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** |
| **C.D(0.05)** | - | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** |

* Significant at 5% Level of significance as compared with control

**Table 7. Effect of botanicals at various ratios on adult emergence infested by pulse beetle *Callosobruchus chinensis* L. on 15$^{th}$ day.**

| Adult emergence % | | | | | | |
|---|---|---|---|---|---|---|
| **Treatments** | **Doses %** | **Chickpea** | **Kidney bean** | **Lentil** | **Soybean** | **Pigeon pea** |
| **Control** | - | 43.16±0.01 | 39.16±0.01 | 37.34±0.01 | 34.23±0.01 | 34.51±0.00 |
| **Neem** | 0.1 | 36.13*±0.00 | 33.24*±0.00 | 29.22*±0.00 | 25.42*±0.01 | 28.06*±0.00 |
| | 0.2 | 33.18*±0.01 | 29.17*±0.01 | 27.35*±0.01 | 21.34*±0.01 | 26.08*±0.00 |
| | 0.3 | 29.34*±0.01 | 26.20*±0.01 | 23.13*±0.01 | 19.22*±0.01 | 23.04*±0.01 |
| | 0.4 | 26.22*±0.00 | 23.42*±0.01 | 19.24*±0.01 | 17.12*±0.01 | 19.51*±0.01 |
| **Mint** | 0.1 | 37.23*±0.01 | 34.52*±0.00 | 31.12*±0.00 | 27.42*±0.01 | 30.80*±0.00 |
| | 0.2 | 33.42*±0.00 | 29.42*±0.01 | 27.14*±0.01 | 23.26*±0.01 | 29.41*±0.00 |
| | 0.3 | 29.22*±0.00 | 27.22*±0.00 | 25.42*±0.01 | 21.17*±0.01 | 26.10*±0.00 |
| | 0.4 | 27.15*±0.01 | 25.13*±0.01 | 23.16*±0.01 | 19.24*±0.01 | 24.60*±0.00 |
| **Garlic** | 0.1 | 38.25*±0.01 | 36.52*±0.00 | 31.56*±0.33 | 28.24*±0.01 | 31.41*±0.00 |
| | 0.2 | 35.42*±0.00 | 35.23*±0.01 | 29.12*±0.00 | 27.34*±0.01 | 30.27*±0.00 |
| | 0.3 | 32.18*±0.01 | 31.42*±0.01 | 27.15*±0.01 | 23.13*±0.01 | 28.86*±0.00 |
| | 0.4 | 29.22*±0.00 | 29.22*±0.00 | 25.18*±0.01 | 21.42*±0.01 | 27.38*±0.00 |
| **Onion** | 0.1 | 39.34*±0.01 | 37.23*±0.01 | 35.34*±0.01 | 31.14*±0.01 | 32.79*±0.00 |
| | 0.2 | 37.24*±0.00 | 36.34*±0.01 | 33.24*±0.00 | 29.22*±0.00 | 31.50*±0.00 |
| | 0.3 | 33.13*±0.00 | 31.42*±0.01 | 31.18*±0.01 | 27.34*±0.01 | 30.27*±0.00 |
| | 0.4 | 32.24*±0.00 | 29.17*±0.04 | 29.24*±0.01 | 23.43*±0.01 | 28.76*±0.00 |
| **S.E(d)** | - | **0.01** | **0.02** | **0.11** | **0.01** | **0.01** |
| **C.D(0.05)** | - | **0.02** | **0.03** | **0.23** | **0.02** | **0.01** |

***** Significant at 5% Level of significance as compared with control

**Table 8. Effect of botanicals at various ratios on adult mortality infested by pulse beetle *Callosobruchus chinensis* L. on 15th day.**

| Adult mortality % | | | | | | |
|---|---|---|---|---|---|---|
| **Treatments** | **Doses %** | **Chickpea** | **Kidney bean** | **Lentil** | **Soybean** | **Pigeon pea** |
| **Control** | - | 21.41±0.63 | 24.86±0.08 | 26.83±0.05 | 28.22±0.06 | 31.24±0.01 |
| **Neem** | 0.1 | 57.36*±0.00 | 49.16*±0.01 | 53.24*±0.00 | 49.26*±0.01 | 46.22*±0.00 |
| | 0.2 | 61.35*±0.00 | 57.24*±0.00 | 56.42*±0.00 | 54.21*±0.01 | 51.18*±0.01 |
| | 0.3 | 77.24*±0.02 | 61.32*±0.00 | 58.18*±0.01 | 56.12*±0.01 | 53.24*±0.00 |
| | 0.4 | 81.23*±0.00 | 77.24*±0.02 | 75.24*±0.02 | 71.23*±0.00 | 68.34*±0.01 |
| **Mint** | 0.1 | 55.52*±0.00 | 45.28*±0.01 | 51.12*±0.01 | 45.34*±0.01 | 39.26*±0.01 |
| | 0.2 | 57.42*±0.00 | 53.23*±0.01 | 53.23*±0.01 | 47.25*±0.01 | 44.18*±0.01 |
| | 0.3 | 73.24*±0.02 | 55.16*±0.02 | 55.21*±0.01 | 54.35*±0.00 | 51.15*±0.01 |
| | 0.4 | 75.13*±0.02 | 75.32*±0.01 | 73.26*±0.00 | 68.13*±0.01 | 65.23*±0.00 |
| **Garlic** | 0.1 | 53.22*±0.00 | 51.13*±0.00 | 48.25*±0.01 | 45.22*±0.00 | 41.24*±0.00 |
| | 0.2 | 55.21*±0.01 | 53.33*±0.00 | 51.23*±0.01 | 48.21*±0.01 | 43.21*±0.01 |
| | 0.3 | 67.17*±0.00 | 63.23*±0.01 | 58.46*±0.00 | 55.16*±0.01 | 45.18*±0.01 |
| | 0.4 | 72.23*±0.00 | 65.16*±0.02 | 62.25*±0.01 | 58.33*±0.00 | 55.22*±0.00 |
| **Onion** | 0.1 | 48.25*±0.01 | 45.16*±0.01 | 45.13*±0.00 | 41.21*±0.01 | 38.44*±0.01 |
| | 0.2 | 52.15*±0.01 | 48.23*±0.01 | 48.28*±0.01 | 45.25*±0.01 | 41.22*±0.00 |
| | 0.3 | 65.23*±0.00 | 62.21*±0.01 | 56.42*±0.00 | 53.52*±0.00 | 43.19*±0.02 |
| | 0.4 | 68.26*±0.00 | 65.15*±0.01 | 59.24*±0.00 | 56.34*±0.02 | 52.23*±0.01 |
| **S.E(d)** | - | **0.22** | **0.03** | **0.02** | **0.02** | **0.01** |
| **C.D(0.05)** | - | **0.44** | **0.06** | **0.04** | **0.05** | **0.02** |

***** Significant at 5% Level of significance as compared with control

## Conclusion

Due to the severe infestation of the pest, seed losses increases and seeds become unfit for the consumption or for the use in any other purposes. Thus, it is important to control the infestation of the pest. According to the current investigation's findings, Neem leaf powder @0.4%, a botanical treatment, was found to be very effective at killing pulse beetles on different pulses which has been used for the experiment. Farmers can use this cost-effective and environmentally friendly pest

management strategy with Neem leaf powder as a low-risk option that offers promising results and minimal health risks. The study's findings thus demonstrated that the locally accessible treatments provided good defence against the pest.

**Declaration**

Conflict of interest: Authors declare no conflict of interest.

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