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## EVALUATION OF ECO-FRIENDLY MANAGEMENT STRATEGIES AGAINST *CALLOSOBRUCHUS CHINENSIS* L. INFESTING STORED BENGAL GRAM (*CICER ARIETINUM* L.)

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### ABSTRACT

Bengal gram (*Cicer arietinum* L.), a key *Rabi* pulse crop in India, ranks third globally in pulse production after soybean (*Glycine max* L.) and pea (*Pisum sativum*). India is the leading producer, contributing the majority share. During the year 2022–23, a study was carried out at the laboratory of AICRP on Nematodes at the Directorate of Research, Kalyani and the Department of Entomology, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur, Nadia, West Bengal, to evaluate the efficacy of different eco-friendly management approaches against *Callosobruchus chinensis* L. in stored Bengal Gram. The assessment focused on parameters including the effect of seed protectants on the percentage of seed damage, on the percentage of seed moisture content, on the percentage of seed germination, and on weight loss. Among the treatments, neem oil @ 5 ml kg<sup>-1</sup> seed was found significantly superior to the others, followed by mustard oil @ 5 ml kg<sup>-1</sup> seed and citronella oil @ 5 ml kg<sup>-1</sup> seed, effective against pulse beetle. All the applied treatments proved more effective than the untreated control.

**Key words :** Bengal gram, *Callosobruchus*, Stored pulses, *Cicer arietinum*, Eco-friendly management.

### Introduction

Bengal gram (*Cicer arietinum* L.) is a vital legume crop cultivated during the *Rabi* season in India. Globally, it holds the third position among pulse crops in terms of production, following soybean (*Glycine max* L.) and pea (*Pisum sativum*). With an annual global output exceeding 11.5 million tonnes, India remains the largest producer, accounting for the majority of this total production (Merga and Haji, 2019).

India is the leading producer of chickpeas, representing over 63% of the total global cultivation area (Anonymous, 2007). Bengal gram was cultivated on 10.91 million hectares in India in 2021–2022, yielding 13.75 million tonnes of total production and a productivity rate of 1260 kg/ha (Anonymous, 2022). West Bengal reported a cultivation area of 36.10 thousand hectares, producing 47.42 thousand tonnes with a slightly higher productivity

of 1310 kg/ha. The districts of Murshidabad, Birbhum, and Nadia are the primary contributors to Bengal gram production within the state (Anonymous, 2019).

Pulse production in India is hindered by inadequate storage facilities and high susceptibility of pulses to insect pests due to their rich protein content. Around 200 insect species are known to damage stored grains, with the pulse beetle (*Callosobruchus chinensis* Linn.) being the most destructive, particularly to chickpea, both in the field and during storage (Other major pests include the Khapra beetle (*Trogoderma granarium* Everts) and the Lesser grain borer (*Rhizopertha dominica* Fab.) Rathore and Sharma, 2002).

Several strategies have been explored for the management of *Callosobruchus chinensis*, including the deployment of larval parasitoids, thermal treatments, and microwave irradiation. The efficacy of synthetic

insecticides is limited due to the internal feeding behavior of the pest and associated risks of chemical residues in consumables. Although fumigation in hermetically sealed storage is effective, its application is impractical at the household level, where on-farm storage of pulses predominates.

There is a need to explore alternative approaches for controlling *C. chinensis* that are cost-effective, environmentally friendly, safe for human health, and highly effective (Regmi and Dhoj, 2011; Park *et al.*, 2003; Islam *et al.*, 2013; Khan *et al.*, 2013; Haile, 2015). The present investigation was undertaken under controlled laboratory conditions to assess the bioefficacy of eco-friendly seed protectants against *Callosobruchus chinensis* (pulse beetle) infesting *Cicer arietinum* L. (chickpea).

### Materials and Methods

This experiment conducted in Completely Randomized Design with twelve treatments and three replications by using Bengal gram against pulse beetle (*Callosobruchus chinensis*) during the year 2022-23 at laboratory of AICRP on Nematodes at the Directorate of Research, Kalyani and Department of Entomology, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur, Nadia, West Bengal under storage conditions. Gunny bags of 1 kg capacity are used for packing material. The treatment details are as given below as T<sub>1</sub> Neem oil @ 5 ml/ kg seed, T<sub>2</sub> Coconut oil @ 5 ml/ kg seed, T<sub>3</sub> Castor oil @ 5 ml/ kg seed, T<sub>4</sub> Mustard oil @ 5 ml/ kg seed, T<sub>5</sub> Citronella oil 5 ml/ kg seed, T<sub>6</sub> Neem leaf powder @ 5 g/kg seed, T<sub>7</sub> Karanj leaf powder @ 5 g/kg seed, T<sub>8</sub> Black pepper powder @ 5 g/kg seed, T<sub>9</sub> Marigold leaf powder @ 5 g/kg seed, T<sub>10</sub> Custard apple leaf powder @ 5 g/kg seed, T<sub>11</sub> Deltamethrin (2.8EC) 0.04ml/kg seed, and T<sub>12</sub> untreated control etc.

#### Preparation of leaf and seed powder

Neem, custard apple and marigold leaves that had been fully matured were plucked from the plant, washed, and grind after drying in the shade. These ground leaves were sieved through a 20-mesh filter to produce the fine powder. The black pepper seeds were washed and ground after being bought from local market. In order to produce the fine powder, it was sieved using 20 mesh.

#### Collection of other materials

The local market was the source for other materials, which included deltamethrin, neem oil, coconut oil, castor oil, mustard oil and citronella oil.

#### Methodology

The experiment was carried out in three replications with CRD. Bengal gram seeds of 500g for every

treatment and replication were mixed with seed protectants. Three pairs of newly emerged pulse beetle, *C. chinensis* were released in each gunnybag. The mouths of the bags were tightened with the help of thread. The bags were kept on wooden racks at storage conditions in the laboratory. Percentage of seed moisture, percentage of seed infestation, percentage of seed germination, percentage of weight loss and meteorological parameters were recorded after 3 and 6 months of storage.

#### Method of observation

The necessary quantity of seeds was randomly selected from the bag of each replication of each treatment in order to record the experimental observations.

#### Per cent seed damage

Using a magnifying lens (10x), 100 seeds were carefully selected at random from every sample of every replication to separate unhealthy and healthy seeds. They were employed in the calculation of the damaged seed percentage. The following formula was used to determine the percentage of seed damaged described by Singh *et al.* (2017a).

$$\text{Seed damage (\%)} = \frac{\text{Total number of damaged seeds}}{\text{Total number of seeds}} \times 100$$

#### Percent seed weight loss

A random sample of one hundred seeds was collected from each replication of a different treatment in order to calculate the weight loss percentage. A 10x magnifying lens was used to separate the damaged seeds. Singh *et al.* (2017a) used the following calculation to determine the percentage of weight loss.

$$\text{Percent seed weight loss} = \frac{I-F}{I} \times 100$$

Where,

I = Initial seeds weight, F = Final seeds weight

#### Seed germination

Per cent seed germination was computed by the prior mentioned formula.

#### Seed moisture content

An electronic moisture meter was used to record the moisture content of each replication of Bengal gram seeds.

#### Statistical analysis

A completely randomized design (CRD) with three replications under storage conditions was used for all of

the experiments. After the required transformation, statistical analysis was performed on the data obtained from several experiments.

## Results and Discussion

### Effect of seed protectants on the percentage of seed damage

The results obtained in respect to per cent seed damage by pulse beetle (Table 1) after 3, 6 months of storage after treatments under Neem oil, Coconut oil, Castor oil, Mustard oil, Citronella oil, Neem leaf powder, Karanj leaf powder, Black pepper powder, Marigold leaf powder, Custard apple leaf powder, Deltamethrin (2.8EC) (Check) etc. Grain damage and weight loss were lowest among the seed protectants in the seed treatment with Neem oil @ 5 ml kg<sup>-1</sup> seed (3.00 and 1.28%) followed by Mustard oil @ 5 ml kg<sup>-1</sup> seed (4.33 and 2.22%), Citronella oil @ 5 ml kg<sup>-1</sup> seed (4.67 and 2.87%), and Black pepper powder @ 5 g kg<sup>-1</sup> seed (48.00 and 10.43%). Maximum grain damage and weight loss were found in Karanj leaf powder @ 5 g kg<sup>-1</sup> seed (89.00 and 27.83%) followed by Neem leaf powder @ 5 g kg<sup>-1</sup> seed (81.00 and 24.02%), as opposed to Deltamethrin 2.8 EC @ 0.04 ml kg<sup>-1</sup> seed (Check) with 0.33 and 0.17 per cent. The present results

were in concurrence with earlier workers of Sharma *et al.* (2022) and Nishad *et al.* (2020) where they reported neem oil as a superior protectant against pulse beetle up to nine months. Similarly, Ramya *et al.* (2017) also found that neem oil gave the best protection against the damage amongst tested oils. These findings were also corroborated by Phadtare *et al.* (2023), who reported that neem oil + APSA80 was most effective in controlling weight loss and seed damage caused by *C. chinensis* up to 270 days of storage followed by neem oil sole. Kumari *et al.* (2022) found neem oil and neem leaf powder were most effective against pulse beetle on mung bean. Similar studies against *C. chinensis* in pulse storage have also been reported by Kumar *et al.* (2017), Khinchi *et al.* (2017) and Reddy *et al.* (1999), Singh *et al.* (2017) and Bajiya (2009), who reported that when seeds were treated with neem kernel powder against *C. chinensis*, there was a significant decrease in grain damage and weight loss.

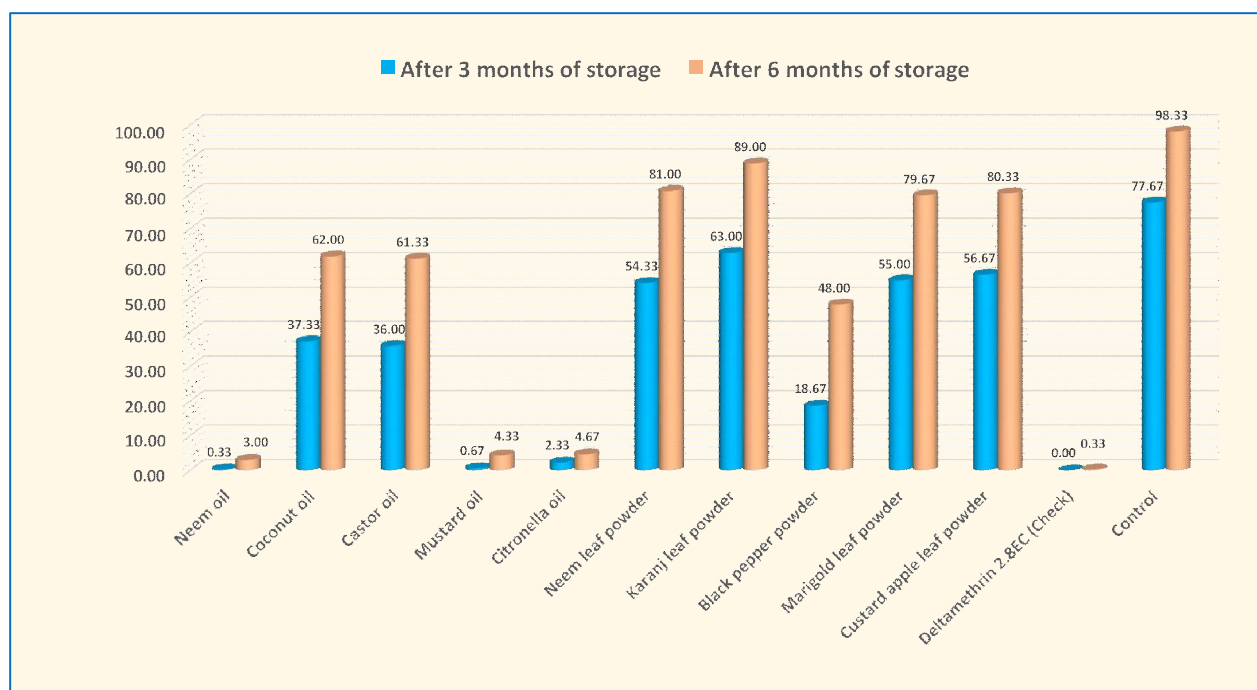
### Effect of seed protectants on the percentage of seed moisture content

The results showed that the most successful preventive measure for maintaining low moisture content

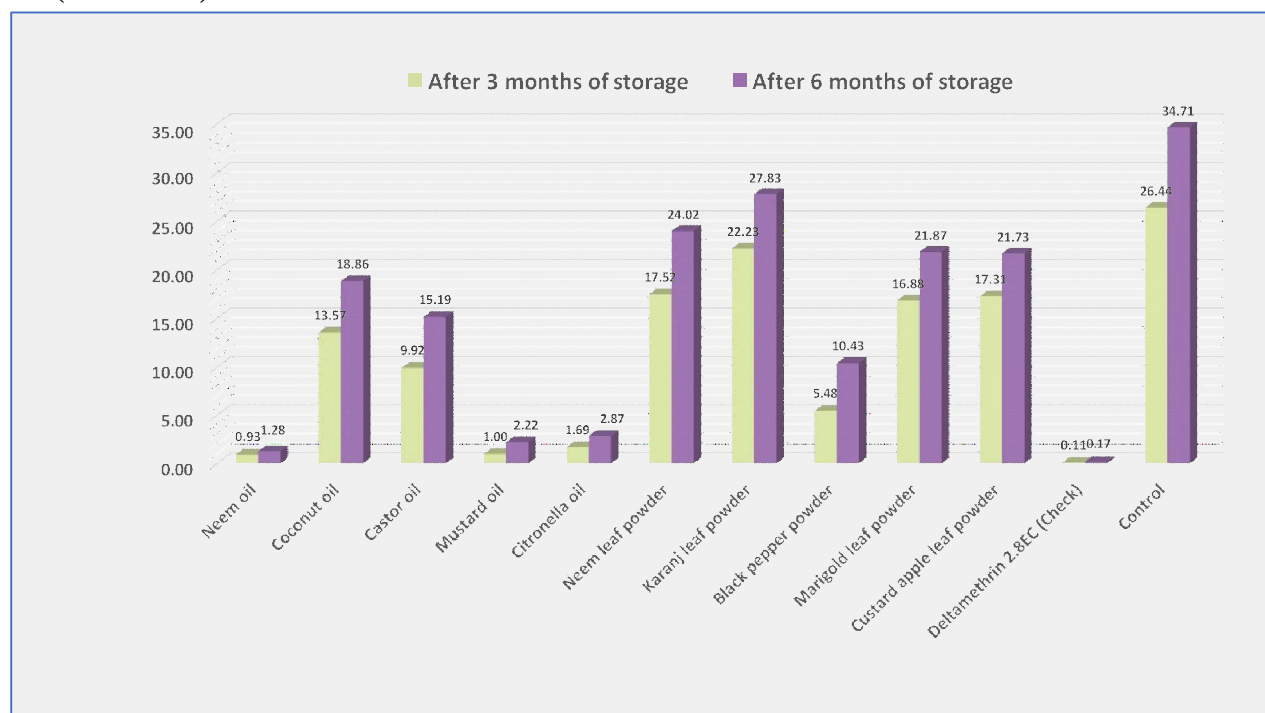
**Table 1 :** Effect of seed protectants on percent weight loss by pulse beetle, *C. chinensis* in Bengal gram during 2022 and 2023.

| Treatments      | Seed protectant<br>(Botanical/<br>Insecticide) | Dose<br>(Kg <sup>-1</sup><br>seeds) | Percent mean seed weight loss |              |                |                           |              |                |
|-----------------|------------------------------------------------|-------------------------------------|-------------------------------|--------------|----------------|---------------------------|--------------|----------------|
|                 |                                                |                                     | After 3 months of storage     |              |                | After 6 months of storage |              |                |
|                 |                                                |                                     | 2022                          | 2023         | Pooled<br>mean | 2022                      | 2023         | Pooled<br>mean |
| T <sub>1</sub>  | Neem oil                                       | 5ml                                 | 0.78(4.12)                    | 1.09(5.96)   | 0.93           | 1.22(6.24)                | 1.33(6.48)   | 1.28           |
| T <sub>2</sub>  | Coconut oil                                    | 5ml                                 | 13.38(21.44)                  | 13.76(21.77) | 13.57          | 18.78(25.68)              | 18.93(25.79) | 18.86          |
| T <sub>3</sub>  | Castor oil                                     | 5ml                                 | 9.63(18.00)                   | 10.20(18.61) | 9.92           | 14.63(22.43)              | 15.74(23.34) | 15.19          |
| T <sub>4</sub>  | Mustard oil                                    | 5ml                                 | 0.89(5.39)                    | 1.11(5.98)   | 1.00           | 2.00(8.05)                | 2.44(8.98)   | 2.22           |
| T <sub>5</sub>  | Citronella oil                                 | 5ml                                 | 1.31(6.52)                    | 2.07(8.12)   | 1.69           | 2.76(9.35)                | 2.98(9.77)   | 2.87           |
| T <sub>6</sub>  | Neem leaf powder                               | 5 g                                 | 16.93(24.27)                  | 18.11(25.11) | 17.52          | 23.93(29.12)              | 24.11(29.25) | 24.02          |
| T <sub>7</sub>  | Karanj leaf powder                             | 5 g                                 | 21.60(27.68)                  | 22.87(28.56) | 22.23          | 27.69(31.73)              | 27.98(31.92) | 27.83          |
| T <sub>8</sub>  | Black pepper powder                            | 5 g                                 | 5.14(12.91)                   | 5.81(13.56)  | 5.48           | 10.26(18.50)              | 10.61(18.86) | 10.43          |
| T <sub>9</sub>  | Marigold leaf powder                           | 5 g                                 | 16.78(24.13)                  | 16.98(24.32) | 16.88          | 21.33(27.49)              | 22.40(28.22) | 21.87          |
| T <sub>10</sub> | Custard apple leaf<br>powder                   | 5 g                                 | 17.39(24.64)                  | 17.22(24.50) | 17.31          | 21.83(27.84)              | 21.63(27.70) | 21.73          |
| T <sub>11</sub> | Deltamethrin (2.8EC)<br>(Check)                | 0.04ml                              | 0.07(0.85)                    | 0.16(1.31)   | 0.11           | 0.13(1.21)                | 0.20(1.48)   | 0.17           |
| T <sub>12</sub> | Control                                        | -                                   | 26.29(30.84)                  | 26.60(31.04) | 26.44          | 34.49(35.96)              | 34.93(36.23) | 34.71          |
| SEm±            |                                                | -                                   | 1.08                          | 1.10         | 1.09           | 1.34                      | 1.32         | 1.33           |
| CD at 5%        |                                                | -                                   | 3.16                          | 3.21         | 3.19           | 3.92                      | 3.84         | 3.88           |

\*The figures given in parentheses are angular transformed values.



**Fig. 1 :** Effect of seed protectants on percent seed damage by pulse beetle, *C.chinensis* in Bengal gram during 2022 and 2023 (Pooled mean).



**Fig. 2 :** Effect of seed protectants on percent weight loss by pulse beetle, *C. chinensis* in Bengal gram during 2022 and 2023 (Pooled mean).

during periods of storage was using environmentally friendly seed protectants. After six months of storage, the mean seed moisture content varied between 12.08 and 13.08 percent. In comparison to the untreated control (13.08%), the treatment using neem oil and deltamethrin 2.8 EC (12.08%) had the lowest mean seed moisture content, followed by mustard oil (12.25%) and the

treatment with Karanj leaf powder (13.00%) had the highest mean seed moisture content, followed by neem leaf powder (12.92%) and custard apple leaf powder (12.83%). The seed moisture content was influenced by the type of seed protectant used and the duration of the storage times. The results of Nishad (2020) are consistent with our findings. He reported that the most effective

**Table 2 :** Effect of seed protectants on percent seed damage by pulse beetle, *C. chinensis* in Bengal gram during 2022 and 2023.

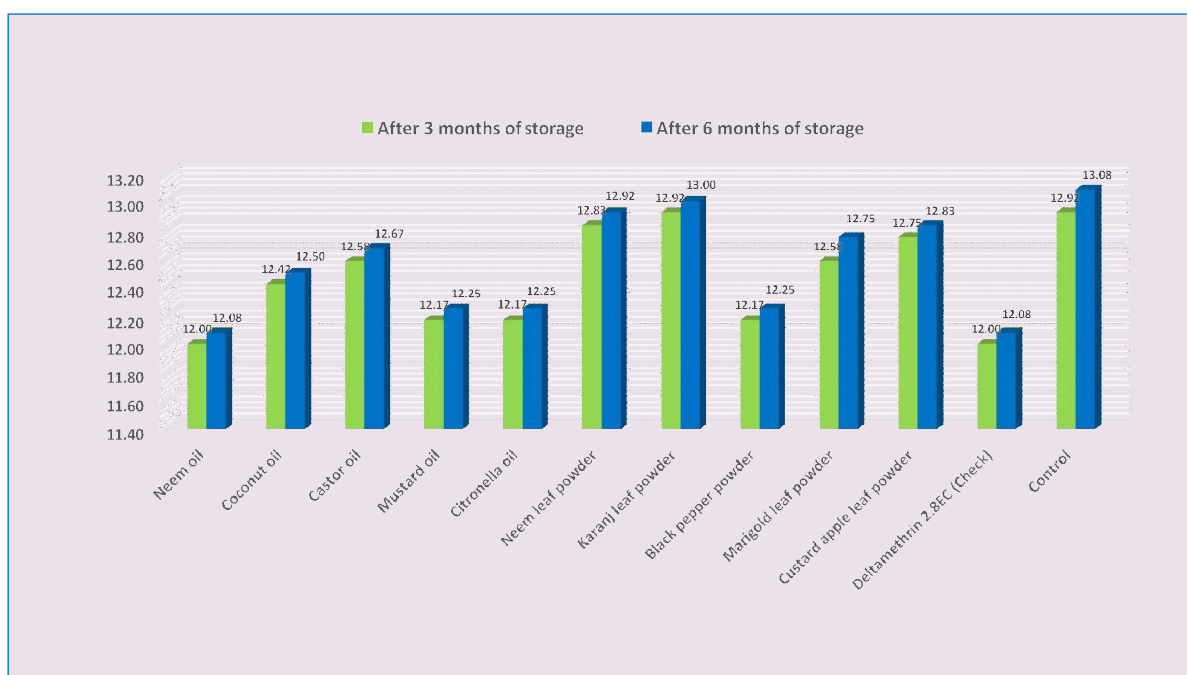
| Treatments      | Seed protectant<br>(Botanical/<br>Insecticide) | Dose<br>(Kg <sup>-1</sup><br>seeds) | Percent mean seed damage  |              |                |                           |               |                |
|-----------------|------------------------------------------------|-------------------------------------|---------------------------|--------------|----------------|---------------------------|---------------|----------------|
|                 |                                                |                                     | After 3 months of storage |              |                | After 6 months of storage |               |                |
|                 |                                                |                                     | 2022                      | 2023         | Pooled<br>mean | 2022                      | 2023          | Pooled<br>mean |
| T <sub>1</sub>  | Neem oil                                       | 5 ml                                | 0.00(0.00)                | 0.67(2.71)   | 0.33           | 2.67(9.27)                | 3.33(10.40)   | 3.00           |
| T <sub>2</sub>  | Coconut oil                                    | 5 ml                                | 38.67(38.43)              | 36.00(36.87) | 37.33          | 61.33(51.56)              | 62.67 (52.35) | 62.00          |
| T <sub>3</sub>  | Castor oil                                     | 5 ml                                | 37.33(37.65)              | 34.67(36.06) | 36.00          | 60.67(51.19)              | 62.00 (51.98) | 61.33          |
| T <sub>4</sub>  | Mustard oil                                    | 5 ml                                | 0.67(2.71)                | 0.67(2.71)   | 0.67           | 4.00(11.28)               | 4.67(12.16)   | 4.33           |
| T <sub>5</sub>  | Citronella oil                                 | 5 ml                                | 2.00(8.13)                | 2.67(9.27)   | 2.33           | 4.67(12.42)               | 4.67(12.42)   | 4.67           |
| T <sub>6</sub>  | Neem leaf powder                               | 5 g                                 | 48.67(44.23)              | 60.00(50.78) | 54.33          | 80.00(63.51)              | 82.00(65.07)  | 81.00          |
| T <sub>7</sub>  | Karanj leaf powder                             | 5 g                                 | 58.67(50.00)              | 67.33(55.16) | 63.00          | 88.67(70.44)              | 89.33(71.01)  | 89.00          |
| T <sub>8</sub>  | Black pepper powder                            | 5 g                                 | 20.67(27.00)              | 16.67(24.04) | 18.67          | 48.67(44.23)              | 47.33(43.47)  | 48.00          |
| T <sub>9</sub>  | Marigold leaf powder                           | 5 g                                 | 56.00(48.45)              | 54.00(47.31) | 55.00          | 79.33(63.04)              | 80.00(63.45)  | 79.67          |
| T <sub>10</sub> | Custard apple leaf<br>powder                   | 5 g                                 | 56.00(48.46)              | 57.33(49.23) | 56.67          | 80.00(63.60)              | 80.67(64.09)  | 80.33          |
| T <sub>11</sub> | Deltamethrin (2.8EC)<br>(Check)                | 0.04 ml                             | 0.00(0.00)                | 0.00(0.00)   | 0.00           | 0.67(2.71)                | 0.00(0.00)    | 0.33           |
| T <sub>12</sub> | Control                                        | -                                   | 77.33(61.71)              | 78.00(62.04) | 77.67          | 98.00(83.44)              | 98.67(84.58)  | 98.33          |
| SEm±            |                                                | -                                   | 1.55                      | 1.56         | 1.56           | 2.10                      | 1.76          | 1.93           |
| CD at 5%        |                                                | -                                   | 4.51                      | 4.57         | 4.54           | 6.12                      | 5.14          | 5.63           |

\*The figures given in parentheses are angular transformed values.

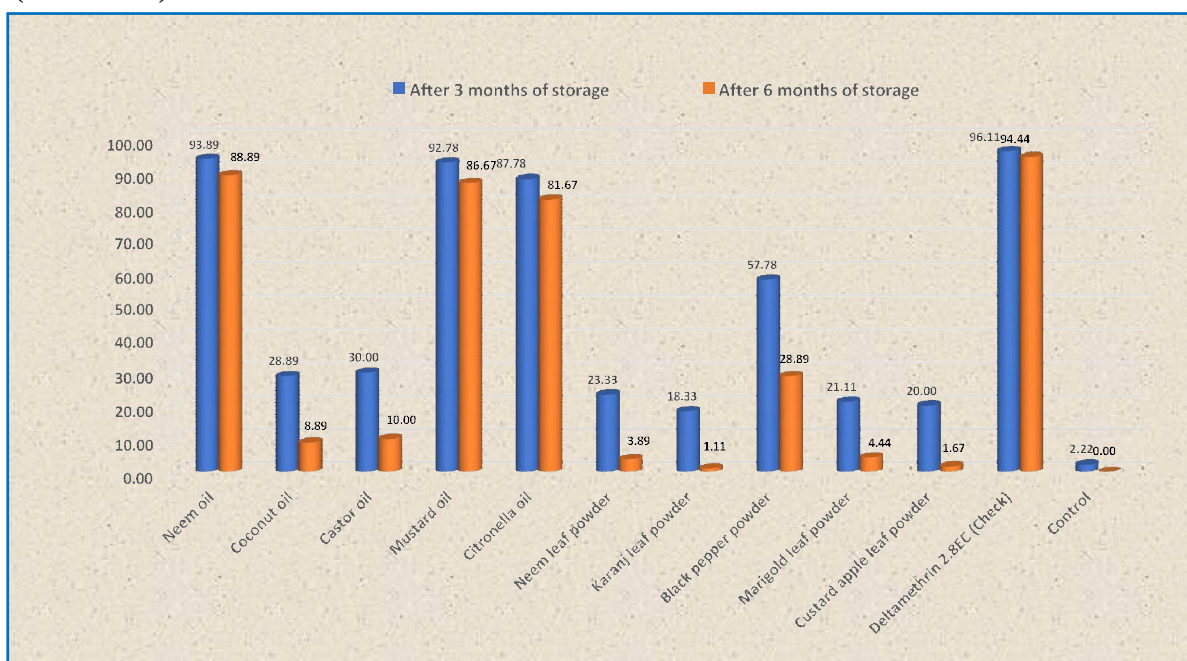
**Table 3 :** Effect of seed protectants on percent seed moisture of Bengal gram under storage condition during 2022 and 2023.

| Treatments      | Seed protectant<br>(Botanical/<br>Insecticide) | Dose<br>(Kg <sup>-1</sup><br>seeds) | Percent mean seed moisture content |              |                |                           |              |                |
|-----------------|------------------------------------------------|-------------------------------------|------------------------------------|--------------|----------------|---------------------------|--------------|----------------|
|                 |                                                |                                     | After 3 months of storage          |              |                | After 6 months of storage |              |                |
|                 |                                                |                                     | 2022                               | 2023         | Pooled<br>mean | 2022                      | 2023         | Pooled<br>mean |
| T <sub>1</sub>  | Neem oil                                       | 5 ml                                | 12.00(20.27)                       | 12.00(20.27) | 12.00          | 12.00(20.27)              | 12.17(20.41) | 12.08          |
| T <sub>2</sub>  | Coconut oil                                    | 5 ml                                | 12.67(20.85)                       | 12.17(20.41) | 12.42          | 12.67(20.85)              | 12.33(20.56) | 12.50          |
| T <sub>3</sub>  | Castor oil                                     | 5 ml                                | 12.50(20.70)                       | 12.67(20.85) | 12.58          | 12.67(20.85)              | 12.67(20.85) | 12.67          |
| T <sub>4</sub>  | Mustard oil                                    | 5 ml                                | 12.17(20.41)                       | 12.17(20.41) | 12.17          | 12.33(20.56)              | 12.17(20.41) | 12.25          |
| T <sub>5</sub>  | Citronella oil                                 | 5 ml                                | 12.17(20.41)                       | 12.17(20.41) | 12.17          | 12.33(20.56)              | 12.17(20.41) | 12.25          |
| T <sub>6</sub>  | Neem leaf powder                               | 5 g                                 | 12.83(20.99)                       | 12.83(20.99) | 12.83          | 12.83(20.99)              | 13.00(21.13) | 12.92          |
| T <sub>7</sub>  | Karanj leaf powder                             | 5 g                                 | 12.83(20.99)                       | 13.00(21.13) | 12.92          | 13.00(21.13)              | 13.00(21.13) | 13.00          |
| T <sub>8</sub>  | Black pepper powder                            | 5 g                                 | 12.17(20.41)                       | 12.17(20.41) | 12.17          | 12.33(20.56)              | 12.17(20.41) | 12.25          |
| T <sub>9</sub>  | Marigold leaf powder                           | 5 g                                 | 12.50(20.70)                       | 12.67(20.85) | 12.58          | 12.67(20.85)              | 12.83(20.99) | 12.75          |
| T <sub>10</sub> | Custard apple leaf<br>powder                   | 5 g                                 | 12.67(20.85)                       | 12.83(20.99) | 12.75          | 12.67(20.85)              | 13.00(21.13) | 12.83          |
| T <sub>11</sub> | Deltamethrin (2.8EC)<br>(Check)                | 0.04 ml                             | 12.00(20.27)                       | 12.00(20.27) | 12.00          | 12.00(20.27)              | 12.17(20.41) | 12.08          |
| T <sub>12</sub> | Control                                        |                                     | 12.83(20.99)                       | 13.00(21.13) | 12.92          | 13.00(21.13)              | 13.17(21.28) | 13.08          |
| SEm±            |                                                | 0.14                                | 0.14                               | 0.14         | 0.12           | 0.13                      | 0.13         |                |
| CD at 5%        |                                                | 0.340                               | 0.40                               | 0.40         | 0.34           | 0.37                      | 0.36         |                |

\*The figures given in parentheses are angular transformed value.



**Fig. 3 :** Effect of seed protectants on percent seed moisture of Bengal gram under storage condition during 2022 and 2023 (Pooled mean).



**Fig. 4 :** Effect of seed protectants on percent seed germination of Bengal gram under storage condition during 2022 and 2023 (Pooled mean).

seed protectant was Neem oil, followed by Mustard oil. Neem oil had a high germination percentage and could maintain the IMSCS level for up to six months of chickpea storage, while also increasing seed moisture as the storage period increased. Majhi (2023) also reported similar findings during storage periods, Ubairah *et al.* (2014) observed an increase in the moisture percentage of chickpea seed. Seed moisture content and appropriate storage may have an impact on grain quality according

to Tabatabaei (2013) and Azadi and Younesi (2013). The impact of moisture on chickpea seed quality during storage was examined by Basavegowda and Hosamani in 2013. More or less similar work has also been reported by Pal and Katiyar (2013) and Nishad *et al.* (2017). A considerable difference in seed moisture content per cent was found among seed protectants.

**Table 4 :** Effect of seed protectants on percent seed germination of Bengal gram under storage condition during 2022 and 2023.

| Treatments      | Seed protectant<br>(Botanical/<br>Insecticide) | Dose<br>(Kg <sup>-1</sup><br>seeds) | Percent mean seed germination |                |                |                           |                |                |
|-----------------|------------------------------------------------|-------------------------------------|-------------------------------|----------------|----------------|---------------------------|----------------|----------------|
|                 |                                                |                                     | After 3 months of storage     |                |                | After 6 months of storage |                |                |
|                 |                                                |                                     | 2022                          | 2023           | Pooled<br>mean | 2022                      | 2023           | Pooled<br>mean |
| T <sub>1</sub>  | Neem oil                                       | 5 ml                                | 94.44(76.52)                  | 93.33(75.36)   | 93.89          | 90.00(71.73)              | 87.78(69.58)   | 88.89          |
| T <sub>2</sub>  | Coconut oil                                    | 5 ml                                | 31.11(33.90)                  | 26.67(31.06)   | 28.89          | 11.11(19.27)              | 6.67(14.96)    | 8.89           |
| T <sub>3</sub>  | Castor oil                                     | 5 ml                                | 32.22(34.54)                  | 27.78(31.80)   | 30.00          | 12.22(20.42)              | 7.78(16.12)    | 10.00          |
| T <sub>4</sub>  | Mustard oil                                    | 5 ml                                | 93.33(75.36)                  | 92.22(75.04)   | 92.78          | 88.89(70.57)              | 84.44(66.80)   | 86.67          |
| T <sub>5</sub>  | Citronella oil                                 | 5 ml                                | 87.78(69.58)                  | 87.78(69.58)   | 87.78          | 83.33(65.97)              | 80.00(63.49)   | 81.67          |
| T <sub>6</sub>  | Neem leaf powder                               | 5 g                                 | 23.33(28.85)                  | 23.33(28.85)   | 23.33          | 4.44(12.00)               | 3.33(8.49)     | 3.89           |
| T <sub>7</sub>  | Karanj leaf powder                             | 5 g                                 | 17.78(24.80)                  | 18.89(25.69)   | 18.33          | 1.11(3.51)                | 1.11(3.51)     | 1.11           |
| T <sub>8</sub>  | Blackpepper powder                             | 5 g                                 | 58.89(50.22)                  | 56.67(48.84)   | 57.78          | 27.78(31.77)              | 30.00(33.19)   | 28.89          |
| T <sub>9</sub>  | Marigold leaf powder                           | 5 g                                 | 22.22(28.07)                  | 20.00(26.51)   | 21.11          | 5.56(13.48)               | 3.33(8.49)     | 4.44           |
| T <sub>10</sub> | Custard apple leaf<br>powder                   | 5 g                                 | 21.11(27.25)                  | 18.89(25.74)   | 20.00          | 2.22(7.01)                | 1.11(3.51)     | 1.67           |
| T <sub>11</sub> | Deltamethrin (2.8EC)<br>(Check)                | 0.04 ml                             | 96.67(79.48)                  | 95.56(78.00)   | 96.11          | 94.44(76.52)              | 94.44(76.84)   | 94.44          |
| T <sub>12</sub> | Control                                        | -                                   | 2.22<br>(7.01)                | 2.22<br>(7.01) | 2.22           | 0.00<br>(0.00)            | 0.00<br>(0.00) | 0.00           |
| SEm±            |                                                | -                                   | 2.10                          | 1.64           | 1.87           | 2.14                      | 2.54           | 2.34           |
| CD at 5%        |                                                | -                                   | 6.14                          | 4.78           | 5.46           | 6.24                      | 7.41           | 6.83           |

\*The figures given in parentheses are angular transformed values

### Effect of seed protectants on the percentage of seed germination

Up to six months of storage, all of the seed protectants performed noticeably better in germination than the control. As the storage period increased, the germination level decreased in all treatments. At 6 months of storage, the mean highest seed germination was observed in Neem oil (88.89%) followed by Mustard oil (86.67%), Citronella oil (81.67%) and Black pepper powder (28.89%), whereas lowest germination was found in Karanj leaf powder (1.11%) followed by Custard apple leaf powder (1.67%) and Neem leaf powder (3.89%) as compared to Deltamethrin 2.8 EC (Check) with 94.44%. Neem oil was shown to be superior among all seed protectant treatments. The current results are in analogous with findings of Nishad *et al.* (2020) and Ramya *et al.* (2017). Similarly, Phadtare *et al.* (2023) reported that the seeds treated with neem oil+ APSA 80 maintained seed germination percent above IMSC standard level up to 9 months storage followed by seed treatment with neem oil. Majhi (2023), Raghvani and Kapadia (2003), Lal and Raj (2012), Singh *et al.* (2014) in pigeon pea and Babu *et al.* (2008) in soyabean corroborated these findings.

### Conclusion

Among eco-friendly seed protectants, neem oil and mustard oil at 5 ml/kg seed can be effectively used against *Callosobruchus chinensis* for long-term storage (up to 6 months). These plant-based protectants not only help maintain seed germination above IMSCS standards with minimal insect damage and weight loss, but also offer a sustainable, eco-friendly, and safer option for humans and the environment—ensuring effective management of pulse beetles (bruchids) in chickpea.

### Author contributions

**Niranjan Mandi:** Investigation, Methodology, Validation, **Pritipriya Pal:** Conceptualization, Data Curation, Formal Analysis, Writing – Original Draft, **Shanowly Mondal (Ghosh):** Supervision, Project Administration, Writing – Review & Editing, **Gautam Chakraborty:** Methodolgy finalization, Supervision, **Shantanu Bista:** Resources, Software, Visualization

### Declaration

We confirm that our submitted manuscript is original work not published before in any form. The final paper

has been reviewed and approved for submission by all stated authors, and this work is not available for publishing anywhere else. The authors state they have no conflicts of interest, financial or otherwise, that might influence how these findings are interpreted or presented.

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### References

- Anonymous (2007). *Chickpea* (Internet). International Crop Research Institute for the Semi Arid Tropics (ICRISAT). Available from [www.icrisat.org](http://www.icrisat.org), Accessed 2007 Feb. 17.
- Anonymous (2019). *Crop Production Statistics 2019-20*. Agriculture Informatics Division, National Informatics Centre, Ministry of communication & IT, Govt. of India.
- Anonymous (2022). *Agricultural Statistics at a Glance 2022*. Ministry of Agri. & FW (DAC&FW), Economics & Statistics Division, Govt. of India. Pp. 40-43.
- Azadi, M.S. and Younesi E. (2013). The effects of storage on germination characteristics and enzyme activity of sorghum seeds. *J. Stress Physiol. Biochem.*, **9(4)**, 289-298.
- Babu, H.M.M. and Ravi H. (2008). Effect of seed treatment on biology of *Callosobruchus maculatus* F. *Indian J. Entomol.*, **74(3)**, 261-266.
- Bajjiya, R.S. (2009). Bio-ecology and Management of Pulse Beetle, *Callosobruchus chinensis* (Linn.) on Mungbean, *Vigna radiata* (Linn.) Wilczek, *Ph.D. Thesis* submitted to Department of Agricultural Zoology and Entomology, S.K.N. College of Agriculture, Jobner, Rajasthan.
- Basavegowda, G.S. and Hosamani A.K. (2013). Effect of commercial cold storage conditions and packaging materials on seed quality of chickpea (*Cicer arietinum* L.). *Global J. Sci. Front. Res. Agricult. Vet. Sci.*, **13(2)**, 23-28.
- Haile, A. (2015). Eco-friendly management of chickpea storage pest, *Callosobruchus chinensis* L. (Coleoptera; Bruchidae) under laboratory conditions in Eritrea. *J. Stored Prod. & Postharvest Res.*, **6(8)**, 66-71.
- Islam, M.S., Haque M.A., Ahmed K.S., Mondal M.F. and Dash C.K. (2013). Evaluation of some spices powder as grain protectant against pulse beetle, *Callosobruchus chinensis* (L.). *Universal J. Plant Sci.*, **1**, 132-136.
- Khan, F.Z.A., Sagheer M., Saeed S., Ali K., Gul H.T., Bukhari S.A. and Manzoor S.A. (2013). Toxicological and repellent potential of some plant extracts against stored product insect pest, *Tribolium castaneum* (Herbst.) (Coleoptera: Tenebrionidae). *Int. J. Biosci.*, **3**, 280-286.
- Khinchi, S.K., Sharma M.M., Khinchi M.K., Bairwa D.K., Acharya D., Naga B.L. and Naga R.P. (2017). Studies on efficacy of certain vegetable oils against pulse beetle, *Callosobruchus chinensis* Linn. using botanicals on mung bean. *Int. J. Chem. Stud.*, **5(3)**, 255-259.
- Kumar, L., Chakravarty S., Agnihotri M. and Karnatak A.K. (2017). Efficacy of some plant oils against pulse beetle, *Callosobruchus chinensis* (L.) infesting green gram under storage conditions. *Research on Crops*, **18(1)**, 157-163.
- Kumari, S., Yadav S.S., Rolania K. and Dhanda S. (2022). Effect of seed protectants against pulse beetle, *Callosobruchus chinensis* infesting mung bean. *Indian J. Entomol.*, **84(1)**, 176-177
- Lal, D. and Raj D.V. (2012). Efficacy of application of four vegetable oils as grain protectant against the growth and development of *Callosobruchus maculatus* and on its damage. *Adv. Biores.*, **3(2)**, 55-59
- Majhi, S. (2023). Studies on the susceptibility of different pulses infested by pulse beetle, *Callosobruchus chinensis* L. and its botanical management on red gram. *M.Sc. thesis* submitted to Dept. of Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, WB, India.
- Merga, B. and Haji J. (2019). Economic importance of chickpea: production, value and world trade, *Cogent Food & Agriculture*, **5**, 1. DOI: 10.1080/23311932.2019.1615718
- Nishad, R.N., Singh R.B., Kumar S. and Yadav S.K. (2020). Eco-friendly management of pulse beetle, *Callosobruchus chinensis* Linn. of stored chickpea seed. *Int. J. Chem. Stud.*, **8(3)**, 05-08
- Nishad, R.N., Singh R.B., Singh A.K., Singh S.P. and Yadav S.K. (2017). Effect of various indigenous botanical seed protectants on seed quality parameters of chickpea seed during ambient storage. *J. Pharmacog. Phytochem.*, **SP1**, 423-426.
- Pal, R.K. and Katiyar R.A. (2013). Bioefficacy of promising botanicals against pulse beetle, *Callosobruchus chinensis* L. infesting stored seed of moong bean. *Int. J. Plant Prot.*, **6(2)**, 489-491.
- Park, I.K., Lee S.G., Choi D.H., Par J.D. and Ahn Y.J. (2003). Insecticidal activities of constituents identified in the essential oil from leaves of *Chamaecyparis obtuse* against *Callosobruchus chinensis* (L.) and *Sitophilus oryzae* (L.). *J. Stored Prod. Res.*, **39**, 375-384.
- Phadtare, P.R., Chaudhari C.S., Aghav S.T., Kadam U.K., Chavan T.R. and Patil M.R. (2023). Management of pulse beetle (*Callosobruchus chinensis* L.) in chickpea using biorational products. *The Pharma Innov. J.*, **12(1)**, 2768-2770.
- Raghvani, B.R. and Kapadia M.N. (2003). Efficacy of different vegetable oils as seed protectants of pigeon pea against *Callosobruchus maculatus* (Fab.). *Indian J. Plant Prot.*, **31(1)**, 115-118.
- Ramya, H.R., Sathish K., Manjarika S.B. and Hazarika L. (2017). Effect of botanicals on growth and development of *Callosobruchus chinensis* (Coleoptera: Bruchidae) and its damage. *Trends Biosci.*, **10(22)**, 4269-4276.

- Rathore, Y.S. and Sharma V. (2002). Management of bruchid infestation in pulses. Indian Institute of pulse Research, Kanpur, U.P., India. Pp-136.
- Reddy, M.U., Bharati S.R. and Reddy D.D.R. (1999). Efficacy of some vegetable oils as protectants against the pulse beetle (*Callosobruchus chinensis*) in green gram (*Phaseolus aureus*) during storage. *Indian J. Nutr. Dietetics*, **36** (10), 436-442.
- Regmi, H. and Dhoj Y. (2011). Eco-friendly management of pulse beetle. *J. Agric. Environ.*, **12**, 81-90.
- Sharma, M., Choudhary S., Naga B.L., Sharma S.L. and Choudhary M.D. (2022). Evaluation of certain botanicals against pulse beetle, *Callosobruchus chinensis* (L.) on cowpea. *The Pharma Innov. J.*, **11**(5), 839-843.
- Singh, C.B., Katiyar M., Pal R.K., Singh S.K. and Singh A. (2014). Relative efficacy of neem based insecticides on seed viability and quality of pigeon pea (*Cajanus cajan* L.) during storage. *Trends Biosci.*, **7**(16), 2322-2326.
- Singh, R., Singh G., Sachan S.K., Singh D.V., Singh R. and Mishra P. (2017). Biology of pulse beetle, *Callosobruchus chinensis* (L) in stored chickpea under laboratory condition. *Bull. Env., Pharmacol. Life Sci.*, **6**(8), 106-108.
- Singh, R., Singh G., Sachan S.K., Singh D.V., Singh R. and Mishra P. (2017a). Assessment of losses due to pulse beetle in chickpea under laboratory condition. *J. Plant Develop. Sci.*, **9**(6), 623-625.
- Singh, R.B., Nishad R.N. and Singh R.P. (2017b). Relative efficacy of botanicals against pulse beetle (*Callosobruchus chinensis* L.) infestation in chickpea during storage. *Bull. Env., Pharmacol. Life Sci.*, **6**(1), 333-336.
- Tabatabaei, S.A. (2013). The effects of storage on germination characteristics of barley seeds. *Int. J. Agron. Plant Prod.*, **4**(12), 3337- 3343.
- Ubairah, Majid A., Akhtar K., Khan A., Zaheer S., Faisal S., Zahoor and Ullah R. (2014). Effect of water activity and storage time on the proximate composition of two chickpea cultivars. *Europ. J. Biol. Med. Sci. Res.*, **2**(2), 25- 36.