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Incidence and Storage-related Infestation of *Callosobruchus chinensis* (L.) in Stored Bengal Gram: Insights from Major Growing Districts of West Bengal, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Field surveys were conducted in the year 2021–22 to assess the infestation of the pulse beetle, *Callosobruchus chinensis* L., in farmer-stored Bengal gram seeds across Birbhum and Murshidabad districts of West Bengal. Five blocks from each district were selected, with five farmers surveyed per block, totaling 100 seed samples. Parameters assessed included moisture content, seed damage, and storage methods. Average moisture content and seed damage were 11.86% and 3.66% in Birbhum and 12.09% and 3.69% in Murshidabad. Rampurhat-II (Birbhum) and Suti-I (Murshidabad) showed the highest moisture and seed damage, while Suri-II (Birbhum) and Raghunathganj-I (Murshidabad) recorded the lowest. Infestation was strongly correlated with moisture: only 12.5% of samples with less than 10% moisture were infested, rising to 100% in those with more than 13%. Plastic bags (40%) were the most used storage method, followed by drums, metal bins, gunny bags, loose storage, and earthen pots. Metal bins had the lowest infestation (11.11%), while earthen pots had the highest (100%). No storage structure was entirely pest-free, underscoring the urgent need for improved post-harvest storage practices.

Keywords: Bengal gram; Callosobruchus chinensis L.; post-harvest losses; storage practices.

1. INTRODUCTION

Bengal gram (*Cicer arietinum* L.), also known as chickpea, is a major legume crop extensively cultivated during the Rabi season in India. It plays a crucial role in sustainable agriculture due to its ability to fix atmospheric nitrogen and its adaptability to semi-arid regions. Globally, chickpea ranks third among pulse crops in terms of production, after soybean (*Glycine max* L.) and pea (*Pisum sativum*). With an annual global production exceeding 11.5 million tonnes (Merga & Haji, 2019), it contributes significantly to the dietary protein intake of millions, particularly in developing countries. India stands as the leading producer, contributing the majority of the world's chickpea production due to favorable agro-climatic conditions and large cultivation areas. Apart from being a vital source of plant-based protein, Bengal gram is rich in dietary fiber, vitamins (such as folate and vitamin B6), and essential minerals like iron, phosphorus, and magnesium, making it a highly nutritious food for both rural and urban populations.

In West Bengal, chickpea is cultivated over an area of approximately 26,177 hectares, yielding a total production of 30,844 metric tonnes. Among the districts, Nadia leads in terms of cultivation area, accounting for 9,906 hectares, followed by Birbhum with 6,781 hectares and Murshidabad with 5,462 hectares. In terms of productivity, Birbhum district ranks highest in the state, with an average yield of 1,390 kg per hectare (Roy *et al.,* 2018).

Several challenges hinder the achievement of higher pulse production, with post-harvest losses being a significant concern. In the absence of control measures, postharvest loss of grains due to insects can be 20–80% within a few months after harvest (Muleta *et al*., 2021). A major issue faced by farmers is the lack of proper storage facilities, which, combined with the high susceptibility of pulses to insect pests, leads to substantial grain damage. Due to their rich protein content, pulses are particularly vulnerable to pest attacks during storage. Regardless of storage and grain type, the conventional storage systems adopted by the farmers could not effectively protect grains against storage losses caused by insect pests (Taddese *et al*.,2020). In India, approximately 200 insect pest species are known to damage stored grains and their products. Among the most common pests affecting stored pulses are the pulse beetle (*Callosobruchus chinensis* Linn.), the Khapra beetle (*Trogoderma granarium* Everts), and the Lesser grain borer (*Rhizopertha dominica* Fab.). Of these, the pulse beetle is considered the most destructive, as it infests chickpeas both in the field and during storage (Rathore & Sharma, 2002).

Insect infestation remains a critical constraint in post-harvest grain storage, particularly in rural and humid-tropical regions of developing countries, where inadequate storage infrastructure and poor hygiene prevail. Accurate quantification of storage losses at the village level is challenging due to inconsistent methodologies and limited empirical data. Among storage pests, *Callosobruchus chinensis* (pulse beetle) poses a significant threat, with damage levels varying by host type and locality. As a result, information about the percentage of grain

damage caused by the pulse beetle in various locations is required.

Hence, in the present research, we aimed to assess the infestation level of the pulse beetle, *Callosobruchus chinensis* L., by conducting a survey in the primary Bengal gram-growing districts of West Bengal.

2. MATERIALS AND METHODS

2.1 Methodology

The surveys were carried out in the year 2021-22 in five selected blocks of major growing districts, viz., Birbhum and Murshidabad. In each block, five farmers were selected randomly. The moisture content, per cent infestation in Bengal gram seed and type of storage practices and protective measures were recorded. The moisture contents of grains were recorded with the help of moisture meter.

2.2 Sampling Technique

Study on insect damage intensity in Bengal gram under storage condition was conducted by observing the number of damaged seeds in the seed samples procured from farmers of different locations as well as from open markets of major growing districts. The sample size was 100 gm. These samples were collected just before the sowing time, placed in polythene bags, sealed and brought to the laboratory for further studies.

The following data were recorded.

i) Percent infestation
ii) Moisture content
iii) Types of storage practice used by the farmers

2.3 Method of Observations

Percent infestation: 100 grains from each sample were taken out randomly, damaged grains were separated and counted. The per cent damaged grains due to insect infestation was recorded by following formula (Singh *et al*. 2017a).

Grain damage (%) =

$$\frac{Total\ number\ of\ damaged\ grains}{Total\ number\ of\ grains} \times 100$$

Moisture content: The moisture level of each sample was determined with use of digital moisture meter as per the procedure given in the manual of the equipment.

Type of storage structure: The type of storage structures used by the farmers were recorded.

3. RESULTS AND DISCUSSION

The survey was carried out in five selected blocks of Birbhum district *viz*., Nalhati-I, Nalhati-II, Murarai-II, Rampurhat-II, Suri-II and Murshidabad district *viz*., Beldanga-II, Bharatpur-II, Raghunathganj-I, Raghunathganj-II and Suti-I. In each block, five farmers were selected randomly. The moisture content, percent infestation of seeds and type of storage practices were noted. The samples sealed in polythene bag weretaken to the laboratory for analysis. A digital moisture meter was used to determine the moisture content. For every sample, the percentage of seeds infested was recorded. The following are the survey results that were obtained:

Keeping above in view, (Tables 1 and 2) the overall average performance of seed samples collected from different blocks of two districts *i.e*., Birbhum and Murshidabad was observed. In Birbhum district, twenty-five samples of farmer's stored Bengal gram seed in each year were collected from five blocks *i.e.*, Nalhati-I, Nalhati-II, Murarai-II, Rampurhat-II and Suri-II (Table 1). Among the total collected samples of both years, the mean seed moisture content of 11.86 percent and mean seed damage of 3.66 percent of Bengal gram seed samples was observed. The maximum mean seed moisture content (12.62%) and seed damage (7.86%) was recorded in the samples of Rampurhat-II block and minimum mean seed moisture content (10.95%) and seed damage (0.71%) in samples of the Suri-II block.

In Murshidabad district, twenty-five samples of farmer's stored bengal gram seed in each year were collected from five blocks *i.e*., Beldanga-II, Bharatpur-II, Raghunathganj-I, Raghunathganj-II and Suti-I. The data presented in Table 2 revealed that, the mean seed moisture content 12.09 percent was observed. The maximum seed moisture content (12.24%) was recorded in the samples of Suti-I block and minimum seed moisture content(11.86%) in samples of the Raghunathganj-I block. The mean seed damage recorded was 3.69 percent. However, the maximum mean seed damage (7.57%) was recorded in samples of Suti-I block and the minimum mean seed damage (2.00%) in sample of the Raghunathganj-I block, respectively.

Table 1. Seed moisture content (%) and seed damage (%) in the samples collected from different blocks of Birbhum districts at farmers level during 2022 and 2023

S. No.	Name of block	No. of sample collected		Seed moisture content (%)			Seed damage (%)		
		2022	2023	2022	2023	Mean (Range)	2022	2023	Mean (Range)
1.	Nalhati-I	5	5	11.17	11.84	12.21	0.00	0.00	3.00
				12.46	12.70	(11.0-13.54)	0.00	1.43	(0-15.71)
				11.42	11.00		0.00	0.00	
				13.14	13.54		12.86	15.71	
				12.18	12.60		0.00	0.00	
2.	Nalhati-II	5	5	11.92	11.44	11.55	0.00	0.00	0.86
				9.30	9.96	(9.30- 12.72)	0.00	1.43	(0-4.29)
				12.42	12.00		1.43	0.00	
				11.80	11.40		0.00	0.00	
				12.50	12.72		2.86	4.29	
3.	Murarai-II	5	5	10.10	9.82	11.99	0.00	0.00	5.86
				12.64	12.90	(9.82-13.50)	2.86	5.71	(0-25.71)
				11.20	11.70		0.00	0.00	
				12.30	12.50		1.43	4.29	
				13.50	13.20		25.71	18.57	
4.	Rampurhat-II	5	5	12.40	12.90	12.62	2.86	5.71	7.86
				13.16	13.00	(11.50-13.40)	17.14	12.86	(0-21.43)
				13.08	13.40		21.43	14.29	
				12.20	12.62		1.43	2.86	
				11.90	11.50		0.00	0.00	
5.	Suri-II	5	5	10.40	10.72	10.95	0.00	0.00	0.71
				9.50	9.80	(9.50- 12.60)	0.00	0.00	(0-2.86)
				10.50	10.90		0.00	0.00	
				12.22	12.60		2.86	2.86	
				11.40	11.50		0.00	1.43	
Total/ Mean		25	25	11.79	11.93	11.86	3.71	3.66	3.66

Percentage of infestation at different moisture levels of the collected samples: With regard to moisture content, out of 100 samples collected from 5 blocks each of Birbhum and Murshidabad district of West Bengal. 8 samples having moisture content up to 10 percent, 77 samples having 10.10 to 13.00 percent, while 15 samples having moisture content more than 13.00 percent (Table 3).

Out of 8 samples (moisture content up to 10.00 percent), only one sample (12.50%) was found infested with insect pulse beetle. In the samples having moisture content between 10.10 to 13.00 percent, 34 samples (44.16%) were infested out of 77 samples collected during survey while in 15 samples having moisture content more than13.00 percent all the samples were found infested (100.00%).

Type of storage practices and receptacles: The prevalent storage practices and receptacles/ structures were observed at the spot and details regarding storage structure, location, grain stored etc. were recorded from five blocks each of both districts of Birbhum and Murshidabad. The names of the blocks surveyed were presented in Table 5. The storage practices and storage receptacles/ structures commonly observed in both districts were plastic bag (40.00%), drum (21.00%), gunny bags and metal bins (18.00%), loose (2.00%) and earthen pot (1.00%) (Table 4).

The most commonly used storage practices for Bengal gram grains were plastic bag storage. Out of 10 blocks surveyed 40 farmers (40.00%) were found to use plastic bag storage from total users. The next common receptacle for storage of Bengal gram grains was drum (21.00%) made up of galvanized iron sheet or plastic fiber, capacity from 50 kg to 2 q grains. Out of 100 users 18 users (18.00%) were found to use metal bins and in gunny bag (capacity 50 kg to 1 q) and

loose were recorded from 2 (2.00%) farmers, respectively. Loose storage of grains was found in surveyed Rampurhat-II block of Birbhum district and Suti-I block in Murshidabad district. The earthen pots of different shape, size and capacity (varies from 5 to 20 kg) are also used by farmers (1.00%) in the surveyed Rampurhat-II block of Birbhum district.

Table-2. Seed moisture content (%) and seed damage (%) in the samples collected from different blocks of Murshidabad districts at farmers level during 2022 and 2023

S. No	Name of block	No. of sample collected		Seed moisture content (%)			Seed damaged (%)		
		2022	2023	2022	2023	Mean	2022	2023	Mean
1.	Beldanga-II	5	5	11.17 12.62 10.78 12.90 13.12	12.42 12.50 11.92 10.72 13.02	12.12 (10.72-13.12)	0.00 2.86 0.00 0.00 11.43	1.43 1.43 0.00 0.00 14.29	3.14 (0-14.29)
2.	Bharatpur-II	5	5	12.28 13.08 12.00 11.17 12.84	11.98 13.12 12.38 10.46 12.66	12.20 (10.46-13.12)	1.43 12.86 1.43 0.00 2.86	0.00 10.00 1.43 0.00 2.86	3.29 (0-12.86)
3.	Raghunathganj- I	5	5	9.98 12.20 12.78 11.42 12.62	10.00 11.96 12.90 11.72 13.00	11.86 (9.98-13.00)	0.00 2.86 1.43 0.00 4.29	0.00 0.00 4.29 0.00 7.14	2.00 (0-7.14)
4.	Raghunathganj- II	5	5	10.60 12.13 13.24 12.72 11.36	11.00 12.00 12.96 12.46 11.92	12.04 (10.60-13.24)	0.00 0.00 11.43 2.86 0.00	0.00 0.00 7.14 2.86 0.00	2.43 (0-11.43)
5.	Suti-I	5	5	13.18 9.96 12.10 13.00 12.70	13.40 9.80 12.74 13.50 12.00	12.24 (9.80-13.50)	15.71 0.00 0.00 15.71 1.43	18.57 0.00 0.00 24.29 0.00	7.57 (0-24.29)
Total/ Mean		25	25	12.08	12.10	12.09	3.54	3.83	3.69

Table 3. Percentage of infestation at different moisture levels of the collected samples

S. No.	Particulars	Moisture content			
		Upto 10.00 %	10.10 to 13.00 %	More than 13.00 %	Total
1.	Sample collected	8	77	15	100
2.	Infested samples	1	34	15	50
3.	Percent sample infested(%)	12.50	44.16	100.00	50.00

Table 4. Different storage receptacles/ structures used in Birbhum and Murshidabad districts

S. No.	Storage receptacle/ structure	Number of users			Percent prevalence
		Birbhum district	Murshidabad district	Total	
1.	Gunny bags	10	8	18	18.00
2.	Plastic bags	19	21	40	40.00
3.	Metal bins	9	9	18	18.00
4.	Drum	10	11	21	21.00
5.	Loose	1	1	2	2.00
6.	Earthen pots	1	0	1	1.00

Table-5. Infestation (%) recorded in different storage structures used by farmers for Bengal gram in Birbhum and Murshidabad districts

Name of the district	Name of blocks	No.of samples stored in different storage structures/receptacles used by farmers						Infested (%)
		Gunny bags	Plastic bags	Metal bins	Drum	Loose	Earthen pot	
Birbhum	Nalhati-I	3 (2)*	2 (1)	2 (0)	3 (1)	0 (0)	0 (0)	40.00
	Nalhati-II	2 (1)	4 (1)	3 (1)	1 (0)	0 (0)	0 (0)	30.00
	Murarai-II	2 (2)	4 (2)	1 (0)	3 (2)	0 (0)	0 (0)	60.00
	Rampurhat-II	3 (2)	5 (3)	0 (0)	0 (0)	1 (1)	1 (1)	70.00
	Suri-II	0 (0)	4 (2)	3 (0)	3 (0)	0 (0)	0 (0)	20.00
Murshidabad	Beldanga-II	2 (1)	5 (2)	2 (0)	1 (0)	0 (0)	0 (0)	30.00
	Bharatpur-II	2 (1)	4 (1)	0 (0)	4 (2)	0 (0)	0 (0)	40.00
	Raghunathganj-I	0 (0)	4 (1)	4 (0)	2 (1)	0 (0)	0 (0)	20.00
	Raghunathganj-II	1 (0)	4 (1)	3 (1)	2 (1)	0 (0)	0 (0)	30.00
	Suti-I	3 (2)	4 (2)	0 (0)	2 (1)	1 (0)	0 (0)	50.00
Total samples		18	40	18	21	2	1	-
Infested sample		11	16	2	8	1	1	
Percent infested samples		61.11	40.00	11.11	38.09	50.00	100.00	-

**Figures in parentheses shows the number of samples infested by storage insects*

Percentage of infestation in different storage structures/receptacles: The data acquired on samples collected during survey revealed that none of the storage structure/ receptacles was found free from infestation. Minimum infestation was recorded in metal bin (11.11%) followed by drum (38.09%), plastic bag (40.00%), loose (50.00%), gunny bag (61.11%) and earthen pot (100%) (Table 5 & Fig. 1).

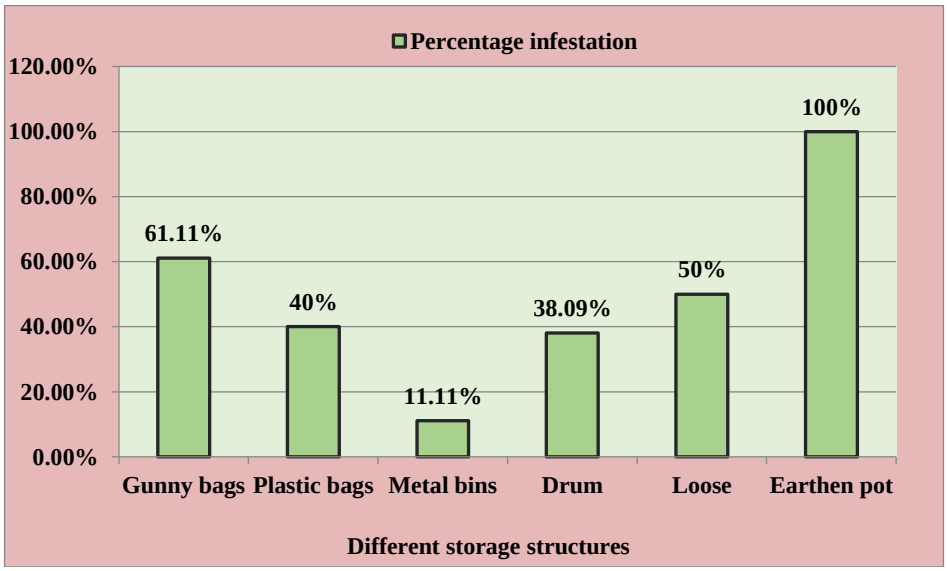

Fig. 1. Percentage of infestation of pulse beetle in different storage structures

In the present investigation survey was conducted in five blocks of the districts Birbhum and Murshidabad and the per cent infestation, moisture content and type of storage structures used by the farmers were recorded.

In Birbhum district, among the total collected samples, the average moisture content of seed (11.86%) and mean seed damage of 3.66% was observed. The maximum moisture content of seed (12.62%) and seed damage (7.86%) was observed in the samples of Rampurhat-II block and minimum moisture content of seed (10.95%) and seed damage (0.71%) in samples of the Suri-II block. In Murshidabad district, the average moisture content of seed and seed damage recorded was 12.09% and 3.69% respectively. The maximum moisture content of seed (12.24%) and damaged seed (7.57%) were recorded in the samples of Suti-I block. However, minimum seed moisture content (11.86%) and seed damaged (2.00%) were recorded in samples of the Raghunathganj-I block, respectively.

One hundred seed samples were collected from different blocks of two districts, out of 100 samples 8 samples having moisture content up to 10 per cent, 77 samples having 10.10 to 13.00 per cent and 15 samples having moisture content more than 13.00 per cent. Out of 8 samples (moisture content up to 10.00%), only 1 sample (12.50%)were found infested with insect pulse beetle. Among the samples having moisture content between 10.10 to 13.00%, 34 samples (44.16%) were infested out of 77 samples collected during survey while among 15 samples having moisture content more than 13.00%, all the samples were found infested (100.00%). These results were also similar to Hossain *et al.,* (2013), Kumar *et al*., (2015), Sharma *et al*., (2017) and Nishad *et al*., (2020).

The survey was conducted in five blocks of each of both districts of Birbhum and Murshidabad revealed that 40.00 percent farmers stored Bengal gram in plastic bag, 21.00 per cent stored in drum, 18.00 per cent in gunny bag and metal bin, 2.00 per cent in loose and 1.00 per cent farmers stored Bengal gram in mud pot and none of the storage structure/ receptacles was found free from infestation. Minimum infestation was recorded in metal bin (11.11%) followed by drum (38.09%), plastic bag (40.00%), loose (50.00%), gunny bag (61.11%) and earthen pot (100%). Gupta (1990) also found that bulk storage (76%) was more popular for pulse storage in Rajasthan than bag storage (24%), which is mostly in line with the current findings. Gupta (1990) also reported bulk storage (76%) was more popular for pulse storage in Rajasthan as compared to bag storage (24%) which is in partially conformity with the present findings. The present survey data is in conformity with observation of Bhargava and Choudhary (2007) and many other workers Bajiya (2009), Kumar *et al*. (2015) and Rolania *et al*. (2021). Singh and Sharma (2003) found that infestation was highest when stored loose in the room, moderate in gunny and jute bags, and lowest in metal containers, which partially supports the current findings.

4. CONCLUSION

The study shows that the moisture content of the grain plays an important role in the infestation of stored Bengal gram.It was found that the extent of infestation increased gradually and significantly with an increase in the level of seed moisture content. It was found that of farmers used plastic bag followed by drum, metal bin, gunny bag, loose and earthen pot to store the Bengal gram grains. Among different storage structures, minimum infestation was observed in metal bin followed by drum, plastic bag, gunny bag, loose and earthen pot. None of the storage structure/ receptacles was found free from infestation. Farmers are strongly advised to dry Bengal gram seeds properly before storage to maintain moisture level below 10% and to use safer storage structures,like metal bins, to minimize losses. Wider adoption of these practices can significantly reduce post-harvest losses, enhance seed quality, and improve food security in pulse-growing areas.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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