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Host preference of pulse beetle, *Callosobruchus chinensis* on different pulses

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Abstract
The host preference of the pulse beetle, *Callosobruchus chinensis*, on seven different pulses *viz*, chickpea, kabuli chana, pigeon pea, green gram, cowpea, black gram and soybean was investigated in the laboratory at the Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, during 2022 and 2023 under storage conditions. The results indicated that chickpea and green gram were the most preferred hosts, in respect to the total developmental periods (29.17 and 28.17 days), percentage of adult emergence (85.56% and 83.33%), fecundity (77.00 and 77.83 eggs), ovipositional periods (6.61 and 6.06 days), percentage of seed damage (92.00% and 91.33%) and weight loss (49.29% and 48.49%), respectively. There was no development occurred in soybean due to the failure of grub emergence from the eggs. Based on the percentage of grain damage and weight loss, the order of host preference by *Callosobruchus chinensis* was: Chickpea > Green gram > Cowpea > Kabuli chana > Pigeon pea > Black gram.

Keywords: Pulses, *Callosobruchus chinensis*, host preference, fecundity, Developmental period and adult emergence

Introduction
Pulses have played a significant role in enhancing the agricultural economy of several countries (Sarwar *et al.*, 2003; Deeba *et al.*, 2006) [19, 8]. Pulses are considered as one of the most important sources of plant-based protein and form a vital component of the daily diet in many developing countries, including India. Pulses are considered poor man's meat because they contain 20-30% protein (Sharma, 1984; Rahman *et al.*, 2010) [21, 16]. India is one of the largest producers of pulses globally. As per recent estimates, the total area under pulse cultivation in India was 31.03 million hectares, with a production of 27.69 million tonnes and an average yield of 892 kg per hectare (Anonymous, 2022) [4]. In India, different pulses are grown, such as chickpea (gram or Bengal gram), green gram (mung bean), black gram (urd bean), lentil (masur), pigeon pea (tur or arhar) and pea.

Achieving higher pulse production faces several obstacles, among which post-harvest losses due to inadequate storage facilities and pest infestations are significant. In India, approximately 200 species of insect pests are known to damage stored grains and grain products. Among these, the pulse beetle (*Callosobruchus chinensis* Linn.), Khapra beetle (*Trogoderma granarium* Everts), and lesser grain borer (*Rhizopertha dominica* Fab.) are key pests affecting stored pulses. Pulses are commonly stored for up to one year, during which they are highly susceptible to infestation by bruchid beetles (Raina, 1970). Among these, the pulse beetle (*Callosobruchus chinensis* L.), belonging to the family Chrysomelidae, order Coleoptera, is the most destructive pest of stored legumes due to its broad legume host range and widespread distribution (Yanagi *et al.*, 2013) [27]. Post-harvest losses caused by bruchid beetles in various pulses are estimated to range from 30% to 40% within six months of storage, with losses potentially reaching up to 100% if left untreated (Akinkurolere *et al.*, 2006; Soumia *et al.*, 2017) [2, 25]. The development, population growth, and degree of infestation caused by the pulse beetle are influenced by the type of host available. However, limited research has focused on this critical aspect of food-insect interactions.

The present study was conducted to evaluate the suitability of various host pulses for the development of this pest, as well as to assess the extent of damage inflicted on different food types.

Materials and Methods

Laboratory experiments were conducted during 2022 and 2023 under the title "Host preference of pulse beetle, *Callosobruchus chinensis*, on different pulses". The study was carried out in the Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, and West Bengal.

Maintenance of stock culture

Healthy and uninfested green gram grains were used to establish and maintain a stock culture of the pulse beetle, *Callosobruchus chinensis*. The grains were sterilized at 60±5°C for eight hours to eliminate any visible or hidden insect infestations. Following sterilization, the grains were conditioned in an incubator at 27±2°C and 65±5% relative humidity for at least one week to restore optimal moisture content. Adult *C. chinensis* beetles were initially collected from a local storage go down and used for mass rearing. The adults were reared in 2.5-liter capacity plain glass jars containing preconditioned green gram grains. The jars were maintained at a controlled temperature of 27±2°C and 65±5% relative humidity. Freshly emerged adults from the stock culture were collected and used as the parental population for subsequent experimental studies.

Methodology

All host grains were used in whole form and sterilized in a hot air oven at 60±5°C for 8 hours to eliminate any concealed infestations. To enhance the initial moisture content, the grains were conditioned in an incubator at 27±2°C and 65±5% relative humidity for a minimum of one week prior to the experiment. Observations were recorded on the following parameters: ovipositional period, fecundity, developmental period (from egg to adult), percent adult emergence, percent grain damage and percent weight loss.

Ovipositional period and fecundity

To assess the ovipositional period and fecundity of *Callosobruchus chinensis*, one pair of newly emerged adults (male and female) was introduced into specimen tubes containing 30 grains of each host type per replication for oviposition. The experiment was conducted using a completely randomized design (CRD) with three replications for each host. The number of eggs laid on the grains was recorded daily until the death of the female in each replication.

Developmental period and percent adult emergence

To determine the total developmental period (egg to adult) and the percentage of adult emergence in various host grains, gravid females were allowed to oviposit on different test hosts. After oviposition, a random sample of 30 grains each bearing a single egg was collected and placed in individual specimen tubes for development. The mouths of the tubes were covered with muslin cloth and secured with rubber bands to ensure ventilation and containment. Each host treatment has three replication and all hosts were inoculated simultaneously to maintain experimental consistency. Starting from the day of first adult emergence, the number and date of emerged adults were recorded twice daily (morning and evening) to determine the total developmental period and calculate the percentage of adult emergence.

Percent grain damage and weight loss

To assess grain damage and weight loss after 90 days of storage, 50 grams of seeds from each host were placed in 250-gram capacity transparent plastic containers in each replication. The experiment was evaluated in CRD with three replications per host. Two pairs of freshly emerged *Callosobruchus chinensis* adults were introduced into each container. After 90 days, the number of damaged grains and the final seed weight were recorded. The percentage of grain damage and weight loss were calculated using the following formulas.

Grain damage

The damaged grains in each replication were individually sorted and counted to calculate the percentage of grain damage. The formula described by Singh *et al.* (2017) [26] was used for this calculation.

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

Weight Loss

After removing the pulse beetles from the samples, the final weight of the grains in each treatment was measured using a single-pan electronic balance. The percentage of weight loss was calculated using the formula provided by Singh *et al.* (2017) [26].

$$\text{Per cent weight loss} = \frac{I-F}{I} \times 100$$

Where,
I= Initial weight of grains
F= Final weight of grains

Statistical analysis

All experiments were conducted under storage conditions using a Completely Randomized Design (CRD) with three replications. The data obtained from the various experiments were subjected to statistical analysis after applying the necessary transformations.

Results and Discussion

The total developmental period, ovipositional period, fecundity, percentage of adult emergence, grain damage, and weight loss were the key parameters considered in evaluating the host preference of the pulse beetle, *Callosobruchus chinensis*.

Developmental period in days

The pooled mean number of days required for the development of *Callosobruchus chinensis* from egg to adult stage ranged from 28.17 to 33.17 days and differed significantly across the various host grains during both years of the study. Among the tested hosts, excluding soybean, the shortest developmental period was recorded on green gram (28.17 days), which was significantly lower than on other hosts. No development occurred on soybean, as no grub emergence from eggs was observed. The longest developmental duration was noted on pigeon pea, with a mean of 33.17 days. The pooled mean developmental periods recorded on chickpea, cowpea, kabuli chana and black gram were 29.17, 29.83, 31.33, and 33.00 days, respectively (Table 1 & Figure 1).

These findings are in agreement with those reported by several researchers. Nishad RN (2020) [15], Sharma *et al.* (2023) [23], Kumar *et al*. (2001) [13], and Bhargava *et al.* (2008) [6] all observed that green gram and chickpea were among the most preferred hosts for the development of *C. chinensis*. The observations are further supported by Falke *et al*. (2021) [9], who also reported no development of pulse beetles on soybean and the longest developmental period on pigeon pea. Similarly, Hosamani *et al.* (2018) [11] also found that the developmental duration of *C. chinensis* was highest on pigeon pea compared to other host pulses.

Adult emergence (%)

The pooled mean percentage of adult emergence from different host grains (excluding soybean) ranged from 16.11% to 85.56% during 2022 and 2023. The highest adult emergence was recorded in chickpea (85.56%), which was statistically at par with green gram (83.33%). The lowest emergence was observed in black gram (16.11%), which differed significantly from all other hosts. Mean adult emergence rates of 77.78%, 73.89%, and 48.89% were recorded on cowpea, Kabuli Chana and pigeon pea, respectively (Table 1 & Figure 1).

These findings are in agreement with the studies conducted by Jaiswal *et al*. (2019) [12] and Sekender *et al.* (2020) [20], who reported that the highest emergence of *C. chinensis* adults occurred in green gram and chickpea. Similarly, Nishad (2020) [15] and Kumar *et al.* (2001) [13] observed greater adult emergence from green gram followed by chickpea. The present results are further supported by Falke *et al.* (2021) [9], who reported maximum adult emergence in green gram and no emergence from soybean seeds.

Ovipositional period in days

The oviposition period of the pulse beetle, *Callosobruchus chinensis*, varied among different host grains, ranging from 6.06 to 7.72 days over both years of study. The shortest egg-laying duration was observed on green gram (6.06 days), followed by cowpea (6.28 days), kabuli chana (6.50 days), chickpea (6.61 days), soybean (7.00 days) and black gram (7.33 days). The longest oviposition period was recorded on pigeon pea (7.72 days) (Table 1 & Figure 1). These results are nearly consistent with the findings of Meena *et al.* (2021) [14] and Sharma (1993) [22], who reported that kabuli chana had the shortest oviposition period, followed by chickpea and green gram.

Fecundity

The fecundity results presented in Table 1 and Fig. 1 indicate that the host grain had a significant impact on egg-laying by *Callosobruchus chinensis* during 2022 and 2023. The pooled average number of eggs laid across different hosts ranged from 38.67 to 77.83. The highest fecundity was recorded on green gram (77.83 eggs) followed by chickpea (77.00), pigeon pea (73.67), Kabuli Chana (73.33) and cowpea (69.17). The lowest number of eggs was observed on soybean (38.67). These findings are in strong agreement with the result of Nishad (2020) [15] who reported the maximum fecundity were observed on green gram and chickpea. Similar results were observed by Sekender *et al.* (2020) [20], who reported fecundity of 70.2 eggs on chickpea followed by 57.8 eggs on green gram.

Seed damage (%)

The findings of the present study (Table 1 and Fig. 2) revealed that insect infestation caused significant seed damage in various pulses except soybean after 90 days of storage during 2022 and 2023, with damage levels ranging from 30.67% to 92.00%. The lowest seed damage was recorded in black gram (30.67%) followed by pigeon pea (79.67%) and Kabuli Chana (87.33%). In contrast, the highest damage was observed in chickpea (92.00%) which was statistically at par with green gram (91.33%) and cowpea (89.67%). Notably, no seed damage was recorded in soybean. These findings are consistent with those reported by Jaiswal *et al*. (2019) [12], Ahmed *et al.* (2018) [1], Ghosal and Senapati (2007) [10] and Chaudhary and Pathak (1989) [7], who also observed maximum grain damage in chickpea followed by green gram and minimal damage in black gram.

Table 1: Developmental period (days), adult emergence (%), ovipositional period (days) fecundity (number) and Percentage of seed damage and weight loss by *C. chinensis* on various pulses after 90 days of storage

Hosts	Developmental period in days (egg to adult stage)*	Adult emergence (%)**	Ovipositional period (days)*	Fecundity	Seed damage (%)**	Weight loss (%)**
Chickpea	29.17 (5.50)	85.56 (67.75)	6.61 (2.76)	77.00 (8.83)	92.00 (73.74)	49.29 (44.58)
Kabuli chana	31.33 (5.69)	73.89 (59.33)	6.50 (2.74)	73.33 (8.62)	87.33 (69.23)	39.43 (38.88)
Pigeon pea	33.17 (5.85)	48.89 (44.34)	7.72 (2.95)	73.67 (8.64)	79.67 (63.22)	29.13 (32.65)
Green gram	28.17 (5.41)	83.33 (66.01)	6.06 (2.66)	77.83 (8.88)	91.33 (72.98)	48.49 (44.12)
Cowpea	29.83 (5.56)	77.78 (61.93)	6.28 (2.70)	69.17 (8.38)	89.67 (71.29)	44.91 (42.05)
Black gram	33.00 (5.83)	16.11 (23.61)	7.33 (2.89)	58.50 (7.71)	30.67 (33.56)	9.43 (17.86)
Soybean	0.00 (1.00)	0.00 (0.00)	7.00 (2.83)	38.67 (6.28)	0.00 (0.00)	0.00 (0.00)
SEm ±	0.04	1.50	0.04	0.13	1.44	1.04
CD at 5%	0.12	4.58	0.11	0.39	4.41	3.18

* The figures given in parentheses are square root transformed values.

** The figures given in parentheses are angular transformed values

Weight loss (%)

The mean percentage of weight loss due to *C. chinensis* infestation varied significantly among different host pulses (except soybean), ranging from 9.43% to 49.29% during 2022 and 2023 (Table 1 & Figure 2). The highest pooled mean weight loss was recorded in chickpea (49.29%), which was statistically at par with green gram (48.49%). In contrast, the lowest weight loss was observed in black gram (9.43%) followed by pigeon pea (29.13%), Kabuli Chana (39.43%) and cowpea (44.91%). These results suggest that chickpea and green gram were the most preferred hosts of *C. chinensis* in terms of feeding damage. The present findings align with those of Jaiswal *et al.* (2019) [12], who reported maximum weight loss in green gram and chickpea. Similarly, Ramesh Babu *et al.* (2021) [18] observed the highest weight loss in cowpea, green gram and chickpea. Comparable trends were also reported by Sharma *et al.* (2023) [23], Singh and Sharma (1981) [24] and Bhadauria and Jakhmola (2006) [5], who found green gram and cowpea to be among the most susceptible hosts based on total weight loss.

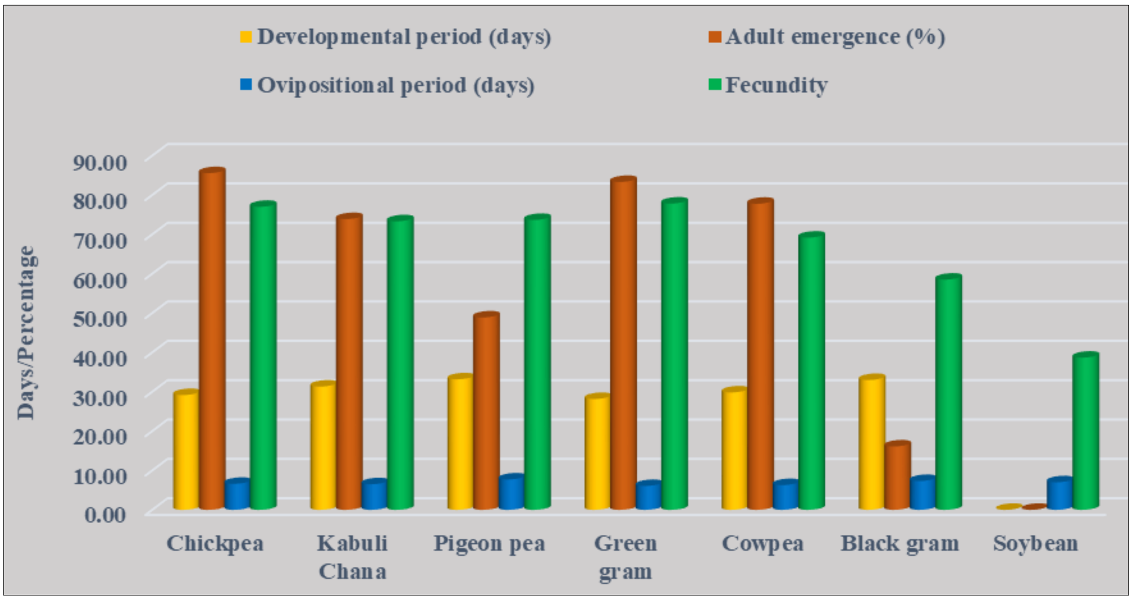

Fig 1: Developmental period (days), adult emergence (%), ovipositional period (days) and fecundity of pulse beetle on various pulses (Pooled mean).

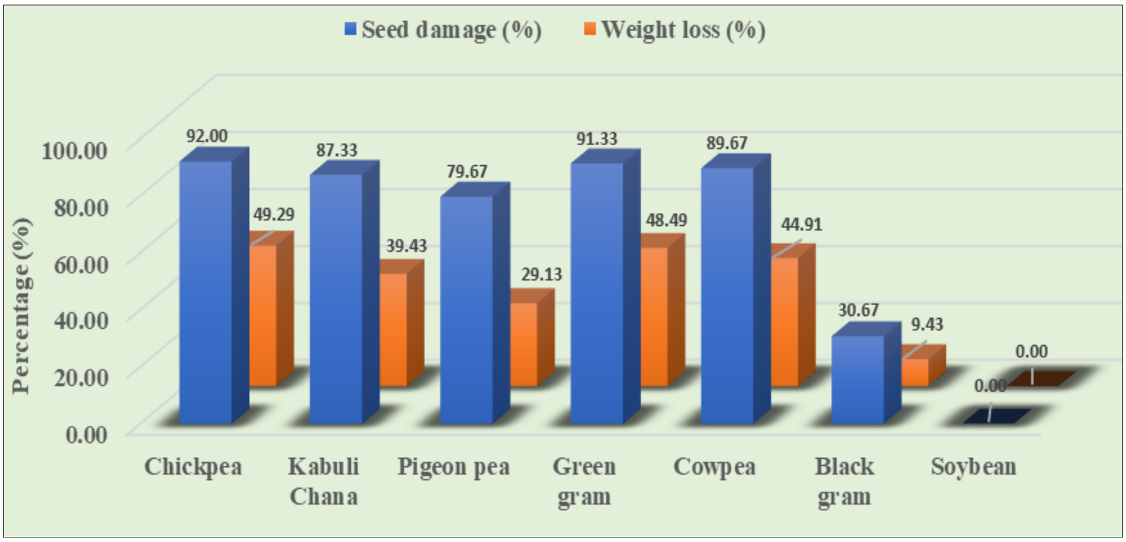

Fig 2: Percentage of weight loss and seed damage by *C. chinensis* on various pulses after 90 days of storage (Pooled mean)

Conclusion

The pulse beetle, *Callosobruchus chinensis*, exhibited a clear and consistent preference among different host grains based on key biological and damage-related parameters, including total developmental period, adult emergence, fecundity, oviposition period, seed damage and weight loss. Among the tested hosts, chickpea and green gram emerged as the most preferred and susceptible to infestation, while black gram was found to be the least preferred host. These findings highlight the importance of host selection in managing *C. chinensis* infestations during storage.

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