www.ThePharmaJournal.com

The Pharma Innovation

**ISSN (E): 2277- 7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.03**
TPI 2021; 10(2): 322-327

www.thepharmajournal.com
Received: 18-11-2020
Accepted: 05-01-2021

**AD Falke**
Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**SK Patil**
Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**MM Sonkamble**
Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**Corresponding Author:**
**AD Falke**
Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

# Studies on host preference of selected pulses to pulse beetle during storage

**AD Falke, SK Patil and MM Sonkamble**

**Abstract**
The present investigation was conducted on host preference in storage pulse beetle (*Callosobruchus chinensis* Linnaeus) under "Free choice" and "No choice" test during *Kharif* 2019-20. Results revealed that combination of several seed characters such as seed coat colour, size, volume, length and breadth, hardness of seed and hundred seed weight have been responsible for biology of pulse beetle to selected crops. In "free choice" test, rice weevil adults oriented towards small size seed of moth bean which was recorded highest seed damage (87.35%) and it was less in black gram (41.50%). Similar results on host preference of bruchids population builds-up, seed damage and seed weight loss also recorded in no choice test over a perior of 120 days **i**n "No choice" test. However, the susceptibility of different crops to pulse beetle weevil on the basis of adults population built-up, per cent seed damage and seed weight loss in descending order was moth bean (224.50, 76.33 and 40.67) > green gram (206.92, 71.25 and 30.75) > cowpea (202.83, 70.17 and 26.26) > pigeonpea (197.08, 63.58 and 24.61) > chickpea (189.58, 62.58 and 21.95) > and blackgram (182.00, 45.58 and 19.11), respectively.
Amongst the seeds, there was no any strong relationship recorded with pulse beetle population with seed characters and soybean was free from attack of bruchids. In free choice test, adult orientation was observed highly positive correlation with per cent seed damage(r=883**). In no choice test, In case of no choice test, population build-up of pulse beetles was highly significant and positively correlated with seed infestation (r= 0.972**) and seed weight loss (r= 0.913**) and also seed infestation has highly significant and positively correlated with seed weight loss (r= 0.941**). It was showed that softer the seed the attack of pulse beetle leads to more seed damage and weight loss.

**Keywords:** Chickpea, host preference, pulses seed, pulse beetle

## Introduction
Pulses are considered as the second most important group of crops worldwide and Pulses are important source of plant protein in many developing countries. Of an about 840 million people in the world are undernourished due to insufficient intake of proteins, amino acids, vitamins and minerals in their diet. Pulses excellent source of proteins (20-30%), which is almost three times higher than that found in cereals and it also contain carbohydrates (50-60%) and minerals as calcium and iron (Ofuya and Akhidue, 2005) [8].
India is a premier pulse growing country and ranks first in pulse production in the world and contributes more than 70 per cent in world's production (Anonymous, 2015) [1]. In India, total pulse grown area is about 25.25 million hectares and production is only 16.47 million tonnes (Anonymous, 2016) [2]. The average productivity of the pulse in India is about 652 kg/ha against the average global productivity of 857 kg/ha. The estimated availability of pulses has declined from 70.10 g/day/person in 1951 to 54.70 g/day/person in 2016-17, whereas Indian Council of Medical Research recommends 65 g/day/person (Ready *et al.*, 2012) [11].
Many biotic and abiotic factors are responsible during post-harvest losses of chickpea during storage conditions. The genus *Callosobruchus* attacks grain legumes during both pre and post harvest stages all over the world. In India, *Callosobruchus maculatus*, *C. analis* and *C. chinensis* are the predominate pest species of the genera (Dias, 1986) [5]. Among the grain insects, spends its entire immature life in individual legume seeds, where they cause weight loss, decrease germination potential and diminish the market as well as nutritional value of the commodity. The pulse beetle, *C. chinensis* Linnaeus cause enormous losses to almost all kind of pulses in storage condition. Due to its damage and the post harvest seed losses may reach up to hundred per cent and thus the seeds become unfit for human consumption as well as planting. The degree of damage varies with different kinds of legumes on the basis of exposure time, storage facilities and other factors associated with seeds (Srinivasan and Durairaj 2007) [15].

Control of storage pests by using synthetic chemicals has become a common practice among the farmers and stockholders. It is now widely known that chemical method has several problems, which include health hazards to the users and grain consumers. It causes residual toxicity, environmental pollution and development of pesticide resistance against bruchids. Recently researchers have paid much attention to develop resistant variety to the pest. The works on the varietal susceptibility of pulses have been reported from India. The present study has been undertaken to evaluate the degree of susceptibility of the selected pulses to pulse beetle.

## Material and Methods

The present studies was carried out on host preference of pulse beetle in storage during 2019-20 at Department of Agricultural Entomology, College Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-431 402, Maharashtra (India).

### i. Pulse beetle culture

To initiate the culture, healthy grains of chickpea were kept in to 32 cm × 22.5 cm size cylindrical jar and 10 pairs of pulse beetle (*C.chinensis* L.) adults were isolated and released into jar. The mouth of the container was covered with a muslin cloth secured firmly by rubber band. Fresh grains were provided periodically for the development of adults. After few days the new adults emergence, the bruchids were introduced into healthy chickpea seeds kept in series of cylindrical jars for building up a homogenous population. Density of population per jar was standardized to prevent overcrowding of adults. These studies were conducted at $30^0$C temperature and 80 per cent relative humidity in ambient conditions.

### ii. Biological study of pulse beetle

The forty seeds were taken randomly from each crop *viz*., chickpea, pigeonpea, green gram, black gram, cowpea, moth bean and soybean and released a pair of pulse beetle. Adult beetle was removed after seven days of release from each crop and number of eggs laid was counted. The counter part of seeds was kept undisturbed in the jar till the emergence of beetle. The mean of egg laying per 10 seeds was calculated and also incubation period, total larval-pupal upto adult emergence and adult longevity were recorded. Total number of adult insects emerged was recorded on the basis of number of seeds with exist holes and counted on each alternate day from the date of emergence of adult up to 20 days. While taking the daily observations on adult emergence and average development period of pulse beetle in each crop growth index was calculated.

### iii. Susceptibility of pulse seed to pulse beetle under 'free choice' and 'no choice' test

Five hundred grams seed of seven pulse crops *viz*., chickpea, pigeonpea, green gram, black gram, cowpea, moth bean and soybean were cleaned of straw, chaff, light grains and other impurities before testing. All the grains were disinfected by keeping in the oven at $60^0$C for 5 hours before keeping it for oviposition, development, loss in seed weight and seed infestation. Initially the moisture content of fresh seed was about 7.26 to 11.14 per cent. Moisture content was measured by oven dry method. Initially screened seeds of each crop on different morphological characteristics as per standard methods and also the experiment conducted on host preference against pulse beetle, *C. chinensis* under free choice and no choice test in storage.

**a) Free choice test**

Under "Free choice test", 100 grains of each pulse crop was kept in open specimen tubes (5 cm x 3 cm) and arranged horizontally in a circular manner in the trough at equidistance from centre. Hundred pairs of 10 days-old adults of pulse beetle females were released in the centre of trough giving free choice to the adults for orientation and then the trough were covered with muslin cloth. The experiment was replicated 3 times. The number of adults oriented in each crop grains was counted at 24 and 48 hours after their release. The released female pulse beetle was placed for one week to lay eggs. After one week, pulse beetle were removed. The observations as per cent seed damage were recorded at 30, 60, 90 and 120 days after released of pulse beetle.

**b) No choice test**

Under "No choice test", 50 g grains of each pulse crop kept in plastic container having capacity 250 g and five pairs of 10 days-old adults were released in each container and the top was kept covered with muslin cloth and tightly fixed with rubber band. After 2 hours after release, all adults were removed. The moisture content of seeds was less than 12 per cent. The experiment was replicated 3 times for observations up to 120 days.

The seeds were weighed with the help of a Mono-Pan-Micro analytical Balance (Mettler) and were counted for knowing the initial weight and number of sound seeds. Each bottle was examined periodically at monthly intervals to note the per cent damaged seeds and calculated the per cent loss in weight. Number of seed infested (showing circular emergence holes) by *C. chinensis* were counted and per cent infestation was worked out.

### iv) Observations

The physical properties of seeds *viz*., seed coat, colour, size, volume, length and breadth, hardness of seed and hundred seed weight of each crop were studied on the basis of characteristic of seed as per the standard methods.

The seed infestation and seed weight loss was calculated by following formula:

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

$$\text{Weight loss (\%)} = \frac{\text{Initial wt. of sound seeds - Final wt. damaged seeds}}{\text{Initial wt. of sound seeds}} \times 100$$

### v. Statistical analysis

The data obtained were subjected to statistical analysis as per the statistical guidelines by Gomez and Gomez (1984) [6]. The results were transformed to arc sin values wherever necessary. The physical parameters of seed were correlated with orientation of adults, per cent seed damage and per cent weight loss by applying simple correlation coefficient method.

## Results and Discussion

### i. Seed characteristics

The data on seed characters *viz*., seed coat colour, size, volume, length and breadth, hardness of seed and hundred seed weight are presented in Table 1.

**ii. Influence of pulse beetle reared on different pulses seed**

Adults of pulse beetle were reared on different seed size and colour of pulse crops for their host preference and the observations was recorded on biological parameters of pulse beetle. The results are presented in Table 1.

**Table 1:** Seed characteristics and biological parameters of pulse beetle reared on different pulses

| S. N. | Crops | Seed characteristics | | | | | | | | Biological parameters of pulse beetle | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seed Colour | Seed size | Seed Volume (10 cc) | Seed length (mm) | Seed breadth (mm) | 100 grain weight (g) | Seed hardness (kg/grain) | Seed Moisture (%) | Incubation period (Days) | Total larval-pupal period (Days) | Adult emergence (%) | Adult longevity (Days) | Develop-ment period (Days) | Growth Index |
| 1 | Chickpea | Brown | Bold | 39.00 | 7.99 | 3.75 | 23.85 | 18.98 | 9.70 | 4.00 | 19.67 | 16 | 8.00 | 27.67 | 0.81 |
| 2 | Pigeonpea | White | Medium | 78.33 | 6.37 | 4.62 | 10.48 | 17.56 | 9.18 | 6.00 | 19.62 | 19 | 12.00 | 32.67 | 0.96 |
| 3 | Greengram | Green | Small | 172.00 | 4.96 | 3.63 | 5.08 | 12.64 | 8.37 | 4.00 | 19.00 | 22 | 9.67 | 28.67 | 1.15 |
| 4 | Blackgram | Black | Small | 170.00 | 4.75 | 3.78 | 5.57 | 12.70 | 8.67 | 4.67 | 18.91 | 14 | 9.00 | 27.00 | 0.79 |
| 5 | Cowpea | Yellow | Medium | 98.00 | 7.72 | 4.97 | 7.47 | 17.56 | 9.36 | 5.00 | 19.33 | 17 | 8.67 | 28.00 | 0.87 |
| 6 | Mothbean | Light brown | Small | 253.33 | 3.65 | 1.67 | 3.51 | 8.73 | 8.72 | 5.33 | 21.78 | 15 | 7.33 | 28.00 | 0.64 |
| 7 | Soybean | Yellow | Bold | 56.67 | 7.75 | 6.51 | 12.23 | 18.50 | 12.80 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 |
| S.E. (m) ± | | | | 2.07 | 0.09 | 0.04 | 0.17 | 0.17 | 0.20 | 0.34 | 0.41 | 0.67 | 0.23 | 0.434 | 0.01 |
| C.D. at 5% | | | | 6.37 | 0.26 | 0.13 | 0.52 | 0.54 | 0.62 | 1.05 | 1.26 | 2.07 | 0.71 | 1.35 | 0.03 |
| C.V. (%) | | | | 2.89 | 2.41 | 1.81 | 2.99 | 1.99 | 3.65 | 14.26 | 4.22 | 7.89 | 5.10 | 3.08 | 1.85 |

**a) Eggs stage/Ovipositional preference**

Eggs were laid on the surface of the pulses grain. The eggs of beetle were cigar shaped and shiny bright yellow. Egg hatched within 3-5 days with an average of 4.0± 1.0 days. The data on the ovipositional preference indicated that the beetle showed marked variation for oviposition in all pulses seed except soybean. The number of eggs laid highest in pigeonpea followed by green gram, cowpea, chickpea, mothbean and black gram on pulses. There was no egg laid by female beetle in soybean. So there were no observations recorded for biology of pulse beetle. The results showed that more the eggs laid more the adult emerged within seeds and more the damaged to the seed. These results amply support findings reported by Jaiswal *et al.* (2019) [7] revealed that the adults exhibited a marked preference for smooth, well-filled seeds for oviposition and the order of preference was *Cajanus cajan* (red gram) > *Vigna radiate* (green gram) > *Vigna unguiculata* (cowpea) > *Cicer arietinum* (chickpea) > *Vigna mungo* (black gram). Wijenayake *et al.* (1999) [17] reported that cowpea beetle, *C.chinensis* preferred smooth coated seeds for oviposition and rejected seeds with a rough coat. The most preferred seeds for oviposition were mung and soybean, whereas chickpea was least preferred.

**b) Incubation Period**

The data on the incubation period, was observed that the highest incubation period was observed in pigeonpea (6.00 days) followed by moth bean (5.33 days), cowpea (5.00 days), black gram (4.67 days) and chickpea and green gram was each 4.00 days. These results are in close accordance with the findings of Patel *et al.* (2005) [9] who observed the pattern of incubation period as maximum incubation period was found in chickpea (5.03 days) followed by green gram (4.56 days) and cowpea (4.53 days). Sekender *et al.* (2020) [14] reported that the incubation period of pulse beetle varied significantly between the pulse beetle grown in gram and mung.

**c) Larval-pupal period**

The larvae passed through at least 4 instar in which all were creamy coloured 'C' shaped, scarabeae form larva and pupa was obtect type and also creamy coloured. The larva and pupal stages were passed inside the seed. The results observed on larval-pupal period of pulse beetle in stored pulses ranged from 18.91 to 21.78 days. The maximum larval-pupal period was recorded in moth bean (21.78 days) followed by chickpea (19.67 days), pigeonpea (19.62 days), cowpea (19.33 days) and green gram (19.00 days) and it was less period was in black gram (18.91 days).These results are in strong agreement with the findings of Patel *et al.* (2005) [9] observed larval-pupal period of pulse beetle completed within 17.19 to 21.05 days in different pulses and also observed the maximum larval + pupal duration was found in chickpea (21.05 days) followed by red gram (20.15 days). Sekender *et al.* (2020) [14] observed the longest larval and pupal period of pulse beetle were in gram 12.6 ± 0.25 and 5.5 ± 0.32 days, respectively and the shortest were in mung 11.3 ± 0.28 and 4.2 ± 0.19 days, respectively.

**d) Adult emergence**

The data on per cent adult emergence indicated that there was variation in adult emergence of *C. chinensis* (14 to 22%) in different pulses seed. The significant less per cent adult emergence was observed in black gram (14%) followed by moth bean (15%), chickpea (16%), cowpea (17%) and pigeonpea (19%).The highest adult emergence was observed in green gram (22%). The results of present investigation are supported with the findings of Das *et al.* (2002) [4] reported that the emergence of adult insect was maximum (257) in *Kabuli* type chickpea but not a single adult emerged from kidney bean.

**e) Adult longevity**

The significant less percent adult longevity was observed in moth bean (7.33 days) followed by chickpea (8.00 days), cowpea (8.67 days), black gram (9.00 days), green gram (9.67 days) and pigeonpea (12.00 days). The findings are supported with results of Patel *et al.* (2005) [9] who revealed that more longevity in pea 14.83 days followed by Bengal gram (12.53 days) and red gram (12.07 days). Sekender *et al.* (2020) [14] observed the highest longevity was in gram, 8.2 ± 0.33 days.

**f) Developmental period**

The least developmental period was observed in black gram (27.00 days) followed by chickpea (27.67 days), cowpea (28.00 days), moth bean (28.00 days) and green gram (28.67 days) whereas the maximum developmental period was observed in pigeonpea (32.67 days). Similar results reported by Wijenayake *et al.* (1999) [17] revealed that the ovipositional preference was not an indication of suitability for the larval development of cowpea beetle, *C. chinensis*. Development

was comparatively faster in mung and the black and white varieties of cowpea followed by chickpea.

**g) Growth index**

Green gram proved to be most nutritious to *C. chinensis* recorded high (1.15) growth index followed pigeonpea (0.96), cowpea (0.87), chickpea (0.81) and black gram (0.79). Whereas, the least nutritious seed of mothbean which was recorded growth index of 0.64. The results are in conformity with the Wadnerkar *et al*. (1978) [16] reported the varieties having maximum growth index are more suitable for pulse beetle in arhar and gram.

**iii. Host preference of pulse beetle under free choice condition**

The data pertaining to number of female adults oriented towards seed and per cent seed damaged under free choice test are presented in Table 2.

**Table 2:** Orientation and seed damage by pulse beetle under free choice test

| Sr. No. | Crops | No. of adult female oriented | | Seed damage (%) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 24 Hrs | 48 Hrs | 30 DAS | 60 DAS | 90 DAS | 120 DAS | Mean |
| 1. | Chickpea | 14.33 | 13.67 | 12.67 (20.84) | 35.33 (36.46) | 83.33 (66.02) | 99.00 (85.38) | 57.50 (49.32) |
| 2. | Pigeonpea | 12.67 | 12.67 | 53.00 (46.72) | 71.00 (57.45) | 90.67 (72.22) | 99.33 (87.29) | 78.50 (62.38) |
| 3. | Greengram | 13.67 | 12.67 | 37.67 (37.86) | 84.00 (66.53) | 97.67 (81.26) | 100.00 (90.00) | 79.83 (63.32) |
| 4. | Blackgram | 11.33 | 12.00 | 10.33 (18.63) | 35.00 (36.27) | 56.33 (48.64) | 64.00 (53.13) | 41.50 (40.11) |
| 5. | Cowpea | 13.67 | 12.67 | 61.67 (51.75) | 83.33 (65.97) | 95.33 (77.64) | 100.00 (90.00) | 85.08 (67.29) |
| 6. | Mothbean | 14.67 | 15.00 | 70.33 (57.10) | 83.67 (66.18) | 95.33 (78.15) | 100.00 (90.00) | 87.33 (69.19) |
| 7. | Soybean | 2.67 | 2.33 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| S.E. (m) ± | | 0.61 | 0.61 | 1.32 | 1.02 | 1.45 | 1.27 | 0.53 |
| C.D. at 5% | | 1.87 | 1.90 | 4.07 | 3.15 | 4.46 | 3.93 | 1.63 |
| C.V. (%) | | 8.86 | 9.21 | 6.87 | 3.76 | 4.13 | 3.11 | 1.83 |

Figures in parentheses are arcsine transformed values,
DAS=Days after storage

**a) Orientation of pulse beetle**

The maximum adult orientation was noticed in mothbean (14.67 and 15) followed chickpea (14.33 and 13.67), green gram (13.67 and 12.67), cowpea (13.67 and 12.67), pigeonpea (12.67 and 12.67) and black gram (11.33 and 12.00) and minimum adult oriented towards soybean (2.67 and 2.33) at 24 and 48 hrs, respectively. Thus, none of the pulses showed immunity to the beetle except soybean. These results are in line with the findings of earlier workers. Chakraborty and Mondal (2016) [3] revealed that a combination of several morphological characters such as texture, seed size, seed weight, volume of seed and seed colour have been responsible for ovipositional preference of bruchids to different pulses. They also reported that dark and brown coloured seeds were preferred most for oviposition over white seeds in "free choice" situation. Salim *et al*. (2018) [12] revealed that seed surface smoothness, seed coat thickness and chemical stimuli influenced on the oviposition and damage caused by pulse beetle, *C. chinensi*s to different genotypes of pulses i.e. lentil, mungbean, chickpea and blackgram. Jaiswal *et al.* (2019) [7] reared *C. chinensis* on five different pulses for their life history and ovipositional preference and revealed not much variation between the pulses.

**b) Seed damage**

The results on per cent seed damage were found marked variation at 30, 60, 90 and 120 days after release of pulse beetle. The highest damaged seed at 30 days after storage was recorded in moth bean (70.33%) followed by cowpea (61.67%), pigeonpea (53.00%), green gram (37.67%) and chickpea (12.67%) and least damaged seed was in black gram (10.33%). In soybean no damage observed because meager adult beetle oriented towards it. The seed damage in descending order was green gram (84.00 and 97.67%) followed by moth bean (83.67 and 95.67%), cowpea (83.33 and 95.33%), pigeonpea (71.00 and 90.67%), and chickpea (35.33 and 83.33%), while, the least per cent damaged seed was continued to be in black gram (35.00 and 56.33%), respectively after 60 and 90 days. Whereas, after 120 days, the highest per cent damaged seed was continued to be in green gram (100%) and damage was 100 per cent noticed also in moth bean and cowpea followed by pigeonpea (99.33%) and chickpea (99.00%) and the less per cent damaged seed in black gram (64.00%).

Among the pulses, moth bean (87.33%) has the mean highest seed damage percentage over 120 days of storage period and black gram (41.50%) has mean lowest damage. Other pulse crops i.e. cowpea, green gram, pigeonpea and chickpea recorded 85.08, 79.83, 78.50 and 57.50 per cent, respectively. The free choice test proved the pulse has more infestation which has maximum orientation of beetle except soybean. These finding are supports with Jaiswal *et al*. (2019) [7] they reported that insect infestation among different pulses caused 46.30 to 63.61 per cent damage and however the order of preference for oviposition on different pulses for *C. chinensis* was *Cajanus cajan* > *Vigna radiate* > *Vigna unguiculata* > *Cicer arietinum* > *Vigna mungo*. Similarly, Salim *et al*. (2018) [12] revealed that the maximum (24.4%) seed damage was observed on chickpea and the minimum (6 - 9%) in blackgram and also reported seed surface smoothness, seed coat thickness and chemical stimuli influenced on the oviposition and damage of pulses by the pulse beetle.

**4. Reaction of pulse beetle adults to different pulses under no choice test**

The data recorded on per cent population build-up, seed damage and weight loss at 30, 60, 90 and 120 days after release of pulse beetle and results are presented in Table 3.

**Table 3:** Population build-up of pulse beetle and its infestation in different seeds of pulse under no choice test

| Sr. No. | Crops | Population build-u | | | | | Seed infestation (%) | | | | | Seed weight loss (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30 DAS | 60 DAS | 90 DAS | 120 DAS | Mean | 30 DAS | 60 DAS | 90 DAS | 120 DAS | Mean | 30 DAS | 60 DAS | 90 DAS | 120 DAS | Mean |
| 1. | Chickpea | 41.33 | 146.67 | 252.67 | 320.00 | 189.58 | 17.33 (24.58) | 51.33 (45.76) | 81.67 (64.68) | 100.00 (90.00) | 62.58 (52.29) | 5.38 (13.40) | 12.81 (20.97) | 30.97 (33.80) | 38.62 (38.42) | 21.95 (27.93) |
| 2. | Pigeonpea | 40.33 | 152.00 | 257.33 | 322.67 | 193.08 | 19.67 (26.31) | 67.33 (55.15) | 71.33 (57.72) | 96.00 (79.56) | 63.58 (52.89) | 5.00 (12.89) | 20.06 (26.60) | 32.71 (34.88) | 40.66 (39.62) | 24.61 (29.74) |
| 3. | Greengram | 45.67 | 177.00 | 275.00 | 330.00 | 206.92 | 18.33 (25.32) | 73.33 (58.92) | 93.33 (75.65) | 100.00 (90.00) | 71.25 (57.58) | 4.57 (12.32) | 25.17 (30.10) | 39.09 (38.70) | 54.17 (47.39) | 30.75 (33.68) |
| 4. | Blackgram | 39.67 | 133.33 | 235.00 | 317.67 | 182.00 | 16.67 (24.06) | 41.67 (40.20) | 57.33 (49.22) | 66.67 (54.75) | 45.58 (42.46) | 2.97 (9.85) | 12.96 (21.10) | 25.91 (30.60) | 34.61 (36.03) | 19.11 (25.92) |
| 5. | Cowpea | 45.33 | 165.00 | 274.00 | 327.00 | 202.83 | 21.33 (27.49) | 74.00 (59.43) | 85.33 (67.59) | 100.00 (90.00) | 70.17 (56.90) | 5.44 (13.47) | 19.11 (25.92) | 35.86 (36.78) | 44.63 (41.92) | 26.26 (30.83) |
| 6. | Mothbean | 49.33 | 184.00 | 285.33 | 379.33 | 224.50 | 32.67 (34.85) | 77.67 (61.82) | 95.00 (77.82) | 100.00 (90.00) | 76.33 (60.90) | 6.30 (14.53) | 44.58 (41.89) | 53.06 (46.75) | 58.74 (50.03) | 40.67 (39.62) |
| 7. | Soybean | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| S.E. (m) ± | | 1.986 | 0.99 | 2.34 | 4.10 | 1.39 | 0.86 | 1.17 | 1.77 | 1.37 | 0.46 | 0.50 | 0.32 | 0.41 | 0.34 | 0.17 |
| C.D. at 5% | | 6.09 | 3.05 | 7.21 | 12.65 | 4.28 | 2.65 | 3.60 | 5.46 | 4.23 | 1.41 | 1.55 | 0.99 | 1.28 | 1.04 | 0.53 |
| C.V. (%) | | 9.21 | 4.59 | 1.80 | 2.49 | 1.40 | 6.41 | 4.40 | 5.47 | 3.36 | 1.71 | 7.97 | 2.34 | 2.27 | 1.62 | 1.11 |

Figures in parentheses are arcsine transformed values
DAS- Days after storage

**a) Population build-up of pulse beetle**

There was no variation was noticed in population build-up at 30, 60, 90 and 120 days after release of pulse beetle. Adult population was recorded significantly maximum in moth bean (49.33, 184.00, 285.33 and 379.33 adults) and minimum in black gram (39.67, 133.33, 235.00 and 317.67) at 30, 60, 90 and 120 days after released, respectively and it was at par with green gram (45.67, 177.00, 275.00 and 330.00 adults, respectively). There was no adults beetle developed in the soybean. So that, there were no any infestation was observed in soybean. Other pulses i.e. green gram, cowpea, pigeonpea and chickpea was recorded population build-up in descending order with the ranged from 45.67 to 330.00, 45.33 to 327.00, 41.33 to 320.00 and 40.33 to 322.67 adults, respectively.

Perusal of data also reveals that population of the beetle increased gradually after 30 days of release. Among all observations the significantly highest in moth bean (224.50 adults) followed by green gram (202.83 adults), cowpea (206.92 adults), pigeonpea (193.08 adults) and chickpea (189.58 adults) and lowest number of adult beetles in and black gram (182 adults) over a period of 120 days. These results are in accordance with the findings of Qazi (2007) [10] they observed similar pattern of mean adult emergence as maximum total adult emergence found in green gram and cowpea followed by black gram.

**b) Seed infestation**

Seed infestation indicated there was marked variation in seed infestation percentage at 30, 60, 90 and 120 days of storage. However, At 30 and 60 DAS, mothbean (32.67 and 77.67%) was recorded significantly maximum seed infestation followed by cowpea (21.33 and 74.00%) and the minimum infestation recorded into black gram (16.67 and 41.67%) followed by chickpea (17.33 and 51.33%), respectively. The seed infestation was recorded in pigeonpea and green gram of 19.67 and 18.33 and 67.33 and 73.33 per cent at 30 and 60 days, respectively. After 90 DAS, significantly highest infestation was recorded in moth bean (95.00%) which was at par with green gram (93.33%), cowpea (85.33%), chickpea (81.67%) and pigeonpea (71.33%), whereas, the significantly minimum infestation i.e. 57.33 per cent was noticed in black gram. At 120 DAS, 100 per cent infestation was recorded in moth bean, cowpea and chickpea followed by pigeonpea (96.00%) and significantly minimum infestation recorded into the black gram (66.67%).

The overall infestation shows that the significantly highest infestation was recorded in mothbean (76.33%) followed by green gram (71.25%), cowpea (70.17%), pigeonpea (63.58%) and chickpea (62.58%) and significantly least infestation was recorded into the black gram (45.58%). These present findings are supported with the results of Salim *et al*. (2018) [12] revealed that all the genotypes of chickpea were found to be highly susceptible to pulse beetle, *C. chinensis* and blackgram genotypes were least susceptible. The susceptibility of lentil and mungbean were observed intermediate. Moreover, maximum (24.4%) of seed damage was observed on chickpea and the minimum (6-9%) was recorded in blackgram.

**c) Seed weight loss**

It was observed there was significant increase in seed damage with the increase in weight loss and also no consistency was observed in weight loss during 30, 60, 90 and 120 days of storage of seed. However, highest per cent weight loss was recorded in mothbean (6.30, 44.58, 53.06 and 58.74%, respectively). The minimum weight loss recorded into black gram (2.97, 12.96, 25.91 and 34.61%, respectively) Rest of crops i.e. green gram (4.57, 25.17, 39.09 and 54.17%), pigeonpea (5.00, 20.06, 32.71 and 40.66%), cowpea (5.44, 19.11, 35.86 and 44.63%) and chickpea (5.38, 12.81, 30.97 and 38.62%) was intermediate at 30, 60, 90 and 120 days, respectively. While soybean showed no weight loss as there was no infestation.

Mean of weight loss over 120 days of storage shows that highest percentage in mothbean (40.67%) followed by green gram (30.75%), cowpea (26.26%), pigeonpea (24.61%) and chickpea (21.95%), whereas minimum loss in black gram (19.11%). These results shows that pulse beetle is major damaging pest of pulses at storage and it takes less time for multiplication causes more infestation and damage simultaneously seed weight loss. The findings are supported with Das *et al.* (2002) [4] revealed that average weight loss was highest (22.88%) in greengram due to the effect of infestation of *C. chinensis* L. while kidney bean showed no weight loss as there was no infestation. Sarwar (2012) [13] reported the tolerant varieties of chickpea showed the least loss in weight due to *C. maculatus* which could be attributed to small and presence of well texture layer of seed.

**v. Correlation coefficient**

The results presented in Table 4, indicated that there was no any significantly relationship was observed between seed characters and biological parameters of pulse beetle. All the morphological characters of seeds were negatively non-significant correlated with biological parameters of pulse beetle except seed volume. Similar relationship was also observed in free choice and no choice conditions. There was observed highly positive correlation of adult orientation with per cent seed damage(r=883**) under free choice test. In case of no choice test, population build-up of pulse beetles was highly significant and positively correlated with seed infestation (r= 0.972**) and seed weight loss (r= 0.913**) that means seed infestation and weight loss increases with population and also seed infestation has highly significant and positively correlated with seed weight loss (r= 0.941**). These findings are in agreement with the results reported by Chakraborty and Mondal (2016) [3] suggested a combination of several factors such as texture, seed size, seed weight, volume of seed and seed colour have been responsible for ovipositional preference of bruchids to different pulses and also revealed that moisture content of seeds, single seed weight and seed coat thickness had negative correlation with oviposition, adult emergence percentage. Dark and brown coloured seeds were preferred most for oviposition over white seeds in " free choice" situation. Das *et al.* (2002) [4] reported that a non significant correlation was found between average number of adults emerged and per cent average weight loss.

**Table 4:** Correlation coefficient 'r' between morphological characteristics of seed with biological parameters of pulse beetle and its infestation

| Particulars | Correlation coefficient 'r' | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Seed volume** | **Seed length** | **Seed breadth** | **100 grain weight** | **Seed hardness** | **Moisture content** | **No. of adults oriented** | **Population build-up** | **Seed infestation** |
| Seed characters x biological parameters of pulse beetle | | | | | | | | | |
| Incubation period | 0.391 | -0.426 | -0.643 | -0.267 | -0.359 | -0.881** | - | - | - |
| Total larval-pupal period | 0.443 | -0.451 | -0.773 | -0.176 | -0.428 | -0.946** | - | - | - |
| Adult emergence | 0.276 | -0.329 | -0.536 | -0.175 | -0.262 | -0.913** | - | - | - |
| Adult longevity | 0.218 | -0.323 | -0.481 | -0.168 | -0.203 | -0.882** | - | - | - |
| Development period | 0.331 | -0.381 | -0.656 | -0.153 | -0.315 | -0.935** | - | - | - |
| Growth index | 0.234 | -0.294 | -0.477 | -0.164 | -0.221 | -0.893** | - | - | - |
| Seed characters x orientation x seed damage under free choice test | | | | | | | | | |
| No. of adults oriented | 0.454 | -0.449 | -0.818* | -0.134 | -0.444 | -0.920** | 1.000 | - | - |
| Seed damage | 0.435 | -0.374 | -0.646 | -0.313 | -0.386 | -0.825 | 0.883** | - | - |
| Seed characters x population x seed infestation under no choice test | | | | | | | | | |
| Population built-up | 0.486 | -0.474 | -0.776* | -0.240 | -0.464 | -0.957** | - | 1.000 | 0.972** |
| Seed infestation | 0.440 | -0.395 | -0.741 | -0.207 | -0.410 | -0.888** | - | 0.972** | 1.000 |
| Seed weight loss | 0.687 | -0.629 | -0.874** | -0.402 | -0.663 | -0.858* | - | 0.913** | 0.941** |
| * Significant at 5% = 0.754 ** Significant at 1% = 0.874 | | | | | | | | | |

**References**


1. Anonymous. Statistical Database of National Horticulture Board, Gurgaon 2015. http/www.nhb.gov.in.
2. Anonymous. Project Coordinator's Report. AICRP on Chickpea, IIPR, Kanpur 2016.
3. Chakraborty S, Mondal P. Physio-chemical parameters of pulses affecting the bruchid (*C. chinensis* Linn.) infestation. Asian Journal of Science Technology 2016;7:2554-2560.
4. Das M, Freir CM, Parra J. Screening of pulse grain resistance to *Callosobruchus chinensis* (L.).Journal of Applied Entomology 2002;118:437.
5. Dias CAR. Ecological studies on *Callosobruchus maculatus* Fab., *Callosobruchus chinensis* L. and *Callosobruchus analis* K. infesting legumes in India. Ph.D. thesis submitted to PG school, IARI, New Delhi 1986.
6. Gomez AA, Gomez AA. Statistical procedures for Agriculture Research, New York, Wiley 1984, pp. 272-356.
7. Jaiswal Deepak Kumar, Raju SVS, Ingle Deepak Shyamrao, Pratik Singh, Srasvan Kumar G. Effect of some seed protectants on adult emergence of pulse beetle, *Callosobruchus chinensis* (L.) in fresh chickpea seeds under storage condition. Journal of Pharmacognosy and Phytochemistry 2019;8(2):534-537.
8. Ofuya ZM, Akhidue V. The role of pulses in human nutrition: A review. Journal of Applied Science and Environment and Management 2005;9:99-104.
9. Patel VK, Chaudhuri N, Senapati SK. Biology of pulse beetle (*Callosobruchus chinensis* Linn.) as influenced by feeding of different grain pulses. Agricultural Science Digest 2005;25(4):254-256.
10. Quzi MA. Fecundity and host preference of *Callosobruchus chinensis* (L.). Pakistan Journal of Agricultural Research 2007;20:179-82.
11. Ready AA, Bantilan MCS, Mohan G. Enabling pulses revolution in India, ICRISAT, Policy Brief No 2012, 26.
12. Salim Ahmad, Azizul Haque, Hyat Mahmud. Effect of pulse beetle, *Callosobruchus chinensis* L. on oviposition and damage in some important genotypes of pulse crops in Bangladesh.Biomed Journal of Science and Technology Research 2018;2(2):1-5.
13. Sarwar M. Assessment of resistance to the attack of bean beetle, *Callosobruchus maculatus* (Fabricus) in chickpea genotypes on the basis of various parameters during storage. Songklanakarin Journal of Science and Technology 2012;34(3):287-291.
14. Sekender Sanjida, Shanjida Sultana, Tangin Akter, Shefali Begum. Susceptibility of different stored pulses infested by pulse beetle, *Callosobruchus chinensis* (Lin.). Dhaka Univ. Journal of Biological Science 2020;29(1):19-25,
15. Srinivasan T, Durairaj C. Reaction of green gram accessions against bruchid, *Callosobruchus maculatus*. Indian Journal of Plant Protection 2007;35(2):248-250.
16. Wadnerkar DN, Kaunsale PP, Pawar VM. Studies on preference of pulse beetle, *C. maculatus* F. to some varieties of arhar and gram. Bulletin of Grain Technology 1978;16(2):122-124.
17. Wijenayake DUS, Karunaratne MMSC. Ovipositional preference and development of the cowpea beetle *Callosobruchus chinensis* on different stored pulses. Vidyodaya Journal of Science 1999;1(8):135-147.