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**Research paper**

# Development of pulse beetle *Callosobruchus maculatus* Fab. (Coleoptera: Bruchidae) in different pulses

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## ABSTRACT

**Development of pulse beetle (*Callosobruchus maculatus* Fab.) was studied on nine different pulses viz., mungbean, urdbean, mothbean, greenpea, cowpea, horsegram, chickpea, wal and pigeonpea under laboratory conditions. The study indicated that chickpea was most preferred host by *C. maculatus* as it recorded highest number of eggs (290.67/100 grains), shortest total developmental period (21.33 days) and highest number of adult emergence (163/100 grains), whereas horsegram was least preferred host as it recorded lowest number of eggs (23.67 / 100 grains), lowest number of adult emergence (4.33/ 100 grains) and shortest adult longevity (4 days). The highest adult longevity was recorded in wal (10 days) followed by chickpea and mungbean (9.33 days). In the case of the incubation period, mungbean and cowpea recorded shortest incubation period (2.67 days) and followed by chickpea, green pea and pigeonpea (3.33 days) whereas it was highest in urdbean (4.67 days) followed by horsegram (4.33 days). Percent adult emergence was lowest in the case of horsegram (18.29%) followed by mothbean (19.86%) and was highest in wal (74.92%).**

***Key words*****:** *Callosobruchus maculatus,* Host, Pulse beetle

## INTRODUCTION

Pulses are important forthe vegetarian diet of the Indian subcontinent because they are rich in protein and have high nutritional value. These are precious commodities used around the globe in a variety of cuisines. They belong to the legume family and their seeds are edible, which is found in pods with a variety of shapes, sizes, and colors. Pulses are the main and cheapest source of proteins in developing countries and hence called 'poor man's meat' (Sharma, 1984). The Union Ministry of Agriculture in its fourth advanced estimate released on 24th May, 2023 estimated India's total pulses output at 27.69 mt as against the target of 27.30 mt for 2021-22 and 25.46 mt of output achieved in the previous year (Ministry of Agriculture & Farmers Welfare 2023). It has been estimated that India's population will reach 1.68 billion by 2030 from the present level of 1.21 billion. Accordingly, the projected pulse requirement for the year 2030 is 32 million tonnes with an anticipated required growth rate of 4.2 percent (United Nations 2017). India has to produce not only enough pulses but also remain competitive to protect indigenous pulse production.

The stored grain insect pest is one of the major limiting factors for reducing the nutritional quality and quantity of grains in storage worldwide. Food security relies heavily on the availability and safety of cereals and pulses or locally available crops such as fieldpea, cowpea *etc*. at household and national levels, and insect infestation may lead to food insecurity (Renzaho *et al*., 2010). Several bruchid species attack cereals and pulses in store and cause a loss of 10-15 percent with germination loss ranging from 50-92 percent. These losses are linked to insufficient and poor storage facilities, lack of knowledge of advanced technology in post-harvest pulse management, and harsh climatic conditions particularly in developing countries like India (Singh and Ron Larson, 2016). The pulse crops are attacked by more than 150 insect pests. It is recorded that 55-60 percent loss in seed weight and 45.50 to 66.30 percent loss in protein content of pulses is due to infestation caused by pulse beetle in *Pisum sativum* (pea), *Vigna unguiculata* (cowpea), *Cajanus cajan* (pigeonpea), *Vigna unguilaris* (adzuki bean), *Lens culinaris* (lentil) (Kutbay *et al*., 2011).

Among the several important insect pests of stored grains, bruchids i.e., pulse beetle, *Callosobruchus* spp. is a major storage grain pest. It causes heavy loss up to 10 to 60 percent. Several

species of bruchids in the genus *Callosobruchus* are known to damage grains of legumes up to 93.3 percent during storage. Among five well-known species of *Callosobruchus* from India, three viz. *C. maculatus, C. chinensis and C. analis* are important pests of stored pulses (Raina, 1970). Pulse beetle causes not only quantitative but also qualitative losses like nutritive loss, and germination loss and makes pulses unfit for marketing as well as for human consumption (Kenghe and Kanawade, 1996). Moreover, *C. maculatus* infests lab-lab bean not only in the post-harvest period but also in the field thus greatly affecting food production and availability to producers and consumers (Ajayi and Lale, 2000). The pulse beetle, *Callosobruchus maculatus*, (Fab.) (Coleoptera: Bruchidae), is one of the most serious post-harvest pest threats to stored legumes in tropical and subtropical regions. Therefore considering its importance for pulses, present investigation was aimed to study the development and losses caused by pulse beetle, *Callosobruchus maculatus* to different pulses.

## MATERIALS AND METHODS

### *Maintenance of culture of Callosobruchus maculates*

The grains of nine different pulses already infested by bruchids were procured from local market and kept in glass jarsto obtain the initial culture of *Callosobruchus maculatus* (Fab.). The taxonomic key given by Haines (1988) was used for the identification and isolation of desired species of pulse beetle i.e., *Callosobruchus maculatus*, Fab. Healthy and uninfected seeds of the same pulses were purchased from the market and kept uniformly in a glass jar. Five pairs of males and females isolated from the original culture were released into a glass jar of healthy grains. A piece of muslin cloth was placed firmly with a rubber band on the mouth of a glass jar to prevent the escape of adults. The newly emerged adults were transferred into similar-sized glass jars containing uninfected and healthy pulses to maintain the culture of the test insect throughout the study. The freshly emerged adults of uniform age were used for further studies.

### *Experimental details*

The development of *Callosobruchus maculatus* on nine different pulses (Table 1) was studied in a laboratory of the Department of Agricultural Entomology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Dist. Ratnagiri (Maharashtra) during the year 2019-20 at room temperature and relative humidity ranged between 25 ± 3 ºC and 85 ± 2 percent, respectively. A statistically designed laboratory experiment was conducted in Completely Randomized Design with nine treatments and three replications. Seeds of different pulses were obtained from university seed cell and local farmers.

**Table 1.** The details of a variety of pulses used for experimentation are as below

| Sr. No. | Name of pulses | Variety used | Source |
|---|---|---|---|
| 1 | Mungbean | Dapoli mung-1 | DBSKKV, Dapoli |
| 2 | Mothbean | MBS-27 | MPKV, Rahuri |
| 3 | Green pea | Saswad local | Farmer |
| 4 | Cowpea | Konkan sadabahar | DBSKKV, Dapoli |
| 5 | Horsegram | Dapoli No. 1 | DBSKKV, Dapoli |
| 6 | Chickpea | JAKI -9218 | Dr. PDKV, Akola |
| 7 | Urdbean | AKU-4 | Dr. PDKV, Akola |
| 8 | Wal | Konkan wal -1 | DBSKKV, Dapoli |
| 9 | Pigeonpea | ICPL-87 | DBSKKV, Dapoli |

Development of *Callosobruchus maculatus* in different pulses was studied by keeping 100 healthy grains of nine different pulses viz., mungbean, mothbean, green pea, cowpea, horsegram, chickpea (desi), urdbean, wal, and pigeonpea in separate glass jars. Grains of each pulse were thoroughly checked with a hand lens and sun-dried for 6 hours to ensure that they were free from prior infestation of any pest. Five pairs of freshly emerged beetles of *C. maculatus* from laboratory culture were released in each glass jar. The mouths of glass jars were closed by muslin cloth and were kept at ambient temperature in the laboratory. Bruchids were allowed to lay the eggs until death. After the death of bruchid its cadavers were removed from the glass jar. Grains were observed daily and different biology and development-related parameters like fecundity, incubation period, hatching percentage, developmental period, adult emergence, adult longevity etc. were recorded. Similarly, per cent adult emergence was also calculated by using the following formula:

$$\text{Percent adult emergence} = \frac{\text{Total number of adults emerged per 100 grains}}{\text{Total number of eggs laid per 100 grains}} \times 100$$

## RESULTS AND DISCUSSION

Results of different developmental parameters of *C. maculatus* influenced by different pulses are presented in the table and explained and discussed below under different headings.

**Table 1.** Development of pulse beetle *Callosobruchus maculatus* in different pulses

| Sr. No | Pulses | Average no. of eggs laid/ 100 grains | Incubation period (days) | Total developmental period (days) | Average no. of adults emerged/ 100 grains | Adult longevity | Percentage of adult emergence to egg laying |
|---|---|---|---|---|---|---|---|
| 1. | Mungbean (*Vigna radiate*) | 93.67 (9.69)* | 2.67 | 24.67 | 39.33 (6.31)* | 9.33 | 41.99 |
| 2. | Mothbean (*Vigna aconitifolia*) | 95.67 (9.79) | 4.00 | 29.33 | 19.00 (4.41) | 8.00 | 19.86 |
| 3. | Green pea (*Pisum sativum*) | 153.33 (12.39) | 3.33 | 35.33 | 86.67 (9.34) | 8.67 | 56.53 |
| 4. | Cowpea (*Vigna unguiculata*) | 156.67 (12.53) | 2.67 | 28.67 | 96.33 (9.83) | 8.33 | 61.49 |
| 5. | Horsegram (*Macrotyloma uniflorum*) | 23.67 (4.89) | 4.33 | 29.00 | 4.33 (2.18) | 4.00 | 18.29 |
| 6. | Chickpea (*Cicer arietinum*) | 290.67 (17.05) | 3.33 | 21.33 | 163.00 (12.74) | 9.33 | 56.07 |
| 7. | Urdbean (*Vigna mungo*) | 80.00 (8.97) | 4.67 | 26.33 | 44.00 (6.65) | 6.67 | 55.00 |
| 8. | Wal (*Lablab purpureus*) | 101.00 (10.06) | 4.00 | 31.00 | 75.67 (8.82) | 10.00 | 74.92 |
| 9. | Pigeonpea (*Cajanus cajan*) | 78.00 (8.85) | 3.33 | 26.00 | 48.33 (6.97) | 8.33 | 61.97 |
| | Mean | 119.19 (10.47) | 3.59 | 27.96 | 66.52 (7.68) | 8.07 | - |
| | SEm± | 0.34 | 0.09 | 0.07 | 0.36 | 0.06 | - |
| | CD (P=0.05) | 1.00 | 0.27 | 0.21 | 1.06 | 0.16 | - |

*figures in parenthesis are $\sqrt{n} + 0.5$ values

### *Eggs laid by C. maculatuson different pulses*

The data recorded on the average number of eggs laid on 100 seeds of nine different pulses indicated that there were significant differences among the treatments. The average number of eggs laid by *C. maculatus* per hundred grains ranged from 23.67 to 290.67 eggs/100 grains. Horsegram recorded lowest number of eggs (23.67/100 grains) and was followed by pigeonpea (78.00/100 grains), urdbean (80.00/100 grains), mungbean (93.67/100 grains) and mothbean (95.67/100 grains) whereas, chickpea recorded highest number of eggs (290.67/100 grains) followed by cowpea (156.00/100 grains) green pea (153.33/100 grains) and wal (101.00/100 grains). Jadhav *et al*. (2015) reported oviposition by *Callosobruchus maculatus* in a range of 26.67 to 54.00 eggs/30 seeds in different cowpea cultivars. Yunus *et al*. (2015) studied the oviposition behavior of *C. chinensis* and reported 78.00 ± 2 eggs on cowpea and 63.00 ± 1.73 on urdbean per 100 grains. Ahamad *et al*. (2018) studied the reaction of pulse beetle *C. chinensis* to 20 genotypes of four different pulses like lentil, mungbean, chickpea and urdbean. They reported a maximum number of eggs on chickpea and minimum on urdbean.

### *Incubation period of C. maculatus eggs on different pulses*

It is clear from the data that, the incubation period of *C. maculatus* ranged between 2-5 days in all the treatments. However, the average incubation period was recorded shortest on mungbean and cowpea i.e. 2.67 days. The longest incubation period of 4.67 days was recorded in urdbean followed by horsegram (4.33 days), mothbean (4.00 days) and wal (4.00 days). The remaining pulses viz., green pea, chickpea and pigeonpea recorded average incubation period of 3.33 days.

In the case of *C. maculatus*, Shinde (2009) reported a mean incubation period of 4.03 days on different cowpea cultivars. Bhubaneshwari Devi and Victoria Devi (2014) reported an incubation period of 6-7 days in mungbean. Radha and Susheela (2014) studied the development of *C. maculatus* in different pulses and reported an incubation period of 3.0 days in green gram, urdbean and cowpea whereas, horsegram and greenpea recorded longer incubation period i.e. 4.0 days and 4.5 days, respectively. Chudasama (2015) recorded the incubation period of eggs of *C. maculatus* in the range of 1-4 days in cowpea.

***Total developmental period (egg to adult emergence) of C. maculatus on different pulses***

Data in the table reveals that the total developmental period (egg to adult emergence) of *C. maculatus*was significantly lowest in Chickpea i.e. 21.33 days followed by mungbean (24.67 days), pigeonpea (26.00 days), urdbean (26.33 days) and cowpea (28.67 days). Thus, it can be concluded that these pulses are more suitable for the development of *C. maculatus* compared to other pulses like green pea, wal, mothbeanand horse gram as they recorded more developmental periods i.e. 35.33 days, 31.00 days, 29.33 days, and 29.00 days, respectively.

In the case of *C. maculatus,* Shinde (2009) reported a developmental period of 21.00 to 27.33 days in different Cowpea cultivars whereas, Rohamare (2012) recorded a developmental period in the range of 23.34 to 26.64 days in different pigeonpea cultivars. Chudasama (2015) recorded a developmental period of 20-24 days in cowpea and 31-37 days in chickpea. Thakur *et al*. (2013) reported developmental periods in the range of 31.00 to 38.00 days in urdbean. In the case of mungbean, Dwivedi *et al*. (2021) reported a developmental period of 29 days in *C. analis*.

***Adult emergence of C. maculatus in different pulses***

Data of adult emergence of *C. maculatus*in different pulses varies significantly. It was observed that maximum number of adults were emerged from chickpea (163.00) and minimum number of adults were emerged from Horse gram (4.33). Pulses like cowpea (96.33), green pea (86.67) and wal (75.67) recorded more adult emergence than the pulses like urdbean (44.00), mungbean (41.00) and mothbean (19.00).

Present findings can be comparedwith the findings of Das *et al.* (2002) who also recorded maximum adult emergence (257) from *Kabuli* chickpea while none from kidney bean. Similarly, Sekender *et al*. (2020) reported maximum adult emergence of *C. chinensis* from chickpea (65.2 ± 7.58) minimum from pea (41.8 ± 1.93) and moderate from mung (51.4 ± 8.47).

***Adult longevity of C. maculatus in different pulses***

The data on adult longevity of *C. maculatus* on nine different pulses ranged from 3 to 11 days. Data on average longevity shows significant variation amongst treatments. The maximum adult longevity was observed in wal (10 days) while the minimum adult longevity of 4.00 days was observed on horse gram. The other pulses in ascending order of adult longevity were urdbean (6.67 days), mothbean (8.00 days), cowpea (8.33 days), pigeonpea (8.33 days), green pea (8.67 days), mungbean (9.33 days) and chickpea (9.33 days). Various authors studied the adult longevity of *C. chinensis*on different pulses while literature on *C. maculatus* is very scanty. Solanki and Mittal (2018) reported an average adult longevity of 9.6 days on chickpea while Jaiswal *et al.* (2018) observed that it ranged between 8-12 days on the same host. Hosamani *et al*. (2018) reported an adult longevity period of 9 ± 0.30 days on cowpea, 10 ± 0.69 days on mungbean, 12 ± 0.45 days on pigeon, 9 ± 0.38 days on chickpea, 8 ± 0.4 days on horsegram, 8 ± 0.29 days on urdbean and 7 ± 0.87 days on mothbean. Similarly, Sekender *et al.* (2020) reported adult longevity of 8.2 ± 0.33 days in chickpea, 7.8 ± 0.33 days in mungbean and 7.0 ± 0.28 days in pea

***Percentage of adult emergence to egg laying***

Data on the percentage of adult emergence to total number of eggs laid per 100 grains of pulses shows the highest adult emergence percent in wal (74.92%) followed by pigeonpea (61.97%) and cowpea (61.49%). Chickpea though recorded the highest number of eggs/100 seeds and the highest number of adult emergence/100 seeds showed comparatively less percent adult emergence (56.07%) may be because of overcrowding. However, adult emergence percent was lowest in horsegram (18.29%) followed by mothbean (19.86%). Results obtained can be compared with Jaiswal *et al.* (2019) who reported maximum adult survival percent in chickpea (90.33%) followed by cowpea (87.67%) and red gram (83.33%). The other pulses green gram and urdbean recorded 80% and 78% adult survival, respectively. The higher percentage of adult emergence to egg laying in some pulses indicates the suitability of these pulses that favor the development and growth of *C. maculatus*. Low adult emergence percentage in horse gram and mothbeanindicates the presence of some growth inhibitory chemicals in these pulses that need to be identified and can be used in resistance breeding programmes in the future.

## CONCLUSION

Data generated during present investigation revealed that, development of pulse beetle *C. maculatus* is significantly affected by the type of pulses. Pulses such as gram, pigeopnpea, cowpea, mungbean and urdbean supported fast

development of *C. maculatus* whereas pulses like green pea, wal, mothbean and horsegram were found comparatively less supportive for its development. Amongst different pulses tested, fastest development of *C. maculatus* was observed on chickpea while it was slowest on horsegram.

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