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Biology of Pulse Beetle (*Callosbruchus chinensis*) on Green Gram under Laboratory condition

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ABSTRACT: Laboratory study on biology of pulse beetle (*C. chinensis*) on stored green gram revealed that insect complete one generation from late August to first week of October when average temperature and relative humidity was 32.26 to 24.87° C and 89.19 to 75.16 per cent, respectively. The incubation period, larval and pupal period and total developmental period of *C. chinensis* was varied from 3 to 6 days, 21-26 days and 31 to 42 days, respectively. The adult duration was 6 to 11 days where male lived longer than female. Pre oviposition, oviposition and post oviposition period was zero to one day, 6 to 8 days and 1 to 2 days, respectively. Total number of egg laid by five female was 525 with an average of 105 eggs per female. Sex ratio of male to female was 1: 1.27. The hatching percentage was 92 per cent. The multiplication rate from 5 pair of insect was 435 with an average of 87 from a single pair at the end of generation.

Keywords: Pulse beetle, Green gram, *Callosobruchus chinensis*, biology.

INTRODUCTION

Pulses are the leguminous plants; belongs to the family leguminosae and sub-family papilionoideae. These are nutrient rich crops. These are very good source of plant-based protein and micronutrients, where the fat content is low and dietary fibre is high. Furthermore, it has a crucial role in soil health maintenance and improvement**.** On the basis of their importance, 2016 was declared as the International Year of Pulses by the 68th session of the United Nations General Assembly. Among the pulses grown, green gram (*Vigna radiata*) is one of the important pulse crop grown in India after chickpea and pigeon pea. It is highly nutritious containing 24.6 per cent protein, 1.0 per cent fat, 56.6 per cent carbohydrate, Ca 0.08g/100g, P 0.045g/100gm, and Fe 5.7mg/100gm and provides 234cal energy per 100gm (Srivastav and Ali, 2004).

Pulses, instead of playing an important role in our daily diet of mostly the vegetarian population, it suffers a great damage by insects and pest during storage. More than 200 species of insect pests are known to attack pulses in field as well as in storage (Zafar *et al.,* 2017). Among which *Callosobruchus* spp. (Chrysomelidae, Coleoptera) is a serious pest which poses very serious threat to pulses both in storage and field. The infestation starts from field, where adult female lays eggs on the maturing green pods, the pest then gain entered into storage bins. The adult pulse beetles do not consume the seed, they only mate and lay eggs on the surface of seed or pod. Damage is caused by grubs which penetrate inside the pod and remain concealed within the developing seeds as hidden infestation rendering them almost hollow, which become unfit for human consumption and production of sprouts.

Earlier, the biology of *Callosobruchus* sp. has been studied by various workers (Raina, 1970; Butani *et al*. 2001; Mondal and Konar, 2006; Pokharkar and Mehta, 2011; Chakraborty and Mondal, 2016; Hosamani *et al*. 2018, Jaiswal *et al*. 2014, Devi *et al.* 2014, Solanki and Mittal, 2018 and Mishra and Jena, 2015) and it is essential to control this pest at right stage of its infestation. Hence, a study has been carried out to understand the biology of *Callosobruchus chinensis* in stored green gram.

MATERIALS AND METHODS

To study biology of *Callosobruchus chinensis* L. in storage, a laboratory experiment was carried out in the Department of Entomology, Dr RPCAU, Pusa, Samastipur, Bihar on green gram variety HUM-16 at normal laboratory condition in the year 2019-20. The data obtained are then analysed statistically by Completely Randomized Design.

Procurement and preparation of seed. The required quantities of green gram grains of variety HUM-16 was procured from Pusa Farm, Dr. RPCAU, Bihar. The grains were then cleaned with the help of scoop and made for sun drying for three days to get healthy grain for experiment purpose.

Collection and rearing of test insect. The species of *Callosobruchus chinensis* were collected from local market from infested seeds of green gram. They were brought to the laboratory and carefully identified and separated on the basis of morphological character. To get pure, uniform and uniparental culture, rearing of the test insect was done separately in 500g of healthy green gram seeds in a plastic jar of 1kg capacity by releasing a single pair of test insect. The freshly emerged adult beetles from this uniparental culture were taken for experimentation.

Biology of *Callosobruchus chinensis* in green gram. For conducting experimental study on biology of the test insect (*Callosobruchus chinensis*) on green gram, six plastic container of 200gm capacity containing 100gm of seeds were taken whose lid has the provision of small holes for proper aeration of the insect. On the next day, five pairs of male and female of *C. chinensis* were taken from the uniparental culture and released in each of the six plastic containers containing fresh green gram seed to facilitate them for egg laying. The plastic containers were suitably labelled and kept as such in normal laboratory condition. On the next day morning, grains were checked for oviposition of pulse beetle. Eggs laid each day on the grains from the first three plastic containers were kept separately in Petri dish and observations on biological parameter were recorded. From the rest three plastic containers the multiplication rate was recorded which were undisturbed from starting (as because while taking observations and handling eggs from first three plastic containers it may cause some disturbance and damage to egg which will affect adult emergence thus affects the data).

The observations were recorded based on the following biological parameters:

a. Egg incubation period: Duration of time taken from egg laying to hatching which was recognized by turning of egg to opaque or creamish white colour due to accumulation of bored material inside the egg.

b. Developmental period (larval and pupal): After hatching larva bore down in the seed making egg shell empty and passes its larval and pupal stages inside the seeds. The indication of pupal stage was formation of net or circular translucent exit hole on the surface of the seed but it is hard enough to record the exact larval and pupal period for the season that it was inside the seed. So, data was recorded as duration of time taken from hatching of egg to adult emergence.

c. Total developmental period: From the day of oviposition to adult emergence.

d. Adult longevity: It was recorded from the day of adult emergence to death of adult.

e. Oviposition details: A period between the time of emergence of female and starting egg laying was considered as pre ovipositional period. Period between starting of egg laying and stopping of egg laying was noted as ovipositional period, while period between stopping of egg laying and death of female was considered as post ovipositional period.

f. Fecundity: The grains containing eggs were replaced daily with healthy grains and total number of eggs laid by an individual was recorded till the female died, which shows the total egg laying capacity of female i.e. fecundity.

g. Hatchability percentage: A total of hundred numbers of eggs on seed were observed separately in a Petri dish and hatchability percentage was recorded using the formula:

$$\frac{\text{Number of hatched egg}}{\text{Total number of eggs observed}} \times 100$$

h. Sex ratio: Number of male / Number of female.

i. Multiplication rate It was recorded as the reproductive potential of insect by counting the number of individual from a single pair of insect at the end of the generation.

RESULTS AND DISCUSSIONS

A. Incubation period

The present observation on different developmental stages of *C. chinensis* revealed that the incubation period was ranged from 3 to 6 days with a mean of 4.3 ± 1.03 days under laboratory condition (Table 1). This observation is in confirmation with Singh *et al*. (2017); Sharma *et al*. (2016); Patel (2005); Solanki and Mittal (2018) who stated that average incubation period of *C. chinensis* were 4.17, 4.20, 4.10 and 4.00 days, respectively. Similar observation was also reported by Sarkar and Bhattacharyya (2015) where the incubation period was ranged from 2.11 to 5.30 days in mung bean infested with *C. chinensis.* However, the present findings contradict with the result of Chakraborty *et al*. (2015) who reported that the egg duration was 6 to 8 days on green gram. This variation is may be due to the climatologically differences especially temperature and relative humidity in the laboratory, geographical location and host seed.

The female of *C. chinensis* laid egg singly often with several eggs on each grain i.e. maximum up to 6-10 egg on single green gram grain. The eggs were cigar shaped, oval, white in colour and smooth in appearance. Freshly laid eggs were transparent and white which firmly attached to the seed surface (Fig. 1) and became milky white colour and opaque before hatching due to accumulation of bored material inside the egg (Fig. 2). This observation is in confirmation with Solanki and Mittal (2018); Verma and Anandhi (2010).

Fig. 1. Freshly laid egg.

Fig. 2. Hatched egg.

B. Larval and pupal period

After hatching, larva bore down inside the seed making egg shell empty and passes its larval and pupal stages inside the seed. The larval and pupal period was ranged from 21-26 days with an average of 24.25 ± 1.65 days (Table 1) which is in agreement with Thakur and Pathania (2013); Singh *et al*. (2017); Patel *et al*. (2005); Varma and Anandhi (2010) and Raina (1970). The grub looks short, creamy color, apodous, with brown color head and 'C' shaped scarabeiform larvae (Fig. 3). Pupa is the inactive stage; it is white to creamy color and obtect type. The indication of pupal stage was formation of circular translucent exit hole or circular window on the surface of the seed by the last instar grub (Fig. 4). The morphology of larva is in confirmation with Verma and Anandhi (2010) who reported that the larvae is 'C' shaped, apodous, short, stout, creamy color with brown color head.

Fig. 3. Larvae.

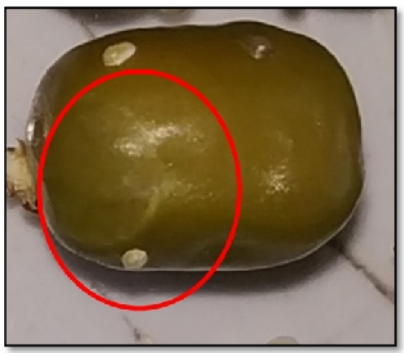

Fig. 4. Window form by the last instar grub indicating pupation.

C. Adult emergance

A characteristics circular window was cut by the last instar grub before pupation through which the adult emerged (Fig. 4). During emergence of adult the head of adult come out first which chew and remove the circular window with its mandible **(**Fig. 5 and 6). Adult beetles were brownish beetle, oval in shape with black, grey and white patches. The elytra look pale brown colour with small dark patches in the middle. In female the elytra were shorter compared to rest of the body, where the tip of abdomen exposed beyond hard wing cover. The portion of abdomen that was visible is white in colour and marked with two black oval spots (Fig. 7). The adults are capable of flight. This species shows sexual dimorphism where the antenna is pectinate type in male where as in female it shows serrate type of antenna. The adult female looks larger than male and also it was heavier than male. This observation with respect to adult beetle is in confirmation with Devi *et al*. (2014); Augustine and Balikai (2018); Solanki and Mittal (2018); Verma and Anandhi (2010).

Fig. 5. Removal of circular piece by the adult to emerge.

Fig. 6. Freshly emerged beetle.

Male

Female

Fig. 7. Adult male and female of *C. chinensis.*

D. Adult longevity

In the present study the adult duration was 6 to 11 days with a mean of 8.15 ± 1.66 days. Adult male lived for 6 to 9 days with an average of 7.10 ± 1.02 where as female lived for 7 to 11 days with an average of 8.75 ± 1.33 days (Table 1). It represents that female of *C. chinensis* lived longer than male beetle. The present result is in confirmation with Chakraborty and Mondal (2015); Verma and Anandhi (2010); Augustine and Balikai (2018).

Table 1: Developmental period of different stages of *Callosobruchus chinensis* on green gram var. HUM 16 under laboratory condition.

Developmental stages	Duration in days		
	Min.	Max.	Mean ± S.D. (n=20)
Incubation Period	3	6	4.3 ± 1.03
Larval - Pupal period	21	26	24.25 ± 1.65
Adult longevity	6	11	8.15 ± 1.66
i. Male	6	9	7.10 ± 1.02
ii. Female	7	11	8.75 ± 1.33
Total life cycle	31	42	36.3 ± 3.65
Pre oviposition Period	0	1	0.25 ± 0.44
Oviposition period	6	8	7.05 ± 0.75
Post oviposition period	1	2	1.55 ± 0.51

n = sample size, S.D. = Standard deviation

E. Total life cycle/ total developemental period

In present study the total developmental period of *C. chinensis* was varied from 31 to 42 days with an average of 36.3 ± 3.65 days on green gram (Table 1). It took nearly one and half month to complete its life cycle. These findings are in confirmation with Chakraborty and Mondal (2015); Jaiswal *et al*. (2018); Hosamani *et al*. (2018); Thakur and Pathania (2013). While it contradicts with the result of Quazi (2007); Samyuktha (2019) who reported that average life span of *C. chinensis* were 22 days and 24.65 days, respectively. This difference in adult longevity may be due to difference in environment condition or difference in temperature and relative humidity in different geographical location and laboratory.

F. Ovipositional details

In present study it was recorded that the pre oviposition period, oviposition period and post oviposition period of *C. chinensis* was zero to one day, 6 to 8 days and 1 to 2 days with an average of 0.25 ± 0.44 days, 7.05 ± 0.75 days and 1.55 ± 0.51 days, respectively (Table 1). This is in confirmation with Verma and Anandhi (2010); Augustine and Balikai (2018); Singh *et al*. (2017).

G. Fecundity

In the present study, as many as ten eggs per green gram seed was observed with more eggs on bold seed. The result revealed that number of female released to the treatment was 5 and at the end of oviposition (during 8 days of egg laying), total number of egg laid by five female was 525 with an average of 105 eggs per female (Table 2). Maximum numbers of eggs were laid on second day of adult release followed by first day, thereafter the number of eggs laid diminished gradually till the end of oviposition with no egg being laid on 9th day. Female was capable of egg laying till the death of male bruchid although it alive till 11th day (Table 1). After the death of male, the female oviposition gradually decreased and stopped. The increment of egg laying also showed that green gram is the preferable host for deposition of more egg. It is in confirmation with the result of Chakraborty and Mondal (2015) who reported that total number of egg laid by five female is 510 with an average of 102 eggs per female. This result is also more or less confirmation with Quazi (2007); Jaiswal *et al.* (2018); Thakur and Pathania (2013); Radha and Susheela (2014).

H. Hatchability

Hatching of egg was identified by observing the difference in colour of egg from translucent to white (Fig. 2). This turning of egg to opaque or creamish white colour is due to accumulation of bored material inside the egg. All the egg laid by the insect would not hatch because of the competition created by population density (multiple eggs per seed) and even if it hatches, it would result in developmental malformation. So, to record hatchability of eggs, one egg per seed was taken by removing all other seed with the help of forceps to eliminate the competition. In the present study total number of seeds observed was 100 with one egg per seed and the hatching percentage was 92 per cent with 92 number of hatched egg (Table 2). This result is in agreement with the result of Singh *et al*. (2017); Chakraborty and Mondal (2015); Sarkar and Bhattacharyya (2015).

I. Sex ratio

In present study total numbers of adult observed were 50 and sex ratio was confirmed based on distinguished character of male and female. The result revealed that the sex development of male and female was 44 per cent and 56 per cent, respectively with 22 number of male and 28 number of female. It showed that the number of male was lower than female. Sex ratio of male and female was 1: 1.27 (Table 2). It is in confirmation with the result of Chakraborty and Mondal (2015); Verma and Anandhi (2010).

K. Multiplication rate

The result revealed that five pair of insect multiplies to 435 at the end of generation. So, the average multiplication rate from single pair was 87 (Table 2). No information is available with respect to multiplication rate. However the result is more or less confirmation with the result of Mondal and Konar

(2006) who reported that the number of adults emerged from a single pair of bruchids was ranged from 33.3 to 73.5 irrespective of generations studied. The difference may be due to difference in temperature and relative humidity of different geographical area and different host variety on which it multiplies.

Table 2: Egg laying capacity, hatchability of egg and sex ratio of *Callosobruchus chinensis.*

Parameters		Observations	
Egg laying capacity	Number of female observed 5	Number of egg laid by 5 female 525	Average number of egg laid by single female 105
Hatchability	Number of eggs observed 100	Number of eggs hatched 92	Per cent hatchability 92
Sex ratio of male and female	Total number of adult observed 50 (Male 22 and Female 28)	Sex development percentage	Sex ratio
		Male : 44% Female : 56%	1:1.27
Multiplication rate	Pair of insect released 5	Multiplication rate from five pair 435	Average multiplication rate from single pair 87

FUTURE SCOPE

The current research paves the way to provide awareness to the farmers about the nature and extent of damage caused by the pulse beetle in stored green gram. For management purpose it is essential to know about the biology of pest and the studies on biology of pulse beetle, *Callosobruchus chinensis* L. will help in adopting proper control measures against this pest.

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Conflict of Interest. None.

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