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BIOLOGY STUDIES OF PULSE BEETLE *(Callosobruchus chinensis* L.) ON CHICKPEA UNDER AMBIENT STORAGE CONDITIONS

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Abstract

Callosobruchus chinensis adults and raised them on chickpea seeds that were cleaned. They. Wrote down how long it took for the *Callosobruchus chinensis* to go through each stage of life like the egg stage the larval stage, the pupal stage and the adult stage. They also looked at how eggs the female *Callosobruchus chinensis* laid, how many of those eggs hatched and how many males and females there were.The time it took for the eggs to hatch was 4.49 days. The *Callosobruchus chinensis* went through four stages of growth as larvae. This took about 18.10 days in total. The stage when the *Callosobruchus chinensis* was a pupa lasted 7.15 days. Each female *Callosobruchus chinensis* laid about 86.27 eggs and about 83.17 percent of those eggs hatched. The adults lived for 8.98 days. There were female *Callosobruchus chinensis* than males.These results show that *Callosobruchus chinensis* can grow and have babies quickly on stored chickpea. This means that the *Callosobruchus chinensis* population can get very big fast so we need to protect the stored chickpea, from the *Callosobruchus chinensis* after it is harvested.

Introduction

Chickpea (Cicer arietinum L.) is one of the most significant pulse crops that are grown and eaten in the entire world especially in the semi-arid and sub-tropical areas. It is a family belonging to the Fabaceae which is usually referred to as gram or Bengal gram. The history of Chickpea is said to have been in the Mediterranean area and has been grown over thousands of years because of its broad adaptability to various agro-climatic factors, good nutrition and economic significance (Singh et al., 1997). Chickpea has remained a leading pulse crop in India. The area covered under Bengal gram in rabi 202324 was 104.74 lakh ha (258.82 lakh acres) as against 110.71 lakh ha (273.57 lakh acres) in rabi 202223. India has some of the largest producers of chickpea with Maharashtra (26.30 lakh ha), Madhya Pradesh (23.46 lakh ha), Rajasthan

(19.38 lakh ha), and Karnataka (9.62 lakh ha) recording the highest production. The final estimates of the Government of India show that the total production of Bengal gram in India during 202223 was 122.67 lakh tonnes (Agricultural Market Intelligence Centre, 2024).

Other than the nutritional value, chickpea is also vital in the sustainability of soil and the sustainability of agriculture. The fact that it is a leguminous crop means that it has a symbiotic relationship with Rhizobium bacteria, which allows the fixation of biological nitrogen and hence increases the soil fertility besides decreasing the reliance on synthetic nitrogen fertilizers. It is incorporated in crop rotation systems and enhances the soil structure, sparks off microbial activities and also enhances the productivity of the crops that follow. Due to these advantageous qualities, chickpea is considered to be an indispensable element of sustainable and low-input agriculture (Giller, 2001).

Although chickpea has agronomic and nutritional significance, it is extremely susceptible to post-harvest insect pests in the storage process. *Callosobruchus chinensis* (L.) is one of the most devastating stored chickpea and other pulse grain pests. This beetle infestation is extremely harmful and leads to grain perforation and powder formation, and worsens of seed quality, decreasing protein and carbohydrate content and germination potential. The pest is especially hard to control due to its short life cycle, fecundity, and capacity to survive and reproduce in a broad spectrum of storage conditions. This means that *C. chinensis* may lead to huge quantitative and qualitative losses in a limited time during the storage process unless timely management measures are implemented (Singh & Tripathi, 2018).

Given the extreme losses incurred due to *C. chinensis* after harvest, there is a need to establish effective and sustainable management protocols in conserving stored chickpea grains and ensuring that the quality of the same is not compromised. The use of botanicals, inert dusts, environmentally friendly powders, and enhanced storage hygiene has been proposed as one of the potential solutions to the traditional methods of control and reduction of infestation and storage loss (Singh and Tripathi, 2018).

Materials and Methods

Insect culture

The pulse beetle, *Callosobruchus chinensis* (L.) was procured as the nucleus culture in the Department of Entomology, Faculty of Agriculture, Kamla Nehru Institute of Physical and Social Sciences, Faridipur Campus, Sultanpur, Uttar Pradesh, India. TheBio-agent Laboratory of the same department under ambient laboratory conditions of temperature and relative humidity kept the culture.

Krishi Vigyan Kendra (KVK), Sultanpur-I, purchased healthy chickpea seeds to use in culturing. Seeds were washed, cleaned and dried in shade and sterilized in a hot air oven at 50 C and kept in a hot air oven at 50 C in 24 hours to get rid of any pre-existing infestation. The sterilized seeds were then utilized in maintaining the stock culture and also in carrying out the experimental studies.

Maintenance of culture

To sustain the consistent and constant insect culture, ten one-day-old adults were added to plastic jars (15 × 10 cm; 250 mL volume), with 100 g of sterilized chickpea seeds. These cultures were started on separate dates and kept in three replications to have a constant supply of insects of the same age to be experimented with. The

muslin cloths were used and attached to the jars using rubber bands so as to ensure that the insects could not escape and contaminate them. The emancipated adults were taken off three days after oviposition. Handling was done with the greatest care not to come into direct contact with the insects or seeds. Seed and insect transfer was done with a camel hair brush, forceps and aspirator.

Mass culturing

C. chinensis was mass cultured by placing 5-10 freshly emerged adults in plastic containers (5 × 5 cm) with 350g of sterilized chickpea seeds in each. The containers were lined with muslin cloth and rubber bands were used to ensure that the insects did not escape and to avoid outside contamination. The culture was kept under ambient lab conditions and used in future experiments.

Monitoring of biological parameters.

Egg incubation period

The incubation period was also noted as the time between the egg hatching and laying of the egg. The change in the appearance of the egg, as the egg became opaque and not clear anymore, and the presence of bored material inside the chorion were identified as the symptoms of hatching.

Larval period

Larval period and instar numbers were calculated by isolating and counting the seeds with single eggs deposited on the same day. It was only one egg per seed that was retained to enable proper recording of the larval development. Larval development time was recorded until pupation.

Pupal period

The pupal stage was counted when the pupal chamber or the window appeared within the seed till the adult beetle appeared.

Oviposition period

In order to observe oviposition, newly emerged mated females were put separately in plastic containers (5 cm diameter) with chickpea seeds. The observations were made starting with the onset of the egg laying up to the end of oviposition.

Fecundity

Fecundity was calculated by the total sum of the eggs laid per female during the oviposition period.

Adult longevity

The adult beetle longevity of males and females was recorded independently starting on the date of adult emergence up to death.

Experimental site

Experiments were performed all in the Department of Entomology, Faculty of Agriculture, Kamla Nehru Institute of Physical and Social Sciences, Faridipur Campus, Sultanpur, Uttar Pradesh, India.

Geographical location

The experimental location is 26 27 0 N latitude and 82 07 0 E longitude and 95 m above the mean sea level (MSL). The Sultanpur district, which is in the eastern region of Uttar Pradesh, is an area of 4,436 km2. It is bordered by the Ayodhya district to the north, Ambedkar Nagar to the east, Jaunpur to the south, Amethi to the west, and Pratapgarh to the south-west.

Climatic conditions

The Sultanpur district climate is sub-tropical in nature with hot summers, monsoon season with moderate to high precipitation and cold winters. The rainfall is received mostly between June and

September, and in some cases, there may be pre-monsoon shower in the spring. The winter conditions normally start in late December and can last until the end of January. The experiments conducted on different biological features of *C. chinensis* were conducted under natural laboratory conditions that were prevailing in the experimental site.

Results and Discussion

Biology of *Callosobruchus chinensis* L. in ambient storage was studied and the findings showed that the pest had successfully completed its life cycle on the grains that were stored and this showed the suitability of chickpea as a host. Eggs took an incubation period of 3-5 days with an average incubation period of 4.49 +0.13 days. This observation closely compares with the findings of Howe (1971) and Rahman and Talukder (2006) who also found a similar incubation time of *C. chinensis* on stored pulses.

The larval stages were filled with four instar stages. The first instar lasted between 3.2 and 5.1 days with a mean of 4.32 + 0.13 days which is similar to the results of Southgate (1979) and Khaire *et al*., (1992). The second instar took between 4.0 and 6.3 days with a mean time of 5.31 ± 0.16 days, and these findings are in agreement with the findings of Singh and Pant (1980) and Rahman *et al*., (2008). The 3rd instar stage lasted between 3.4 and 5.2 days with a mean duration of 3.95 + 0.12 days, which agrees with the results of Khaire *et al*., (1992) and Park *et al*., (2003). The fourth instar took between 5.8 and 7.3 days to complete with a mean

of 6.21 0.19 days averages in line with the findings reported by Southgate *et al*., (1968) and Islam *et al.,* (2010).

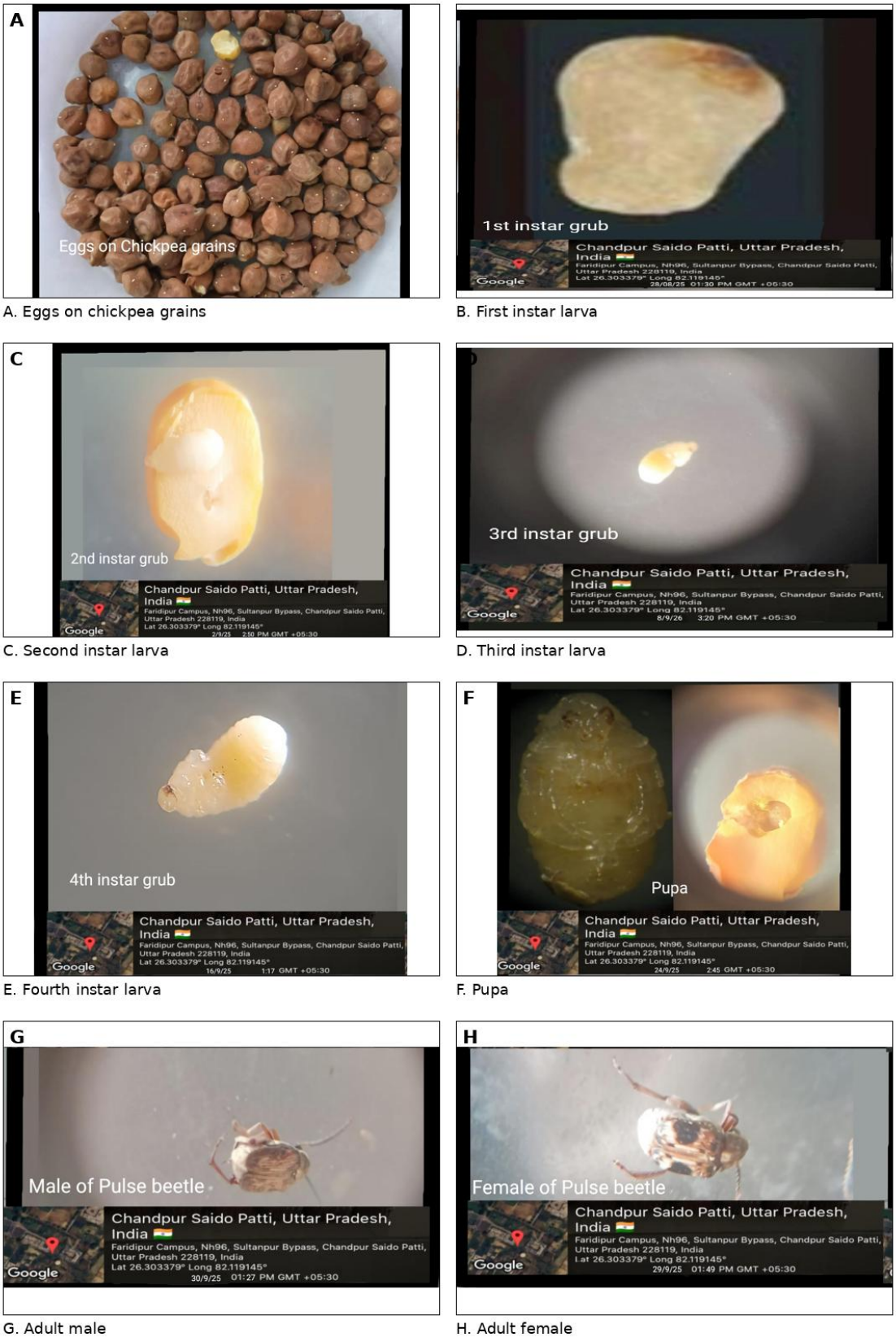

Plate1. Representative life stages of *Callosobruchus chinensis* on chickpea under ambient storage conditions.

Table 1. Biology Studies of pulse beetle on chickpea under ambient stored condition

Developmental Stages	Range (Min. & Max.)	Mean±SD
Egg (Incubation period) (days)	3-5	4.49 ±0.13
1st instar (days)	3.2-5.1	4.32 ±0.13
2nd instar (days)	4.0-6.3	5.31 ±0.16
3rd instar (days)	3.4-5.2	3.95 ±0.12
4th instar (days)	5.8-7.3	6.21 ±0.19
Complete grub period	16.5-23.0	18.1 0±0.54
Pupal period (days)	7-8	7.15 ±0.21
Pre-oviposition (days)	5-8	7.32 ± 0.22
Oviposition (days)	5-9	6.58 ±0.20
Fecundity	85-94	86.27 ±2.59
Hatching	82-87	83.17 ±2.50
Sexratio	-	0.83 :1.26
Adult longevity	9-17	8.98 ±0.27
C. D. at 0.05%		**0.10**

S.D.= Standard deviation, C.D.= Critical difference

The larval or grub stage took between 16.5 and 23.0 days with a mean of 18.10 ± 0.54 days. This finding supports the previous observations made by Howe (1971) and Rahman and Talukder (2006) who also found a similar larval development duration in pulse beetles infesting stored legumes. The length of the pupal period was 7-8 days with an average of 7.15 + 0.21 days which is within the range of the findings of Singh and Pant (1980) and Ali *et al.,* (2011).

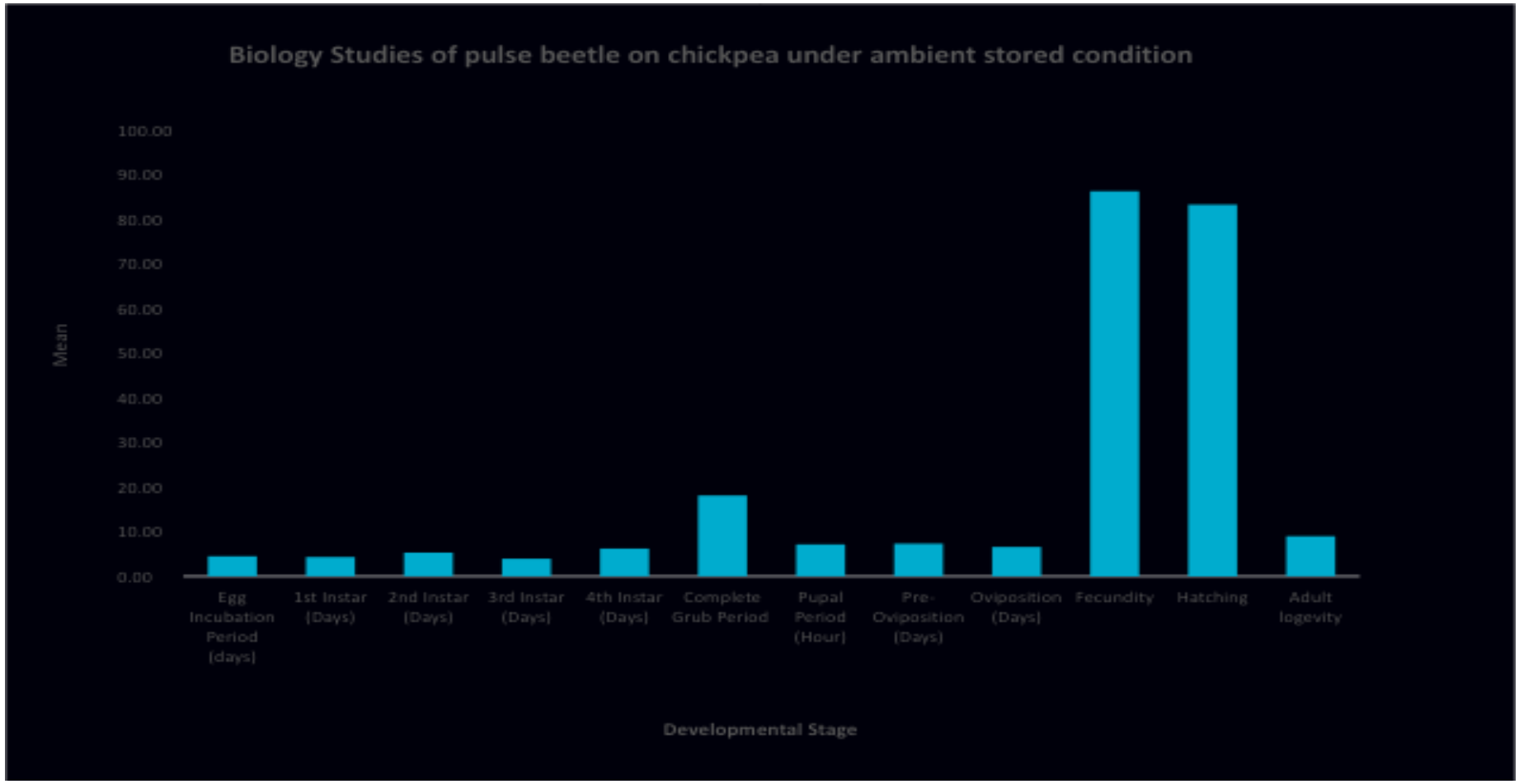

Fig1.Biology Studies of pulse beetle on chickpea under ambient stored condition

In regard to reproductive biology, the pre-oviposition period of adult females was between 5 and 8 days with a mean of 7.32 ± 0.22 days. Oviposition was then followed by 5 to 9 days with an average of 6.58 ± 0.20 days. The results can be compared to the ones of Park *et al.,* (2003), Islam *et al.,* (2010) or Rahman *et al.,* (2008). The fecundity was 85 to 94 eggs/female with an average of 86.27/2.59 eggs/female. The fecundity of the current study compares closely with the previously reported fecundity of *C. chinensis* by Howe (1971) and Southgate (1979) which showed the reproductive potential of *C. chinensis* on chickpea seeds that were stored.

The egg hatching percentage varied from 82 to 87%, with a mean of 83.17 ± 2.50%. This finding is consistent with the findings of Rahman and Talukder (2006) and Islam *et al.,* (2010) who also reported that hatchability was high in amenable storage conditions. There was a variation in the sex ratio, which was 0.83: 1.26, showing uneven emergence of the male and female sex. Singh and Pant (1980), Rahman *et al.,* (2008) and Islam *et al.,* (2010) have also reported similar variations in sex ratio. These differences could be explained by the fact that there are differences in the host suitability, environmental factors, and physiological adaptability of the developing stages.

The adult lifespan was between 9 and 17 days and the mean adult lifespan was 8.98 +/-0.27 days. The results can be compared with the findings of Khaire *et al.,* (1992) and Ali *et al.,* (2011). The relatively brief life cycle, fecundity, and egg hatchability of *C. chinensis* used in the current study are clear indications of the dire pest potential of the organism in stored chickpea. The insect can develop fast and reproduce effectively under the ambient conditions of storage and as a result, it will generate enormous quantitative and qualitative losses unless the relevant management measures are implemented in time. The detailed biological parameters recorded in the present study are presented in Table 1 and illustrated in Fig. 1.

Conclusion

The current research on the biology of *Callosobruchus chinensis* L. on chickpea under ambient storage conditions proved that the insect was able to finish its life cycle effectively and to reproduce successfully on the stored seeds. The incubation period took 3-5 days and the larval development was done in 4 instar stages taking an approximate of 18 days to develop. The pupal stage took a period of 7 days and adults lived 9-17 days under the available conditions.

The pre-oviposition period of female beetles was 5-8 days, and oviposition period 5-9 days. The mean fecundity was 86.27 eggs per female, and the mean egg hatching was 83.17 which showed the high reproductive potential and good settlement of the pest in the chickpea seeds. Sex ratio also varied, which also indicated the different emergence of males and females in storage conditions.

In general, the findings affirm that chickpea offers a very appropriate substrate to the growth and multiplication of C. chinensis. The destructive potential of the insect as a serious storehouse pest of chickpea is highlighted by the relatively short period of development, high fecundity and high survival rate. Thus, proper and prompt management practices are necessary to reduce losses that occur during post-harvest, maintain seed quality and guarantee safe storage of chickpea grains.

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