Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(4): 27-29

Received: 18-05-2020
Accepted: 19-06-2020

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Field biology of *Callosobruchus chinensis* (L.) on Green gram, *Vigna radiata* (L.) and Black gram, *Vigna mungo* (L.) in two different seasons

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Abstract
Field experiment was conducted to examine the biology of *Callosobruchus chinensis* (L.) during summer and winter season considering green gram (variety-Pratap) and black gram (variety-KU301) as host plants. In green gram, the incubation period was 4.92±0.14 days and 6.24±0.13 days, larval period was 17.50±0.12 days and 23.57±0.18 days, pupal period was 7.53±0.09 days and 9.41±0.07 days, total developmental period was 29.95±0.21 days and 39.22±0.22 days during summer and winter respectively. In black gram, the incubation period was 5.46±0.12 days and 7.37±0.15 days, larval period was 18.28±0.08 days and 24.50±0.12 days, the pupal period was 8.17±0.07 days and 10.12±0.12 days, the total developmental period was 31.91±0.15 days and 42.08±0.21 days during summer and winter respectively. The data revealed that the developmental period was shorter in the summer season than in the winter season and also the total developmental period was longer in black gram as compared to green gram.

Keywords: Green gram, black gram, *Callosobruchus chinensis*, biology

Introduction
Pulses are considered as a boon for the mankind, they are an essential component in all food baskets and dietary guidelines of the world. The global pulse production was 71 million tons from an area of 79 million hectare with an average yield of 910 kg per hectare during 2015-16 Anonymous [1]. India ranks first in terms of area and production of pulses. India's pulse production was highest in the year 2016-17 which was 22.40 million tons cultivated in an area of 29.27 million hectares Anonymous [1]. Green gram, *Vigna radiata* (L.) and Black gram, *Vigna mungo* (L.) are important pulse crop in the country, offering myriad purposes.
In a major setback to India's striking pulse production figures, a major portion is lost in the process of post-harvest handling and storage. Insects cause up to 20-35% damage to stored grains in tropical regions and 5-10% in the temperate zone Nakakita 1998 [7]. Among these *Callosobruchus chinensis* is the most destructive. It starts its infestation from the field and this primary infestation is carried over to the storage houses. Although field infestation is low but such infestation has serious consequences because the insects multiply very rapidly under favourable conditions in the storage Taylor [9]. An insight on the biology of the pulse beetle is essential to bring out an appropriate management strategy so as to minimize the damage. Keeping this in view a field experiment was conducted to study the biology of *Callosobruchus chinensis* (L.) on Green gram, *Vigna radiata* (L.) and Black gram, *Vigna mungo* (L.) in two different seasons.

Materials and Methods
The culture of the *Callosobruchus chinensis* (L.) was maintained in the Physiology laboratory, Department of Entomology, Assam Agricultural University, Jorhat. The experiment was conducted at the ICR farm, AAU, Jorhat. Green gram (variety-Pratap) and black gram (variety-KU301) were sown in the month of February and also in the month of August in a plot size of 20 X 15 m. All other agronomic practices were followed to raise the crop. Pesticide use was totally restricted. To facilitate egg laying in the field condition, cloth bags (30×15 cm) were prepared by folding the muslin cloth and supported from inside by hard foam sheets . The sides were stiched so that the two ends remained open. After pod formation, four mature pods were selected and covered by a cloth bag.

A single pair of 0-24 hr old adult beetle was released in each bag. The open ends of the bags were tightly closed with a thread after releasing the pair of adult pulse beetle. The beetles were removed after 24 hrs to have the same date of oviposition. The pods were removed from the cloth bag and observed under microscope. Fecundity**,** incubation period (days)**,** larval period (days)**,** pupal period (days)**,** total developmental period (days) and adult longevity (days) were recorded for both the seasons. The total developmental period was determined by counting the days between oviposition by the released adults and the first adult emergence Borah [3]. The data was subjected to t- test for independent sample and analyzed using SPSS -16 software.

Results and Discussion

The results pertaining to the biology of *C. chinensis* (L.) in green gram and black gram are presented in table 1 and table 2 respectively. The criteria considered were fecundity, incubation period, larval period, pupal period, total developmental period and adult longevity.

Fecundity (number of eggs laid per day per female)

It was seen that the female beetles laid eggs on the pod wall of the host plants. Fecundity was found to be significantly different during both the seasons *i.e*. summer and winter. In the pods of green gram the mean fecundity during summer was found to be 4.96±0.13 and 3.60±0.19 in the winter season. The mean fecundity in the pods of black gram was 3.10±0.12 during summer and 1.57±0.11 in the winter season. No relevant literature was found regarding fecundity to compare with the findings.

Incubation period

The incubation period of *C. chinensis* (L.) varied significantly during both the seasons. During summer season in green gram, incubation period was 4.92±0.14 days and 6.24±0.13 days during winter. In black gram, incubation period was 5.46±0.12 days and 7.37±0.15 days during summer and winter season respectively. Mondal and Chakraborty 2016[4] reported that the incubation period of *C. chinensis* (L.) during October- November was 6.03 days while the incubation period during April-May was 5.35 days. Similar results were reported by Vidyashree 2013 [11] and Pandey and Singh 1997 [8].

Larval period

The insect went through four larval instars and the larval period of *C. chinensis* (L.) varied significantly during both the seasons. In green gram, the larval period was 17.50±0.12 days in the summer season and 23.57±0.18 days in the winter season. The larval period in black gram was 18.28±0.08 days during the summer season and 24.50±0.12 days during the winter season. The results are in conformity to Vidyashree 2013 [11], reported the larval period of *C. maculates* (Fab.) on chickpea during April-May was 18-26 days and the larval period during November-December was 36-44 days. Similar results were reported by Pandey and Singh 1997 [8] and Venkate Gowda 1984 [10].

Pupal period

The pupa was cream in colour and the pupal period of *C. chinensis* (L.) varied significantly during both the seasons. The insect had undergone a mean pupal period of 7.53±0.09 days in the summer season and 9.41±0.07 days in the winter season in green gram. In black gram, the pupal period was 8.17±0.07 days and 10.21±0.12 days in the summer season and winter season respectively. Similar results were reported by Alice *et al.* [2] who found that the pupal period at 20°C was 8-9 days, however at 30°C, pupal period was 6-7days. Vidyashree 2013 [11] reported the pupal period of *C. maculates* (Fab.) during April-May was 6-7 days, while it was 8-10days in the month of November-December. The results of the present investigation can also be supported with the work by Borah 2001 [3] who studied the field biology of *C. maculates* (Fab.) on green gram genotypes during the kharif season and found that the pupal period was 7- 8days.

Total developmental period

The developmental period of *C. chinensis* (L.) varied significantly with the seasons. In green gram, the mean developmental period was 29.95±0.21 days in the summer season and 39.22±0.22 days in winter season. The mean developmental period in black gram was 31.91±0.15 days and 42.08±0.21 days during summer and winter season respectively. It was seen that the developmental period increased with decreasing temperature in the winter season and the results are in conformity with Mondal and Chakraborty 2016 [4] and Vidyashree 2013 [11]. Han and An 1990 [6] also reported that the developmental period of *C. chinensis* (L.) increased as temperature decreased from 30 to 20°C. The total developmental period as reported by Alice *et al.* 2013 [2] was 29-30 days at 30°C while at 20°C, the developmental period was 36-39 days which are in conformity to the present findings.

Longevity

In green gram, longevity of the adult male and female *C. chinensis* (L.) varied significantly in both the seasons. In the summer season mean longevity of the adult male was 7.73±0.23 days while it was 10.36±0.21days in the winter season. The adult female had a longevity of 6.70±0.21 days in the summer season while the mean longevity in the winter season was 8.10±0.27 days. In case of black gram, the adult longevity of male and female *C. chinensis* (L.) did not vary significantly in both the season. In the summer season the male longevity was 8.90±0.23 days while in the winter season it was found to be 9.40±0.29 days. The longevity of adult female was 7.40±0.26 days and 6.80±0.20 days during summer and winter season respectively. Mondal and Chakraborty 2016 [4] reported that the longevity of male was longer than the female irrespective of the seasons and that the adults survived longer in the winter season than in the summer season, which is in agreement with the present findings.

Table 1: Biology of *Callosobruchus chinensis* (L.) in green gram

Season	Developmental parameters(Mean ± SE)						
	Fecundity (no.of eggs laid/day/female)	Incubation period	Larval period	Pupal period	Total developmental period	Longivity (male)	Longivity (Female)
Summer	4.96± 0.13	4.92±0.14	17.50±0.12	7.53±0.09	29.95±0.21	7.73±0.23	6.70±0.21
Winter	3.60±0.19	6.24±0.13	23.57±0.18	9.41±0.07	39.22±0.22	10.36±0.21	8.10±0.27
t-value	5.78	18.16	27.13	21.55	34.92	8.70	4.00
Remarks	S	S	S	S	S	S	S

Data represent mean of 28 observations

S- Significant at P≤0.05, NS-Non Significant at *P*>0.05

Table 2: Biology of *Callosobruchus chinensis* (L.) in black gram

Season	Developmental parameters(Mean ± SE)						
	Fecundity (no.of eggs laid/day/female)	Incubation period (Days)	Larval period (Days)	Pupal period (Days)	Total developmental period (Days)	Longivity (male)	Longivity (Female)
Summer	3.10±0.12	5.46±0.12	18.28±0.08	8.17±0.07	31.91±0.15	8.90±0.23	7.40±0.26
Winter	1.57±0.11	7.37±0.15	24.50±0.12	10.21±0.12	42.08±0.21	9.40±0.29	6.80±0.20
t-value	8.70	22.31	53.24	18.33	52.67	0.26	1.80
Remarks	S	S	S	S	S	NS	NS

Data represent mean of 28 observations
S- Significant at P≤0.05, NS-Non Significant at *P*>0.05

Conclusion

From the present study we have seen that *Callosobruchus chinensis* (L) do oviposit in the field condition and this is carried over to the storage. It has been found that the biology of *Callosobruchus chinensis* (L.) differed significantly in both the seasons and from the results we can conclude that the developmental period of *C. chinensis* (L.) was longer in the winter season as compared to the summer season. The males had a longer longevity than the females irrespective of the seasons. Moreover it can be seen that the developmental period was longer in black gram as compared to green gram. This may be det alue to the pod morphology which renders less fecundity of the insect or may be due to varietal differences. The study reveals that temperature can be a major factor in insect growth and development apart from other abiotic factors and can be used as a pest management strategy.

Acknowledgement

The authors are grateful to Dr. Bijon Dutta, Professor of the Department of Entomology and Dr. Anjumani Devi, Assistant Professor of the Department of Entomology, Assam Agricultural University, Jorhat-785013, Assam for their constant support and guidance throughout the course of the work.

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