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Variations in Biological Parameters in Laboratory Condition of Callosobruchus Chinensis Linn. Throughout the Years in Tarai Region,West Bengal in Green Gram (*Vigna Radiata* Linn.)

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ABSTRACT

Pulses are rich in proteins and found to be the main source of protein to vegetarian people of India. It is second important constituent of Indian diet after cereals. They can be grown in all kind of climatic conditions. They give ready cash to farmer. The most important species of storage insect pests of food legumes include: Callosobruchus chinensis Linn. The studies on biology of C. chinensis were carried out on most preferred host pulse green gram. A prolonged oviposition period from 9 to 11 days was observed during January - February. The shortest oviposition period from 4 to 5 days was observed during May. Incubation period was prolonged 7 - 9 days during January-February. The shortest incubation period was observed during May 2 - 4 days. The developmental duration increased as temperature decreased from 30 to 20˚C. Incubation period (6-8 days), larval-pupal period (23-42 days) and total developmental period (29-49 days) was observed to be prolonged during January - February (winter) followed by November - December (winter) in this area. Shortest period of incubation, larval-pupal and developmental was observed during May (summer) followed by April-May(summer) and June-July(rainy season).

KEYWORDS Pulse beetle, Callosobruchus callosobruchus, green gram, biology, temperature, relative humidity

INTRODUCTION

The pulses are a large family and various species are capable or surviving in very different climates and soils. Pulses are rich in proteins and found to be the main source of protein to vegetarian people of India. It is second important constituent of Indian diet after cereals. They can be grown in all kind of climatic conditions. They give ready cash to farmer. Pulses being legumes fix atmospheric nitrogen into the soil. The pulses have played a vital role in the improvement of agricultural economy of different countries (Sarwar et al., 2003; Deeba et al., 2006). Pulse crops are susceptible to many insect pests both during the field and storage. The most important species of storage insect pests of food legumes include: ***Callosobruchus chinensis*** Linn., ***C. maculatus*** Fab***.,*** ***C. analis*** Fab., ***Acanthoscelides obtectus*** Say. and ***Bruchus incarnatus*** Boh. (Bushara,1988 and Kashiwaba et al., 2003). In addition, ***B. rufimanus*** Boh. , ***B. dentipes*** Baudi., ***B. quinqueguttatus*** Oli., B***. emarginatus*** W. , ***B. ervi*** Fro***., B. lentis*** W. and ***B. pisorum*** Linn. may also cause significant losses in some legumes (Bushara,1988 and Desroches ***et al***.,1995). Of many insect pests the pulses are badly damaged by pulse beetles of the genus Callosobruchus (Coleoptera : Bruchidae) during storage throughout the world and this discourages the poor farmers from large-scale production and storage of pulses. Losses as high as 50% may often be encountered in some of the important legumes such as faba bean, field pea, chickpea and lentil from some belligerent storage insect pests like ***C. chinensis*** (Ali and Habtewold,1994; Damte and Dawd, 2006). Even with only a small amount of actual biological losses, economic losses can reach up to 100% (Boeke ***et al***., 2004).

Thus, it is very essential to study about the biological parameters of the said insect pest throughout the year . So that the most infectious period of a year can be identified. The information could help the farmers in the storage of the pulses through traditional storage system.

MATERIALS AND METHODS

The biology of pulse beetle ***C. chinensis*** was carried out under laboratory condition on local variety of green gram (***Vigna radiata*** Linn.) throughout the year. To maintain culture in the laboratory, adults of pulse beetles were collected from the local grain market and the species of ***C. chinensis*** was carefully separated by using stereoscope binocular microscope on the basis of morphological characters i.e. presence of frons with three pairs of setae and conical labrum in adult and then maintained on 100gm disinfected green gram seeds.

Rearing of the insect was done in three plastic containers (5cm diameter x 5 cm) containing 100gm seeds. Freshly emerged five pairs of one day old adults of ***C. chinensis*** were released in each of the three containers . Opening of the containers was covered by muslin cloth to facilitate free aeration. After death, the adults were removed from these containers eggs laid by the females were used for multiplication. In order to facilitate the observation, one egg was kept on each grain, while others were removed with the help of needle. Such 100 grains were kept individually in plastic vials under laboratory condition at a room temperature of 28.62 ± 2.46°C and relative humidity of 82.61 ± 3.96%.

RESULTS

A critical observation on the biology of ***C. chinensis*** revealed that the eggs were oval, plano- convex and broad anteriorly, narrow at the posterior. The freshly laid eggs were translucent, milky- white with yellow tinge and smooth. The eggs later become pale yellowish or grayish. Newly emerged adults of the same age were found to mate within an hour during summer or took a maximum of three hours during winter. The adults were polygamous. After mating the females were laid eggs singly if the seeds were found to be sufficiently but the seeds are insufficient then it laid maximum up to six on a single green gram seed.

The studies on biology of ***C. chinensis*** were carried out on most preferred host pulse green gram. A prolonged oviposition period from 9 to 11 days was observed during January - February. The shortest oviposition period from 4 to 5 days was observed during May. Incubation period was prolonged 7 - 9 days during January-February. The shortest incubation period was observed during May 2 - 4 days. The longest larva l- pupal duration was during January - February and the shortest during June - August, the values were 37- 48 and 17-23 days respectively. The developmental period was as long as 49 days during January - February but 27 days during May. Longevity of the adults vary during different months of a year and also depending upon the sexes. Sex ratio (female : male) showed very little differences in different generations completed throughout the year. In general, the females were of less number than the males. During July - July, August-September and September - October female and male ratio was less than unity. There were differences in fecundity in different generations of a year. Highest fecundity was recorded during June - July with a mean of 77.8. The lowest was during November - December with a mean of 54.36. The hatchability (%) of eggs laid by ***C. chinensis*** on green gram seeds was the highest (78.48 %) during March - April. The lowest hatchability was observed during July- August when the percentage was 41.39. The adult emergence (%) of ***C. chinensis*** varied in different months. Mean adult emergence percentage was in the following descending order 68.3% (April- May) > 56.7% (Mar.- April) > 51.5% (May - June) > 49.3% (Jan- Feb) > 45.8% (Nov.- Dec.) > 38.6 % (Oct.- Nov.) > 30.2% (Sept. - Oct.) > 25.6% (Aug - Sept.) > 24.6% (Jul. - Aug.) > 23.7 % (June- July). Growth index also vary in different months, highest was during April-May (2.47) followed by May (2.09), March – April (1.86), November – December (1.28), May – June (1.26), October - November (1.04), September – October (0.98), July – August (0.90), June - July (0.89), August - September (0.88) and January - February (0.87) (Table 1).

DISCUSSION

The pest infestation on pulses depends on the surrounding environmental conditions as well as maintenance of storage places. Temperature and relative humidity are important climatic factors for growth and development of the bruchid pest. The oviposition period of ***C. chinensis*** tends to increase from the period November - December and was maintained till March - April followed by a noticeable decline in duration in May found minimum during study (Table 1). These differences may be due to differences in food as well as environmental conditions. Obviously the population build up during the period of minimum fecundity can be arrested at a subthreshold level by adopting suitable control measure. The adult female longevity was somewhat greater than the males. These results were in agreement with the study done by Pokharkar and Mehta (2011) . Such differences in adult longevity may be due to differences in temperature and relative humidity.

Studies on percent hatchability

Hatchability percentage has been increased during March - May when relative humidity has been the highest (about 80%) at this time and temperature was around 30˚C. The hatching of eggs laid ***C. chinensis*** was found up to 75.57% and 81% in two successive generations in green gram. The correlation studies also proved that hatchability has a highly significant positive correlation with relative humidity. The emergence of adult also shows a somewhat similar kind of result although the best suitable months for the emergence of adults are November to May (Fig. 1). The present investigation has been carried out round the year in the laboratory where temperature (˚C) and relative humidity (%) varied in different seasons. Rearing protocol in the laboratory remained the same except the natural variations of temperature and relative humidity. Therefore, the differences in respect of the life history criteria of different generations in a year have been influenced by prevailing temperature and humidity. This observation is corroborates somewhat with Han and An (1990) and Pandey and Singh (1997). Han and An(1990) studied the bio-ecology of ***C.chinensis*** in Korea. The developmental duration increased as temperature decreased from 30 to 20˚C. There were 4 generations in a year, with peak adult emergence in May and over wintering took place in stored pulses. Pandey and Singh (1997) studied the biology of ***C. chinensis*** on ***Vigna mungo*** and ***Cicer arietinum***. The incubation period lasted for 4-5 days and combined larval-pupal period for 20-28 days where temperature was 28˚C ± 5. ***C. chinensis*** is polygamous. The adult male mated several times (Begum ***et al***., 1987). The mated females started egg lying within 6-12 hours and usually laid single egg on single green gram seed when seeds are sufficient in number (Utida,1942).

Studies on duration of various life stages

Ovipositional period, incubation period, combined larval-pupal period, developmental period and life span of adult beetles varied significantly in different months. It was noted that with the decreasement of temperature the developmental period increased and the work was corroborate to the work done by Parajulee ***et al.***, 1989. Incubation period (6-8 days), larval-pupal period (23-42 days) and total developmental period (29-49 days) (Table 1) was observed to be prolonged during January - February (winter) followed by November - December (winter) in this area. Shortest period of incubation, larval-pupal and developmental was observed during May (summer) followed by April-May(-summer) and June-July(rainy season). Rajak and Pandey (1965) reported that the life cycle varied from season to season with minimum 27 days and maximum 114 days. Moreover, the grabs hibernated during winter months from November-February. Singh (1997) recorded that low temperature in December and January reduce the development of immature stages of pulse beetle in seeds of green gram while the most suitable month for the development of pre-adult stages of this beetle was July to October. On the other hand Boshra (1993) mentioned that an increasing temperature from 20 to 34˚C shorten the incubation period, larval and pupal durations as well as adult longevity of ***C. chinensis*** and the optimum temperature and relative humidity for the development of immature stages was 27˚C and 70% respectively. All mentioned parameters in this study are negatively correlated and developmental period was highly significant with both temperature and relative humidity. Significant variations in the above mentioned biological parameters during different months might be due to climatologically differences especially temperature and relative humidity in the laboratory .

Studies on growth index

Studies on growth index (Table 1, Fig 2) revealed that the favourable environmental conditions for multiplication of ***C. chinensis*** were ranged between March-May (summer) followed by October-November respectively. The number of generations of ***C. chinensis*** completed in a year were eleven. However, Parajulee ***et al.***, (1989) have recorded 13 overlapping generations/ year at Chitwan district of Nepal. Han and An(1990) have obtained only 4 generations in a year in Central Korea where temperature range 12-30˚C. In the present study, the optimum temperature (23.97-31.55˚C) and r.h. (52.11-75.61%) for fecundity and development of ***C. chinensis*** was recorded during March-April (Summer). Labeyrie (1980) recommended optimal temperature for fecundity and development of stored product insect ranged 25-30˚C. Prevailing temperature (26.26-30.42˚C) and r.h.(72.11-85.21 %) during rainy season of this area was not susceptible for the growth and development of ***C. chinensis***. Atmospheric humidity during these period (June-October) was considerably higher in comparison to that of other months. Humidity and grain moisture contents are closely related factors. Even though stored green gram seeds are dried to reach the safe moisture level before storage, moisture content is due course comes to equilibrium with humidity in the air after a certain period of time.

CONCLUSSION

The results of the study show that the developmental period of the egg to adult was around a month. During optimum period of growth e.g. July-August the duration of developmental period shortened and the life cycle completed within very short period causing huge damage to seeds. But during unfavorable conditions depending on the food supply, temperature and humidity duration of developmental period may increase. Moreover the beetle could breed throughout the year. The current research paves the way to provide awareness to the farmers about the nature and extent of damage caused by the beetle in storage.

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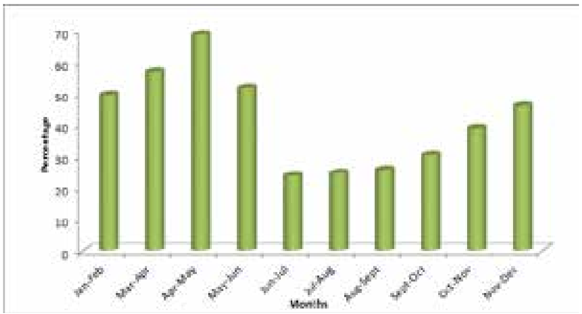

Fig. 1. Variations in adult emergence of *C. chinensis* during the different months of a year on green gram

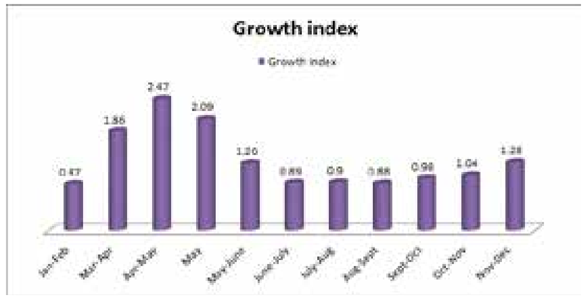

Fig. 2. Variations in growth index of *C. chinensis* during the different months of a year on green gram

Table 1. Biological parameters of *C. chinensis* studied on green gram throughout the year under laboratory condition

Month	Oviposition period (days)	Incubation period (days)	Hatchability (%)	Developmental period (= Larval-Pupal) (Days)	Adult emergence (%)	Longevity of adults (days)		Sex ratio (♀: ♀)	Growth index
						Female	Male		
Jan - Feb	10.12±1.13	8.03±0.96	69.21±1.18	39.25±3.81	49.3±2.16	12.01±2.16	14.11±2.02	1:1.1	0.87(11)
Mar - Apr	8.32±1.69	7.12±0.56	78.48±1.52	22.25±2.16	56.70±5.15	7.58±0.78	9.70±1.13	1:2.19	1.86(3)
Apr - May	7.36±0.36	5.35±0.74	70.32±1.02	21.00±2.62	68.3±3.08	6.66±0.50	7.90±0.74	1:1.83	2.47(1)
May	4.12±0.52	3.19±0.79	66.12±1.17	20.75±2.19	47.75±4.72	6.50±0.53	7.27±1.25	1:1.99	2.09(2)
May - June	5.36±0.23	4.36±0.81	47.36±1.08	20.62±1.78	51.5±5.29	6.40±0.54	7.45±2.51	1:1.26	1.26(5)
June - July	5.62±1.03	4.78±0.86	46.64±1.18	19.69±2.45	23.7±3.09	7.36±0.18	8.18±1.16	1 :0.78	0.89(9)
July - Aug	6.21±0.52	5.69±0.52	41.39±2.56	20.59±2.69	24.6±3.45	7.79±1.06	8.33±1.01	1:1.13	0.90(8)
Aug - Sept	6.51±0.61	5.36±0.23	54.61±2.31	22.71±3.52	25.6±3.59	7.87±0.25	8.79±0.77	1:0.52	0.88(10)
Sept - Oct	6.45±1.02	5.76±0.51	64.37±2.01	24.35±2.02	30.2±3.39	7.92±0.89	8.98±0.78	1:0.73	0.98(7)
Oct - Nov	7.25±0.36	6.03±0.84	58.25±3.65	25.62±2.71	38.61±4.69	8.54±2.31	9.35±1.05	1:1.28	1.04(6)
Nov - Dec	9.23±0.76	7.46±0.71	62.36±1.09	31.06±3.06	45.8±5.73	9.07±1.08	11.79±1.43	1:0.89	1.28(4)
SEm (±)	0.51	0.31	1.78	0.89	1.86	0.61	0.52	-	0.06
CD (p=0.05)	1.47	1.02	3.98	1.84	4.19	1.09	1.08	-	0.09

In a column data following **±** indicate SD values
In a column, data in parentheses indicate ranking

REFERENCES

1. Ali, K. and Habtewold, T. 1994. Research on Insect Pests of Cool-Season Food Legumes. In ***Cool-Season Food Legumes of Ethiopia***, Proceedings of the First National Cool-Season Food Legumes Review Conference, Addis Ababa, Ethiopia, 16–20 December 1993; Tilaye, A., Bejiga, G., Saxena, M.C., Solh, M.B., Eds.; ICARDA/IAR: Aleppo, Syria, 367-396.
2. Bushara, A. G. 1988. Insect Depredation during Storage. In ***World Crops: Cool Season Food Legumes***; Summerfield, R. J., Ed.; Kluwer: Dordrecht, the Netherlands, 367-378.
3. Boshra, S. 1993. Some factors affecting the longevity, oviposition and rate of development of ***Callosobruchus chinensis*** Linn. during storage, ***Bull. Ent. Soc. Egypt***, **71**: 163-171**.**
4. Begum, D.A. ; Taslima; Khan, M.Z.A.; Khatoon, N.; Howlader, A.J. and Ahmed, M. (1987). The influence of mating on fecundity, fertility and adult longevity of pulse beetle, ***Callosobruchus chinensis*** Linn. Annual Bangladesh Science Conference, Dhaka, Bangladesh, 10-14 Jan., 1987.
5. Boeke, S. J. ; van Loon, J. J. A. ; van Huis, A. and Dicke, M. 2004a. Host preference of ***Callosobruchus maculatus***: a comparison of the response of ***Callosobruchus maculatus*** (Coleoptera: Bruchidae) to a resistant variety of cowpea. ***J. Stored Prod. Res.,*** **22**: 227-233.
6. Deeba, F., Sarwar, M. and Khuhruo, R. D. 2006. Varietal susceptibility of Mungbean Genotypes to Pulse beetle, ***Callosobruchus analis*** (F.) (Coleoptera: Bruchidae) . ***Pakistan J. Zool***., **38**: 265-268.
7. Damte, T. and Dawd, M. 2006. Chick pea, lentil and grass pea insect pest research in Ethiopia: A review. In ***Food and Forage Legumes of Ethiopia: Progress and Prospects***, Proceedings of a Workshop on Food and Forage Legumes, Addis Ababa, Ethiopia, 22–26 September 2003; Ali, K., Keneni, G., Ahmed, S., Malhotra, R., Beniwal, S., Makkouk, K., Halila, M.H., Eds.; ICARDA: Aleppo, Syria, 260-273.
8. Desroches, P.; Elshazly, E.; Mandon, N.; Duc, G.; Huignard, J. **1995.** Development of ***Callosobruchus chinensis*** (L.) and C. ***maculatus*** (F.) (Coleoptera: Bruchidae) L. in seeds of ***Vicia faba*** differing in tannin, convicine and vicine Contents. ***J. Stored Prod. Res***. **31**:83-89.
9. Han, E. D. and An, J. H. (1990). Studies on ecology and control of the azuki bean weevil ***Callosobruchus chinensis*** (Linn.), in Korea. ***Res. Rep. Rural Dev. Adm. Crop Prot***., **32** : 24-59.
10. Kashiwaba, K.; Tomooka, N.; Kaga, A.; Han, O.K.; Vaughan, D. A. 2003. Characterization of resistance to three bruchid species (***Callosobruchus*** spp., Coleoptera, Bruchidae) in cultivated rice bean (***Vigna umbellata***). ***J. Econ. Ent***., **96**: 207-213.
11. Labeyrie, V. 1980. The ecology of bruchids attaching legumes(pulses). Proceedings on the International Symposium held at Tour (France), April 16-19, 1980.
12. Pandey, N. K. and Singh, S.C. 1997. Observation on the biology of pulse beetle, ***Callosobruchus chinensis*** (Linn.) infested stored pulses. ***Uttar Pradesh J. Zool.***, **17**: 38 – 42.
13. Pokharkar, P. K. and Mehta, D. M. 2011. Biology of pulses beetle, ***Callosobruchus chinensis*** in stored chickpea. ***Prog. Agric***., **11**: 34 – 36.
14. Parajulee, M. N.; Neupane,F. P. and Thapa, R. B.1989. Life and seasonal histories, host preference and control of pulse beetle, ***Callosobruchus chinensis*** (Linn.) (Coleoptera:Bruchidae). ***J. Ins. Agril. Ani. Sci***., **10**:1-6.
15. Rajak, R. L. and Pandey, N. D. 1965. A life history study of the pulses beetle ***Callosobruchus chinensis***(L) (Coleoptera: Bruchidae). Labdev. ***J. Sci. Tech***., **3**: 119-123.
16. Sarwar, M.; Ahmad, N.; Siddiqui, Q. H.; Mohammad, R.; Sattar, M. and Toufiq, M. 2003. Varietal resistance in stored mung bean against the infestation of pulse beetle, ***Callosobruchus anali*** (Fabricius) (Coleoptera:Bruchidae). ***Pakistan J. Zool.***, **35**: 301-305.
17. Singh, S. 1997. Ovipositional behaviour and development of three species of bruchids under field condition. ***Ann. Plant Prot. Sci.***, **5**: 214-215.
18. Utida, S. 1942. Studies on the experimental population of the azuki bean weevil ***Callosobruchus chinensis Linn***. VI The relationship between the size of the environment and rate of population growth., ***Mem. Coll. Agric***. Kyoto, **53**: 1-8.