

SUSCEPTIBILITY OF DIFFERENT STORED PULSES INFESTED BY PULSE BEETLE, *Callosobruchus chinensis* (LIN.)

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Abstract

The susceptibility of different stored pulses infested by *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) was observed in three varieties of stored pulses i.e. gram (*Cicer arietinum* L.), pea (*Pisum sativum* L.) and mung (*Vigna radiata* L.) during April, 2017 to May, 2018. The longest incubation-, larval- and pupal period of pulse beetle were in gram 5.4 ± 0.29 , 12.6 ± 0.25 , 5.5 ± 0.32 days, respectively and the shortest were in mung 4.6 ± 0.25 , 11.3 ± 0.28 , 4.2 ± 0.19 days, respectively. The shortest developmental period of pulse beetle was 20.1 ± 0.46 days in mung. The incubation-, larval-, pupal- and total developmental period of pulse beetle varied significantly between the pulse beetle grown in gram and mung ($p < 0.05$). The highest longevity and fecundity were in gram, 8.2 ± 0.33 days and 70.2 ± 7.53 , respectively. The fecundity did not vary significantly in different stored pulses ($p > 0.05$). The longevity and number of adults emerged varied significantly ($p < 0.05$) between the gram and pea. The number of male emerged did not vary significantly ($p > 0.05$) between the different stored pulses and the number of female emerged varied significantly ($p < 0.05$) between gram and pea, pea and mung. The experiment revealed that pulse beetle preferred smooth coated and large size seeds to oviposit. Pea was found to be most resistant to attack by *C. chinensis* L. whereas mung was more susceptible than gram and pea.

Introduction

Tremendous losses of the crops (pre- and post-harvest commodities) always occurred during storage due to bruchids. Among the various pest of stored pulses *Callosobruchus* (syn: *Bruchus*) are renowned as the major pest and serious damaging insects^(1,2). Varma *et al.* ⁽³⁾ have estimated that 15% damage of gram occurred by *Bruchus chinensis* and *B. theobroma*. The initial infestation started in the field itself, where adult female laid shiny bright yellow eggs, which were singly glued to seed surface and hatched within 3-5 days. The larvae were creamy colored, "C" shaped that bore into the pulse grain. Pupa were obtect type and also creamy colored. The larval and pupal period varied from 13 - 20 days. The entire development took place inside the developing seed and adult emerged

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out leaving behind holed grains⁽³⁻⁵⁾. Their oviposition and growth rate were continuous and need 3 - 4 months for total destruction of the seeds and in the meantime the pest rapidly increased their population⁽⁶⁾. Pulse have a prominent place in daily diet and contains 20 - 30% proteins, supply a good production of carbohydrates, minerals and fats⁽⁷⁾. Protection of pulses from these pests is one of the major problem. In developing countries, 12-30% damages are caused due to *Callosobruchus* sp. because they feed on the protein content of the grains⁽⁸⁾. Proliferation of insect pests occur during storage due to high moisture content of grains (>12%), high temperature (25 - 35°C) and relative humidity (>60%)⁽⁹⁾. Less than 10% moisture content in pulse grain can reduce the infestation rate⁽¹⁰⁾.

In tropics, traditional farmers stored large quantity of food grains under one roof and that may lead to cross infestation among the stored products, which share common pests⁽¹¹⁾. According to Gugar and Yadav⁽¹²⁾, 55 - 60% weight and 45.50 - 66.30% protein content losses occurred due to damage caused by pulse beetle. A single larva can destroy several mature seeds and severe infestation leads to 100% damage⁽¹³⁾. These losses often become enormous and cannot be neglected. Nineteen insect species have been recorded so far from stored grains in Bangladesh⁽¹⁴⁾. Low-yielding indigenous pulses are cultivated in different parts of the country that are highly susceptible to disease and insect pest. Agricultural stored products are infested 10 - 40% annually by insect pest that causes economic loss in Bangladesh⁽¹⁵⁾.

From 2015 - 2016, the production of pulse is nearly 378 metric tons per thousand acres in Bangladesh⁽¹⁶⁾. This huge amount of pulses need protection from insect pests. Heavy infestation on grains found to cause weight loss, decrease germination capacity, reduce commercial value of seeds and grains become unfit for human consumption⁽¹⁷⁾. Pulse beetle is an internal feeder of grains. Treatment of pesticide with food grain is not advisable, because it leads to several health hazards to human being, wildlife and environment. To prevent a heavy build-up of *Callosobruchus* sp. population it is necessary to gain the knowledge about host, pest and environment interaction. The present study was undertaken to determine the susceptibility and suitability as well as to investigate the biology and biotic performance of *C. chinensis* L. that can help to find out a easy way to control method of this pest.

Materials and Methods

The experiments were conducted by using three types of stored pulses *viz.*, gram (*Cicer arietinum* L.), pea (*Pisum sativum* L.) and mung (*Vigna radiata* L.) and the life cycle and biotic performances of *C. chinensis* L. on these pulses were observed. The experiments were conducted in the Entomology Laboratory, Department of Zoology, University of Dhaka during April, 2017 to May, 2018. Experiments were carried out within an incubator at 30°C and 75% relative humidity (RH).

Pulse beetles (*C. chinensis* L.) were collected from Polashi bazar, Dhaka where the various types of pulses were stored. Pulse beetles were identified following the method used by Southgate *et al.*⁽¹⁸⁾, Southgate⁽¹⁹⁾ and Rahman⁽²⁰⁾. The cracked or damaged pulse grains were removed from each of the three pulse grain varieties and only fresh pulse grains were used as test samples. These pulses were washed thoroughly by tap water and then dried under sunlight. These pulses were deep freezed for about 24 hours to eliminate possible insect contaminations. Gram was selected as rearing means for stock culture and beetles were reared for three generations before they were used in the experiments.

For observing the life cycle of *C. chinensis* L. one hundred grains of each variety were taken in the Petri dishes and 5 pairs of male and female *C. chinensis* L. were released into each Petri dish. Then Petri dishes were kept into incubator at 30°C and 75% relative humidity for 24 hours. After 24 hrs the beetles were removed from the Petri dishes and the Petri dishes were again kept into the incubator at same temperature and humidity. The samples were observed daily. Experiments were replicated ten times for each variety that was marked as Rep.-1, Rep.-2, Rep.-3 and so on.

Experiment for biotic performances was replicated five times for each type of pulses. Fifty pulse grains from each type of pulse (gram, pea, mung) were kept in separate Petri dish. One pair of newly emerged male and female adults were released in each Petri dish. The Petri dishes were kept into incubator at 30°C and 75% RH. Released beetles were allowed to oviposit for two days. After two days, each pairs of beetles from each replication were transferred to fresh grains and were allowed to lay eggs again. The same transferring processes of male and female beetles were carried out after every two days till the death of adult. After the test all pulses were collected and the pulses containing eggs were separated out by examining under magnifying glass and the number of eggs laid by each female during her life time was recorded to study the fecundity. The pulses (gram, pea, mung) on which the beetles laid eggs were transferred into another sets of Petri dishes and observed daily until the adults emerged. After emergence the number of male and female adults were recorded.

Data obtained from the experiment were analyzed by one-way ANOVA. To evaluate the relative effectiveness of life cycle and biotic performance of pulse beetles on different type of pulses, the experiment data were subjected to t-test for significance in their differences. In all cases, a significance level of $p < 0.05$ was used.

Results and Discussion

The life cycle of *Callosobruchus chinensis* L. including incubation-, larval-, pupal- and total developmental period of all the three different stored pulses are shown in Table 1.

Adult females laid eggs on surface of the grains and they were attached singly with sticky substance. Eggs were cigar shaped and yellow in color. The longest incubation

period was observed in gram, 5.4 ± 0.29 days and the shortest period being observed in mung, 4.6 ± 0.25 days. The incubation period of pulse beetle varied significantly between gram and pea ($t = 0.04911$), gram and mung ($t = 0.03204$) but did not vary significantly between pea and mung ($t = 0.39574$) ($p > 0.05$) (Table 1). Almost similar observation of incubation period was reported by Patel *et al.*⁽¹⁾ in gram, pea and mung bean as 5.03, 5.53 and 4.53 days.

Table 1. Comparison of different developmental stages of the pulse beetle, *C. chinensis* reared in gram, pea and mung at 30°C and 75% relative humidity.

Name of pulses	Incubation period (days) (Mean \pm SE)	Larval period (days) (Mean \pm SE)	Pupal period (days) (Mean \pm SE)	Total developmental period (days) (Mean \pm SE)
Gram	5.4 ± 0.29 a	12.6 ± 0.25 a	5.5 ± 0.32 a	23.5 ± 0.59 a
Pea	4.7 ± 0.25 b	11.7 ± 0.35 b	4.4 ± 0.25 b	20.8 ± 0.28 b
Mung	4.6 ± 0.25 bc	11.3 ± 0.28 bc	4.2 ± 0.19 bc	20.1 ± 0.46 bc

Column followed by different letters indicate significance of 't' value at $p < 0.05$.

The larval and pupal periods passed inside the seed. The larvae were yellow-whitish and pupae were dark brown in color. The longest larval and pupal period were observed in gram, 12.6 ± 0.25 and 5.5 ± 0.32 days, respectively and the shortest larval in mung, 11.3 ± 0.28 and 4.2 ± 0.19 days, respectively. The penetration ability of larva to the seed coat is influenced by the physical properties of the seed coat such as thickness, hardness, roughness⁽²¹⁾. The larval period varied significantly between gram and pea ($t = 0.03129$), gram and mung ($t = 0.00227$) and the pupal period were also varied significantly between gram and pea ($t = 0.01029$), gram and mung ($t = 0.00206$) ($p < 0.05$). But the larval and pupal period did not vary significantly between pea and mung ($p > 0.05$) (Table 1).

The total developmental period of *C. chinensis* was longest in gram 23.5 ± 0.59 days and shortest in mung 20.1 ± 0.46 days that are comparable to Patel *et al.*⁽¹⁾ who recorded the total developmental period 23.49 days on pea and 17.19 days on mung. Among these three pulses, the rate of development was slower in gram. The total developmental period varied significantly between gram and pea ($t = 0.00622$), gram and mung ($t = 0.00014$) ($p < 0.05$) but between pea and mung ($t = 0.22595$) it did not vary significantly ($p > 0.05$) (Table 1). According to Varma *et al.*⁽³⁾ total developmental period varied from 22 -28 days.

The results of the present study corporate with the results obtained by Singh *et al.*⁽²²⁾ who reported the incubation period of *C. chinensis* L. was 4 - 5 days and total developmental period 17.41 days. However, Howe *et al.*⁽¹³⁾ observed the incubation and total development period and those were 4.2 and 18 - 22.5 days, respectively. Raina⁽²³⁾ reported that the incubation period and larval and pupal period were 3.5 and 18 days,

respectively. Among different pulses, the developmental responses varied. Differences between the duration of developmental stages may vary due to temperature, humidity and different types of pulses^(1,24,25).

The biotic performances of *C. chinensis* L. in all the three different stored pulses are shown in Table 2. The fecundity was highest in gram 70.2 ± 7.53 and lowest in pea 55.4 ± 3.73 . The fecundity did not vary significantly between gram and pea ($t = 0.07695$), pea and mung ($t = 0.17174$), gram and mung ($t = 0.40731$) ($p > 0.05$). The number of adult emerged was highest in gram 65 ± 7.58 and lowest in pea 41.8 ± 1.93 and the number of male and female emerged was 33 ± 4.47 male and 32.2 ± 3.42 female in gram, 23.6 ± 1.19 male and 18.2 ± 1.25 female in pea, 27.6 ± 6.50 male and 23.8 ± 2.30 in mung. Adult emergence was highest in gram, closely followed by mung bean. The number of adults emerged varied significantly between gram and pea ($t = 0.01401$) ($p < 0.05$), but did not vary significantly between gram and mung ($t = 0.15457$), pea and mung ($t = 0.17603$) ($p > 0.05$). The number of male emerged did not vary significantly between gram and pea ($t = 0.0533$), gram and mung ($t = 0.27864$), pea and mung ($t = 0.30138$) ($p > 0.05$). The number of female emerged varied significantly between gram and pea ($t = 0.00435$), pea and mung ($t = 0.04613$), but did not vary significantly between gram and mung ($t = 0.052703$) ($p > 0.05$). The longevity of the adult was longest in gram 8.2 ± 0.33 days and closely followed by mung 7.8 ± 0.33 days and shortest in pea 7.0 ± 0.28 days. The longevity of the adults varied significantly between gram and pea ($t = 0.01998$) ($p < 0.05$), but did not vary significantly between gram and mung ($t = 0.2356$), pea and mung ($t = 0.07055$) ($p > 0.05$) (Table 2). Raina⁽²³⁾ reported that the longevity of male and female were 9.76 and 9.44 days that are comparable with the present findings.

Table 2. Biotic performances of *C. chinensis* in different stored pulses at 30°C and 75% relative humidity.

No. of observation (n)	Name of pulses	Fecundity (Mean \pm SE)	Longevity (days) (Mean \pm SE)	No. of adult emerged (Mean \pm SE)	No. of male (Mean \pm SE)	No. of female (Mean \pm SE)
5	Gram	70.2 ± 7.53 abc	8.2 ± 0.33 a	65.2 ± 7.58 a	33 ± 4.47 abc	32.2 ± 3.41 a
5	Pea	55.4 ± 3.73 abc	7.0 ± 0.28 b	41.8 ± 1.93 b	23.6 ± 1.19 abc	18.2 ± 1.25 b
5	Mung	57.8 ± 8.04 abc	7.8 ± 0.33 abc	51.4 ± 8.47 abc	27.6 ± 6.50 abc	23.8 ± 2.30 ac

Column followed by different letters indicate significance of 't' value at $p < 0.05$.

In the present study, it was observed that the adults of *C. chinensis* preferred to oviposit on smooth coated and large sized seeds. Wijenayake *et al.*⁽²⁶⁾ reported that the beetles preferred smooth coated seeds for oviposition and rejected seeds with rough coat. But smoothness of the seed coat is not the only factor for higher oviposition. There is a combination of factor such as seed texture, weight and volume of seed, size and shape, seed color that are responsible for ovipositional performance of bruchids^(21,27).

Considerable numbers of eggs were oviposit on all seeds. According to Yadav and Pant⁽²⁸⁾ *Callosobruchus* spp. will oviposit on any seed, even though the seed may not be suitable for the development of the young. Grish⁽²⁹⁾ reported that *C. maculatus* oviposition performances had been shown towards the smoothness of seed coat and size of the grain.

From the present study, it can be concluded that mung was more susceptible than others to complete the life cycle of *C. chinensis*. Biotic performance of pulse beetle on pea was very poor, hence it can be considered relatively resistant to attack by pulse beetle. Among the three pulses, mung was more susceptible and pea found to be more resistant to attack by *C. chinensis*. Farmers should not store mung with other pulses in the same place to avoid cross infestation for their high susceptibility to *C. chinensis*. To prevent the infestation of pulses or to take any prerequisite it is necessary to know the susceptibility of different pulses.

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