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Research article

Oviposition behavior of pulse beetle *Callosobruchus chinensis* (L) reared on different pulses and cereals

Fakhar-un-Nisa Yunus, Khadija Asif, Farzana Rashid*

Lahore College for Women University, Lahore 54000, Pakistan

Abstract

Pulse beetle, *Callosobruchus chinensis* (Dhora) is a serious pest of stored grain products; it attacks mainly on the pulses, cereals and different types of grains. The damage due to this pest affects the germinative ability and nutritive value of the seed. In the present study, we observed the oviposition behavior of *Callosobruchus chinensis* on different pulses and cereals. For this purpose rearing of pulse beetle was done in controlled laboratory conditions i. e.temperature of 37± 2ºC and 40± 5% relative humidity and adult beetles was used in the experiment.*Callosobruchus chinensis* reared on five different pulses i.e. *Phaseolus vulgaris* (Kidney beans), *Lens culinaris* (Masoor or black gram), *Cicer arietinum* (White grams or chickpea), *Vigna radiata* (Mung beans) and *Vigna unguilata* (Cowpea, black eyed bean or white lobia) and five different cereals *Triticum aestivum* (wheat), *Zea maize* (Maize), *Pennisetum glaucum* (Pearl millet), *Hordeum vulgre* (barley) and *Avena sativa* (Oat) selected on the basis of their nutritional values. The maximum number of eggs was recorded on kidney beans (147.67±0.58), mung beans (132.00±2), moderate on cow pea (78.00±2) and least on white gram (66.67±2.52) and black gram (63.00± 1.73) whereas in the case of cereals the highest preference of oviposition was recorded on maize (13.67±1.53) and wheat (7.67±1.15) while least preference on barley (5.67±0.58) and millet (2.3±0.58) and minimum on aot (0). So, the result showed significant differences among the oviposition rate on different pulsesand cereals. ANOVA test was applied to compare the results.

Keywords: Oviposition behavior, *Callosobruchus chinensis*, Pulses and cereal.

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***Corresponding Author**: Dr. Farzana Rashid; **Email**: dr.farzanarashid@gmail.com

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Introduction

The greatest loss to the world population of pulses, cereals and oilseedsare due to the attack of insects, fungi and rodents, which mostly attack on the stored grainproducts [1, 2]. Insects, rodents and microorganisms not only consume the stored product, but also spoil the edible and inedible parts of the stored grains which also caused post-harvest deterioration that is obvious decay and adverse changes in odor, taste, appearance and nutritive value [3]. Seeds and grains from the basic and crucial input for agricultural production in Pakistan. Maize (*Zea mays*) is one of the important cereal crops of the world ranking third among major cereals next to wheat and rice. Pulses and cereals being rich sources of protein play a significant role in the diet of the common people but pulses are more difficult to store than cereals because they suffer a great damage during the storage due to insect pests and micro-organisms [4, 5]. It is estimated that about 25-40% stored agriculture products is damaged annually due to the stored pests [6].

Among, all the pests of stored grain products, the insects are the major cause of food grain damage [7]. The most common insects which attack the stored products are belong to the order Coleoptera and Lepidoptera [8, 9]. These are the largest orders which contain most prominent stored pests [10, 11]. Pulse beetle, *Callosobruchus chinensis* is a serious damage, pest of the world; it attacks mainly on the pulses, cereals and different types of grains. The damage due to this pest affects the germinative ability and nutritive value of the seed [12].

Callosobruchus chinensis is a cosmopolitan pest of the stored pulses [13, 14]. Pulses give us a lot of important constituents like protein, carbohydrates, minerals and vitamins which not contain any cholesterol and fat component. It provides iron, magnesium, phosphorous, zinc and other minerals which are important in the maintenance of good health. Pulses constitute 20-25% proteins by weight, which is double the protein content of wheat and three times of rice [15].

Generally it is agreed that grains store better and more cheaply than other major food. Losses during the post-harvest handling, processing, storage and distribution systems vary between 20-60% [16]. Chemical insecticides are used to protect cereals and pulses against the attack of stored pests as few insecticides like carbamate group are used by the farmers [17]. The use of locally available plant materials to manage insect damage in storefoodstuffs is also a common practice in developing countries. Host plant resistance method is the most effective method against the stored product insect. Some strains are introduced which resists the growth of insects on the stored products [18, 19].

C. chinensis is a cosmopolitan pest of stored legumes (Fabaceae), particularly of the genus Vigna. Females cement eggs to the surface of the host. Larvae burrow into theseeds where their entire development (four instars plus pupal stage) is completed, the larvaecannot move among seeds and are thus restricted to the seed them and beetles emerge from seeds reproductively mature. Emerging adults are well adapted to storage conditions, requiring neither food nor water to reproduce. Because beetles most commonly occur in seed stores, so, lab conditions do not significantly differ from their natural conditions.*Callosobruchus chinensis* need a substrate for egg laying, virgin females have a long life span than those females who are mated and not allowed to lay eggs [20]. In the present study, we investigated the possible effects of different pulses and cereals on oviposition behavior of *Callosobruchus chinensis* female (Locally named as Dhora).

Materials and Methods

Insects and materials

The culture of pulse beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) was reared on whole green gram (mung). Culture was maintained at 37± 2ºC and 40± 5% relative humidity. Adult insects (2-3 days old) were used for experiments. Experiments were carried out in the laboratory at 37± 2ºC and 40± 5% relative humidity.

The pulses and cereals which were selected on the base of their nutritive value for the experiments were: *Phaseolus vulgaris* (Kidney beans), *Lens culinaris* (Masoor), *Cicer arietinum* (White grams or chickpea), *Vigna radiata* (Mung beans) and *Vigna unguilata* (Cowpea, black eyed bean or white lobia) and five different cereals *Triticum aestivum* (Wheat), *Zea maize* (Maize), *Pennisetum glaucum* (Pearl millet), *Hordeum vulgre* (Barley) and *Avena sativa* (Oat).

Exprimental setup

The newly emerged adults were removed from the rearing jars daily. These adults were kept in 4"x 3/4" culture bottles. Each was filled with 10 gm of grains in triplicate for each grain mentioned above. Ten pairs of insects (10 males and 10 females) were placed in each of them. The culture bottles were covered with muslin cloth. The parent beetles were sieved out after 10 days of oviposition and the seeds were kept under laboratory condition until the emergence of F1 progeny. Observation and data recording were done every 72 hours to monitor the number of eggs laid, number of adults emerged, days of adult emergence and the number of seeds with damaged hole. When the insects were needed for experiments, the culture medium was sieved through a 3 mm-mesh sieve and the procedure was repeated until the final experiment. Experiments performed three times with each grain.

Bioassay for oviposition preference

For the assessment of oviposition preference, 30 seeds of pulses were randomly taken from each jar containing 10 gm of seeds and the number of eggs ovipositor on each diet were counted. Simple and compound microscopes as well as light bulb were regularly used to carry out the experiment and the observations were recorded every three days and the eggs were left intact on the seeds. Each of the diet was repeated in triplicates. Counting was proceeded until the completion of egg stage.

Data analysis

Analysis of variance (ANOVA) was used to check the oviposition behavior of *Callosobrochus chinensis* and its host preference for egg-laying behavior was analyzed and a single classification ANOVA was used to compare the mean number of eggs laid among different pulses and among different cereals. All statistical tests were carried out at $P < 0.05$ level of significance.

Results

The pulses which are selected for the rearing of *Callosobruchus chinensis* were *Phaseolus vulgaris* (kidney beans), *Lens culinaris* (Masoor), *Cicer arietinum* (White grams or chickpea), *Vigna radiata* (Mung beans) and *Vigna unguilata* (Cowpea, black eyed bean or white lobia) and five different cereals *Triticum aestivum* (wheat), *Zea maize* (maize), *Pennisetum glaucum* (Pearl millet), *Hordeum vulgre* (barley) and *Avena sativa* (oat). These are selected on the basis of their nutritive values (Table 1).

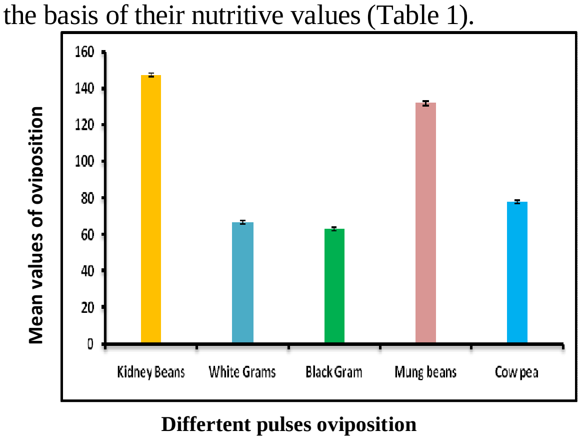

Figure 1: Mean values of oviposition of *Callosobruchus chinensis* on different pulses

The suitability of treatments for oviposition of *C. chinensis* was highly significant ($P<0.05$). The mean values on different pulses were as *Phaseolus vulgaris* (kidney beans) the oviposition rate is 147.67, on *Vigna radiata* (Mung beans) it is 132, on *Cicer arietinum* (White grams or chick pea) 66.67, *Lens culinaris* (Masoor) 63 and *Vigna unguilata* (Cowpea) 78 (Figure 1).Whereas in case of cereals the highest preference of oviposition was recorded on maize (13.67±1.53) and wheat (7.67±1.15) while on barley (5.67±0.58) and millet was least (2.3±0.58) and nill on aot (Figure 2).

Table: 1 The nutritive value of certain pulses and cereals

Pulses & cereals	Protein (%)	Calcium (mg/100g)	Iron (mg/100g)
Kidney beans	22.1	137	6.7
Chickpea	20.1	149	7.2
Masoor	24.2	56	6.1
Mung beans	28	132	6.7
Cowpea	23.4	76	5.7
Wheat	10.9	16	1.0
Maize	9.3	6	1.8
Millet	4	8	2.1
Barley	3	29	2.5
Oat	6	48	1.9

Discussion

Callosobruchus chinensis is a harmful insect of stored stored grain products such as pulses and cereals. It causes destruction to such a limit that the stored products become totally unfit for the human and animal consumption as *Callosobruchus chinensis* is a polyvoltine and cosmopolitan pest of stored grain products. A variety of environmental and ecological factorsfactors include food supply, quality of food available, temperature and population density,influence the number and viability of eggs ovipositor by the female beetles. These females are capable of laying eggs on several pulses and cereals and larvae causes high losses of energy and seed storage as different diets influence different effect on the behavior of the ovipositor female beetle.

The present study revealed the different oviposition rate of *Callosobruchus chinensis*on different pulses and cereals (Figure 3).The number of eggs laid on pulses and cereals was significantly different, relatively maximum number of eggs was laid on *Phaseolus vulgaris* (kidney beans), *Vigna radiata* (Mung beans), *Zea maize* (maize) and *Triticum aestivum* (wheat)whereas lower number recorded on *Cicer arietinum*(White grams or chickpea), *Lens culinaris* (Masoor), *Hordeum vulgre* (barley), *Pennisetum glaucum* (Pearl millet) and *Avena sativa* (oat)which might be due to the considerable variations in seed size among the grains since seed size is the features that have been reported to influence the performance of bruchids on different varieties. The lower number of eggs recorded on *Lens culinaris* (Masoor),*Cicer arietinum* (White grams or chickpea), *Hordeum vulgre* (barley), *Pennisetum glaucum* (Pearl millet) and *Avena sativa* (Oat) which are small sized seeds might be due to the small surface area provided for egg lying which was not attractive for further oviposition. This condition was confirmed that associated small grain size with resistance, the highest number of eggs were recorded on kidney bean (large sized seed) and maize in the present investigation, although reports regarding the relationship between seed size and susceptibility to bruchids are diverse as found non-significant negative correlation between seed size and ovipositon on kidney beans. According to our findings the maximum number of eggs was recorded on red beans (147.67± 0.58) and the lowest number of eggs on black grams (Masoor) is 63.00 ± 1.73. While the basic reason for this great difference is due to its size and its surface area and obviously nutritional value of the diet. Large and smooth surface area provides a greater chance of oviposition by the *Callasobruchus chinensis* (Dhora). The results presented here are also consistent with previous observations (Figure 1 & 2).

Oviposition behavior of *C. chinensis* also depends on the quantity of resources. Females of *C. chinensis* oviposit on larger, higher quality hosts and generally lay smaller clutches on smaller and lower quality hosts [21], so due to high quality resources of red beans it showed the greatest number of eggs, i.e. 147.67/ 30 gm, as compared to others mung beans 132.00/ 30 gm, white gram 66.67/ 30gm, black gram 63.00/ 30 gm and cow pea 78.00/ 30 gm. The results obtained from the present studies showed that the *C. chinensis* laid a maximum number of egg percentage on red beans i.e. 30% as compared to others. The black gram showed the lowest percentage of oviposition rate as 13%. Chick pea, one of the pulses on which lower number of eggs was recorded 66.67± 2.52 had a rough seed coat, although rough seed coat was a character deterrent for oviposition and absent in susceptible varieties.

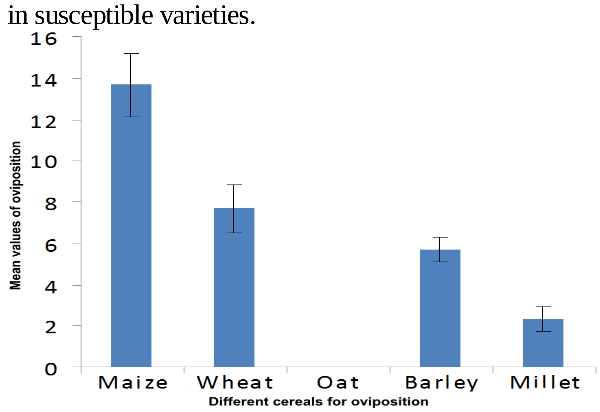

Figure 2: Mean values with difference of the oviposition rate on different cereals on *Callosobruchus chinensis*

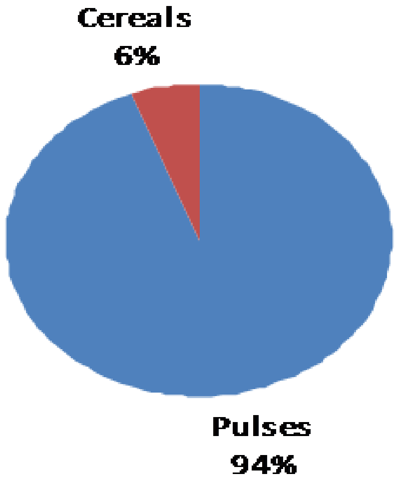

Figure: 3 Comparison of % frequency of oviposition behavior of *Callosobruchus chinensis* between pulses and cereals

Conclusions

The study was initiated with the objective to observe the oviposition behavior on different pulses and cereals to *C. chinensis* by evaluation of some biological parameters. The results of evaluation of some biological parameters of *C. chinensis* on different pulses and cereals revealed that preference of oviposition by *C. chinensis* varied among grains and oviposition was least on black gram and oat. The less number indicated that the black gram and oat is not a host for *C. chinensis*. The reason behind the less number of eggs on black gram and oat is its small surface area and rough seed coat. It is revealed from the results that the large and smooth surface area of the seed is preferredto the female to lay eggs, as the maximum number of eggs observed on the red kidney beans, maize and wheat. White chick pea and black grams, barley and millet were more resistant to the attack of *C. chinensis*. We observed the relatively higher susceptibility to the mung beans, red kidney beans, maize and wheat where the females lay more eggs.

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