Original Research Article

The effect of differentpulses on the oviposition preference and reproduction of pulse bruchid, *Callosobruchus chinensis* (Coleoptera: Bruchidae)

ABSTRACT

Studies were conducted to ascertain the population growth and oviposition preference of pulse bruchid, *Callosobruchus chinensis* on some pulses viz., *Vigna radiata*, *Lens esculenta*, *Cicer arietinum*, *Cajanus cajan* and *Pisum sativum* under conditions of restricted (no choice) and unrestricted (choice) access. Results revealed that under conditions of choice and no choice test, oviposition and adult emergence was highest on *C. arietinum*(6.84nos).*Lens esculenta* recorded lowest egg deposition under conditions of no choice while no egg laying activity was observed under choice conditions. Developmental period was significantly shorter in *V. radiata* while it was longer in *P. sativum* in both choice (37days for male and 36.32 days for female)and no choice test(37.10 days for male and 36.46 days for female).In *V. radiata*, the adult longevity was shorterin both choice(7.48 days for male and 5.91 day for female) and no choice (7.68 days for male and 6.13 days for female)test and adults were significantly heavy than on *C. arietinum*,*C. cajan* and *P. sativum* in both choice and no choice test. Overall, *V. radiata* was found to be a superior host with shorter development period and healthier adults while *C. arietinum* was better in terms of oviposition preference and adult emergence. These insights offer valuable assistance for enhancing pulse cultivation practices in the region.

Keywords: Biology,*Callosobruchus chinensis*, oviposition, Pulse, Reproduction

1. INTRODUCTION

Pulses, one of the major and cheapest sources of proteins, form an integral part of the vegetarian diet as a rich source of protein as well as essential minerals, vitamins, dietary fibres and amino acids (Singh and Singh, 1992; Jat *et al*., 2013; Pratap *et al*., 2016). Hence, they are popularly branded as "poor man's meat" (Aykroyd and Doughty, 1982). One of the major constrains in pulse production are insect pests which severely infest the crop, not only in field but also in storage facilities which ultimately results in reduced yield, nutritional quality and germination potential of seeds (Karthikeyan *et al*., 2006; Pratap *et al*., 2016).

Among the storage insect pests associated with pulses, the adzuki bean weevil or pulse bruchid, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) is one of the predominant grain pest which is responsible for weight loss and seed damage (Singal andSingh, 1990), decrease in germination potential (Kiradooand Srivastava, 2010; Mainali *et al*., 2015) and reduction in the market as well as nutritional value (Modgil and Mehta, 1997; Mainali *et al*., 2015) of pulses. Infestation of the adzuki bean weevil initiates from the field which is carried over to the storage where they mate and oviposit leading to subsequent increase in their population and damage. The insect is known to breed successfully in a number of pulses which vary according to the variety and eco-geographic factors (Giga and Smith, 1987; Howe and Currie, 1964; Nakamura, 1969; Duraimurugan *et al*., 2014).

The morphology, size, chemical and nutrient content of different pulses extensively influence feeding, development, reproduction and oviposition of pulse bruchids (Johnson and Kistler, 1987; Huignard*et al*., 1990). For this very reason, it has been previously found that both infestation as well as biological parameters is different on different hosts. In the course of evolution, these factors or behaviors have been molded in such a way that the available host could be utilized to the maximum in favor of the insect (Wijeratne, 1998). Because of their importance in feeding on seeds, the ecology of nutrition of adzuki bean weevil is of paramount importance which ultimately gets reflected in their growth and survivality. According to Mainali *et al*. (2015), the relationship between oviposition preferences and endurance of the offspring on seeds would help in determining the oviposition behavior based on seed morphology and also in identifying the leguminous seeds that probably could be used against the insect as a component of integrated pest management.

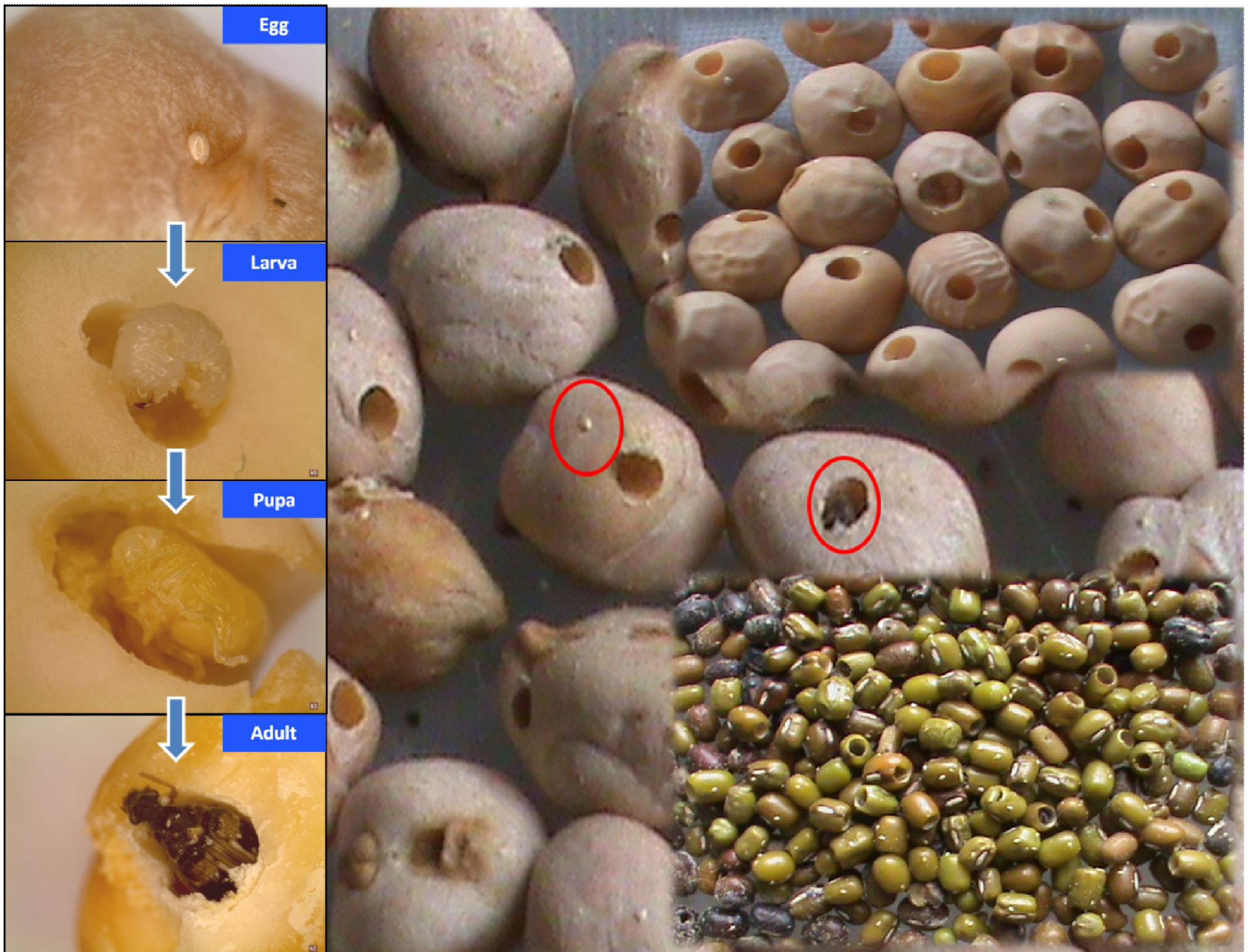
Based on these facts, it was considered worthwhile to ascertain the biological parameters as well as the ovipositional preference of adzuki bean weevil,*C. chinensis*on five different pulses. The hypothesis of the study was to verify whether the type of pulse influenced the ovipositional preference, developmental period and body weightof*C. chinensis*under laboratory conditions.

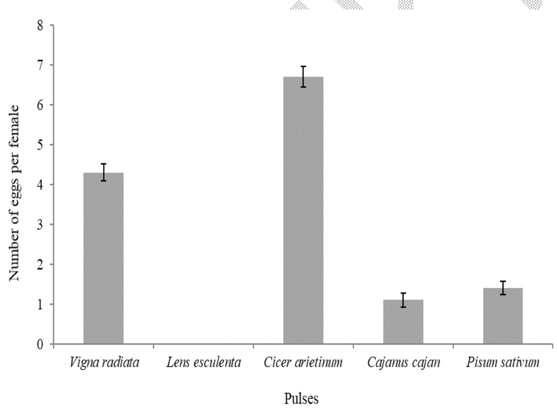
2. MATERIALS AND METHODS

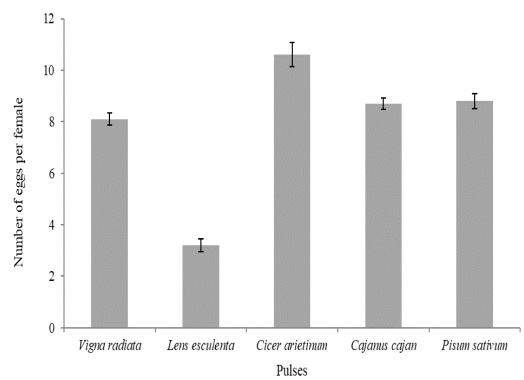
Five pulses viz., green gram (*Vigna radiata*) cultivar Kopergaon K 851, lentil (*Lens esculenta*) cultivar Noorie, kabuli chickpea (*Cicer arietinum*) cultivar KWR-108, pigeon pea (*Cajanus cajan*) cultivar T-21 and pea (*Pisum sativum*) cultivar HUP-2 were considered for the experiments. Infestation free seeds were obtained fromAssam Agricultural University, Jorhat, Assam, India and from the Regional Agricultural Research Station (RARS), Shillongoni, Nogaon, Assam, India. The seeds were washed, cleaned properly in distilled water and dried before inoculation.The culture of *C. chinensis* was maintained on green gram for more than 10 generations. From this culture, freshly emergedadults were separated into males and females on the basis of external sexual differences (Halsted, 1963) which were considered for further experiments. All the experiments were carried out in the laboratory of plant Protection, College of Horticulture and Forestry, Central Agricultural University, Pasighat under controlled conditions, where temperature and humidity were maintained at 28±2°C, 85±5% RH, and 16L: 8D photoperiod.Biological parameters were ascertained by following the method of Mainali *et al*. (2015) with slight modifications. A choice test was carried out to ascertain the ovipositional preference, fecundity and adult emergence rate of *C. chinensis*. 20 seeds of each pulse was kept separately in small Petri dishes(200 × 20 mm) which were placed inside a custom made rearing box (60 × 40 × 85 cm) covered with fine mesh to prevent the bruchids from escaping. As soon as the adults emerged, they were isolated without any food to record their mean body weight and longevity. Some of the seeds in which eggs were laid were retained separately to determine the larval and pupal duration as suggested by Devi and Devi, 2014. Both the experiments were replicated for 10 times for choice and no-choice test. Data were checked for normality by application of a Shapiro-Wilk test and visual inspection. The data which did not pass the normality test were log10-transformed for further analysis andadult emergence rate were compared using a Chi-square test of a contingency table (Mainali *et al*., 2015).

3. RESULT AND DISCUSSION

Paradigms of population growth studies on different commodities of grains suggest that there are number of factors involved like chemical cues on seed surface (Credland and Wright, 1988), previous experiences (Chiu and Messina, 1994), sensory receptors (Messina *et al*., 1987), morphology of seeds (de Sa *et al*., 2014) etc. which stimulates the females of *Callosobruchus*spp. for egg deposition on a particular host. In the present experiment, the number of eggs laid was significantly higher on *C. arietinum* in both choice and no choice test followed by *V. radiata* in choice test (Fig. 1A). An obvious reason would be that *Callosobruchus* spp. prefers to lay eggs on the seeds with larger surface area (Mainali *et al*., 2015). According to Raina (1970), Jakhomola and Singh (1971), Girish *et al*. (1974) and Satyavir (1980),Singha and Rajkumari (2021) seed size positively influences the ovipositional preference of *C. chinensis*. In this case, the seed size of *C. arietinum* was large in comparison to other pulses in test (Erle *et al*., 2009). The females of *C. chinensis* did not prefer to oviposit on *L. esculenta* seeds when other pulses were available to them in choice test while in no choice test, they oviposited the least on *L. esculenta* seeds which was similar to the findings of Islam *et al*. (2007). Certain chemical parameters like levels of proteins or phenols in the seed-coat maybe responsible for significantly reducing the oviposition in *L. esculenta*. Bhattacharya and Banerjee (2001) had accounted that high phenol concentration in *L. esculenta* seeds had fewer egg deposition indicating that *C. chinensis* females have the ability to discriminate hosts that could be toxic for the embryonic development of their offspring (Mainali *et al*., 2015). Further, the eggs deposited on *L. esculenta* failed to support the development of the progeny. Moreover, size and texture also play an important role in the oviposition of female; the size of *L. esculenta* seeds was so small that it may have deterred the female to lay eggs on the seed (Qazi *et al*., 2001). The developmental period of both sexes of *C. chinensis* from egg to adult stage on different pulses revealed that interaction between both sexes and pulses was not significant in both choice [$F (3, 72) = 0.20$, $P = 0.89$] and no choice [$F (3, 72) = 1.05$, $P = 0.376$] test. Developmental period was significantly shorter in *V. radiata* than on *C. arietinum*, *C. cajan* and *P. sativum* while in *P. sativum*, it was significantly longer in both choice and no choice test (Fig. 1 B). This indicated that *C. chinensis* was able to efficiently utilize the host nutrient content in all four pulses for its development as in line with the results of Applebaum and Birk (1972) and Mphuru (1981). The findings are also in agreement with Patel *et al*. (2005) who reported that developmental of *C. chinensis* was shortest in *V. radiata* and longest in *P. sativum*. Developmental success of the offspring of *C. chinensis* may be affected by seed pilosity, seed hardness, seed size, nutrients and allelochemicals present in the seeds (Mainali *et al*., 2015). A thick seed coat and higher phenol content may prolong the development of C. chinensis larvae in *P. sativum* (Patel *et al*., 2005). Presence of high levels of proteins and phenols in the hard seed-coat in *L. esculenta* may be the probable reason which prevented the larvae from penetrating and feeding in to the seeds (Manohar and Yadava, 1990; Bhattacharya and Banerjee, 2012). A significant difference was also found in adult emergence on different pulses in choice [$\chi 2$ (3) = 8.85, P = 0.03] test. Adult emergence was significantly higher on *C. arietinum* in comparison to *V. radiata*, *C. cajan* and *P. sativum* in both choice and no choice test (Fig. 1C). Higher adult emergence in *C. arietinum* in both choice and no choice test might be due to the fact that more eggs were deposited on the seed surface which led to higher emergence of adults. The adult longevity on *V. radiata* was significantly shorter than *C. cajan* and *P. sativum* in both choice and no choice test. Though, adult longevity was significantly shorter in *V. radiata* in comparision to *C. arietinum* in choice test, it was not significant in no choice test (Fig. 1D). Also, adults emerging from *V. radiata* were able to complete their longevity within a short span of time in choice condition. The present findings are in confirmation with Rahman *et al*. (1942), De Luca (1966) and Varma Anandhi (2006) and Singh and Boopathi (2022)who have reported a short life cycle in *V. radiata* by *C. chinensis*. This implies that *C. chinensis* could complete more number of generations in a year when reared on *V. radiata* followed by *C. arietinum*. The influence of host nutritive content was also reflected in the body weight of adults with heavier adults emerging from *V. radiata* in both choice and no choice test. The interaction effect between sex and pulses was significantly reflected in adult body weight for both choice [F (3, 72) = 21.11, P < 0.01] and no choice [F (3, 72) = 15.82, P < 0.01] test. Post-hoc comparisons showed that males and females emerging from *V. radiata* were significantly heavier than the ones emerging from *C. arietinum*, *C. cajan* and *P. sativum* in both choice and no choice experiments (Fig. 1E). Food quality is the determinant for the fitness of insects (Moreau *et al*., 2006). Here it was seen that larvae reared on *V. radiata* produced heavy adults, suggesting efficient utilization of host nutritive contents which we believe may be an index of adult fitness just like in case of pupal weight (Tammaru*et al*., 2002; Moreau *et al*., 2006). In conclusion, *C. arietinum* was found to be better in terms of preference for oviposition. *C. arietinum* with a larger surface area might have ovipositional significance over the smaller seeds while *V. radiata* supported fastest development and healthier adults in comparison to other seeds.


Egg
Larva
Pupa
Adult


Number of eggs per female
8
7
6
5
4
3
2
1
0
Vigna radiata
Lens esculenta
Cicer arietinum
Cajanus cajan
Pisum sativum
Pulses


Number of eggs per female
12
10
8
6
4
2
0
Vigna radiata
Lens esculenta
Cicer arietinum
Cajanus cajan
Pisum sativum
Pulses

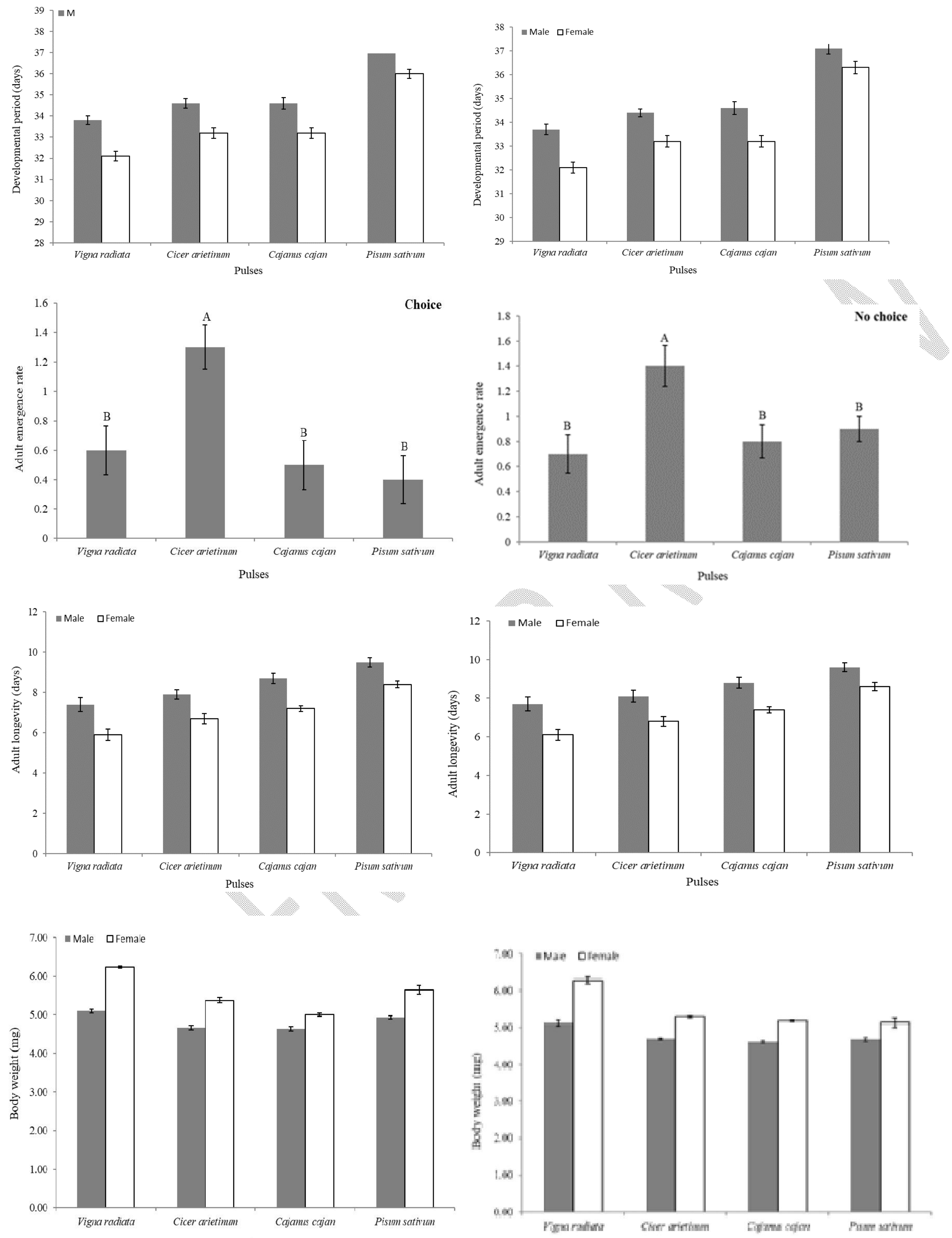


Fig. 1. Number of eggs laid (A), developmental period (B), adult emergence rate (C), Adult longevity (D) and Adult body weight (E) (Mean ± SE) of *Callosobruchus chinensis* on different leguminous seeds in choice and no-choice tests

4. CONCLUSION

In conclusion, the present study demonstrated that pulse bruchid, *Callosobruchus chinensis*preferred*Cicer arietinum* for oviposition and adult emergence. Life cycle of the bruchid is shorter in *Vigna radiata* than other pulses and adults were also healthier than others. The study signifies the importance of physical attributes of seeds as an oviposition substrate and will probably help in identifying seeds that could be used against the insect as a component of integrated pest management and the resistant variety of *Cicer arietinum* and *Vigna radiata* may be developed against*Callosobruchus chinensis*

DISCLAIMER(ARTIFICIALINTELLIGENCE)

Author(s) hereby declare that NO generativeAItechnologiessuchasLargeLanguage Models (Chat GPT, COPILOT, etc.) and text-to-image generators havebeenusedduring thewritingor editing of thismanuscript.

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