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Host preference studies of pulse beetle, *Callosobruchus chinensis* (L.) on different pulses

Geeta Kumari Meena, Hemant Swami, Lekha and Gaurang Chhangani

Abstract
The present investigation, "Host preference studies of pulse beetle, *Callosobruchus chinensis* (L.) On different pulses" was carried out under laboratory conditions at Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur during 2020-21. The results of the present investigation revealed that green gram, cowpea and lentil (4.33) were found most preferred host in terms of incubation period, cowpea as most preferred host in terms of larval-pupal period (18.33) and fecundity (97.67), green gram was recorded as most preferred host in terms of pre-oviposition period (0.67) and total life cycle (42.67 for male, 44.00 for female), kabuli gram (6.00) was recorded as most preferred host in terms of oviposition period and chickpea (2.00) was found preferred host in terms of post-oviposition period.

Keywords: Life cycle, storage pests, fecundity, incubation period and Adult survival

Introduction
Pulses are an important constituent of daily Indian diet as a source of protein, carbohydrates, fiber, calcium, potassium, zinc, magnesium and iron. They also have inherent efficiency to fix atmospheric nitrogen, which improve soil fertility. India ranks first in pulse production in the world with an annual production of 23.15 million tonsand contributes 70 per cent to total world pulse production with an average productivity of 817 kg/hain 28.34 million ha area during 2019-20 (GOI, Data bank 2020) [2]. Among the Indian states, Rajasthan stands at third position in pulse production with an annual production of 3.68 million tons and productivity of 622 kg/ha (Agricultural Statistics at a Glance, 2019) [1]. Chickpea (*Cicer arietinum* L.) is among the mostwidely consumed legumes in the world, particularlyin tropical and subtropical areas (Chhangani *et al.*, 2018) [5], having a share of around 40 per cent in the total production followed by pigeon pea *Cajanus cajan* (L.) Millsp (20%) and green gram, *Vigna radiata* (L.) Wilczek (8%) and black gram, *Vigna mungo* (L.) Hepper (10%) (NABARD Rural Pulse 2015) [3].

The three species of pulse beetle *viz. Callosobruchus chinensis* Linnaeus, *Callosobruchus analis* Fabricius and *Callosobruchus maculates* Fabricius have been reported to cause damage in different kinds of pulses in India (Raina, 1970) [7]. The pest is distributed throughout the tropics and subtropics areas of the world. As the beetles can actively fly, the infestation can start in the fields itself. The damage is unnoticed until the beetle emerges out from the infested grain through the emergence holes. Grubs of pulse beetle feeds on endospermic portion of the seed and destroys it completely leaving only seed coat. Thus stored grains become non-viable and loose its nutritive value. These types of grains become unfit for human consumption as well as for sowing. In the hilly areas, it is a serious pest of stored pulses with annual loss of about 0.21 MT amounting to Rs. 315 million (Rathore and Sharma, 2002) [9]. Therefore, biology of pulse beetle on various hosts *viz.*, green gram, black gram, chick pea, cow pea, pigeon pea, lentil and kabuli gram was studied under laboratory conditions during present investigation to observe the host preference.

Materials and Methods
The nucleus culture of pulse beetle, *C. chinensis* was obtained from Department of Post-Harvest Technology, CTAE, Udaipur for mass multiplication. The sound and healthy black gram grains were sieved and sterilized at 60+5 ºC for eight hours to eliminate both apparent and hidden infestation, if any present. These grains were conditioned at least for a week in an environmental chamber maintaining 33+2 ºC and 60+5 per cent relative humidity to raise their moisture content.

The beetles from nucleus culture were transferred on these grains in to the plastic jars of one liter capacity and the mouths of jars were covered tighten with muslin cloth. These jars were kept at a temperature of 33+2°C and 60+5 per cent relative humidity. The adults from the progressive generations so emerged from the culture were used for further experimentation.

Biology of pulse beetle, *C. chinensis* on different hosts

The experiment to study the biology of pulse beetle was conducted in Completely Randomized Design with three replications in UG laboratory at Department of Entomology, RCA, Udaipur during 2020-21 Utilizing grains of different pulse as hostviz. green gram, black gram, chick pea, cow pea, pigeon pea, lentil and kabuli gram. The observations were recorded on different biological parameters of stored grain insect pest *C. chinensis*.

To study the fecundity of adult female, two pairs of freshly emerged male and female adults (0-24 hrs. old) were isolated from stock culture and released in jars, containing 100 grains of relevant host separately and each host grains containing jars were replicated three times. The mouth of the jars was covered with a muslin cloth with the help of rubber band for aeration and to prevent escape of the adult. The jars were kept at room temperature for observation. The released beetles were allowed to mate and oviposit for 24 hours, the grains containing eggs were replaced with the fresh healthy grains. The process of replacing the grains of the host was carried out till the death of adults and the total numbers of eggs laid by the female on grains were counted from these jars.

The grains containing the eggs laid by the female were transferred into another sets of jars after the counting number of eggs and observed daily until the emergence of grubs. After hatching, the total duration (in days) of larval and pupal period was recorded, by splitting-open the whole grain with the help of the needle and forceps as most of the period is spent in the grains.

Observations

1. **Incubation period:** The time (in days) taken by the eggs to hatch was recorded. The hatching of eggs were determined by the change in colour of the eggs. The hatched eggs turned to creamish white colour due to the accumulation of frass inside the egg.
2. **Larval and pupal period:** Larval and pupal period (in days) within the grain was recorded by gently splitting-open the whole grain with the help of the needle and forceps to observe the stage of insect under a stereo-zoom binocular.
3. **Pre-oviposition period of female:** The duration (in days) before laying eggs by female was recorded.
4. **Oviposition period of female:** The duration (in days) after the emergence of female beetle and before the state of egg laying was recorded.
5. **Post-oviposition period:** The duration (in days) after the cease to oviposition till the death of adults were recorded.
6. **Adult longevity:** The longevity of male and female adults (in days) after the emergence up to their death was recorded.
7. **Life cycle completed (days):** Single generation time period was calculated.
8. **Fecundity:** Grains with fresh eggs were separated and total numbers of eggs were counted from each jar.
9. **Adult survival (%):** A sample of 100 grains of each host was exposed to pulse beetle in jars and checked for adult emergence. The grains of different host with freshly laid eggs were separated and number of eggs were counted and kept in different jars and the observations on number of adult emergence were recorded from different hosts. The per cent survival of the test insect on each host was calculated by the formula (Howe, 1971):

$$\text{Per cent survival} = \frac{\text{No. of adults emerged}}{\text{No. of eggs laid}} \text{ x } 100$$

Results and Discussion

The experiment to study the effect of different pulse host *viz*., green gram, black gram, pigeon pea, chickpea, cowpea, kabuli gram and lentil on biology of pulse beetle (*C. chinensis*) in terms of incubation period, larval and pupal period, pre-oviposition period, oviposition period, post-oviposition period, total life cycle, fecundity and adult survival was carried out by inoculating 20 pair of pulse beetles on respective pulses by maintaining the optimum laboratory conditions. The results of experiment have been presented in Table (1) which shows that the most preferred host by the pulse beetle was green gram with the shortest life cycle whereas the black gram was found least preferred with longest life cycle.

Incubation period (Days)

The observations recorded on incubation period of pulse beetle, *C. chinensis* on different pulses ranged from 4 to 6 days with the minimum incubation period of 4.33 days on green gram, cowpea and lentil followed by 4.67 days on chickpea, pigeon pea and kabuli gram. The maximum incubation period of 5.00 days was recorded on black gram. (Table 1)

Larval-pupal period (Days)

The mean larval-pupal period of pulse beetle, *C. chinensis* recorded on different pulse varied from 17 to 28 days with the minimum larval-pupal period of 18.33 days on cowpea, followed by green gram with 18.67 days, lentil with 20.33 days, pigeon pea with 21.00 days, chickpea with 21.67 days. The maximum larval-pupal period of 26.33 days was recorded on black gram and 26.00 days on kabuli gram which were statistically at par to each other and higher from rest of the pulses. (Table 1)

Pre oviposition period (Days)

The observations recorded on pre oviposition period of pulse beetle, *C. chinensis* varied from 0.67 to 2.00 days on different pulses. The minimum pre oviposition period of 0.67 days was recorded on green gram followed by cowpea with 1.00 days, lentil with 1.33 days, pigeon pea with 1.67 days and chickpea with 1.67 days. The maximum pre ovipositional period of 2.00 days was recorded on black gram and kabuli gram. (Table 1)

Oviposition period (Days)

The oviposition period of pulse beetle, *C. chenensis*o bserved ondifferent pulses ranged from 6 to 8.33 days. The minimum oviposition period of 6.00 days was recorded on kabuli gram followed by chickpea with 7.00 days, 7.33 days on green gram, black gram and lentil, 7.67 days on cowpea, while maximum oviposition period 8.33 days was recorded on pigeon pea. (Table 1)

Post oviposition period (Days)

The post oviposition period of pulse beetle, *C. chinensis* recorded on different pulses varies from 2 to 3.67 days. The minimum post oviposition period of 2.00 dayswas recorded on chickpea followed by kabuli gram with 2.33 days, green gram with 3.00 days and 3.33 days on lentil. The maximum post oviposition period of 3.67 days was recorded on black gram, cowpea and pigeon pea. (Table 1)

Adult longevity period (Days)

There wassignificant differences in female and male longevity of pulse beetle, *C. chinensis* reared on different pulses hosts. The longevity of male beetles varied from 8.00 to 9.33 days; whereas, in female beetles it ranged from 9.33 to 11.00 days. The maximum duration 9.33 days of male longevity was recorded on black gram, chickpea and cowpea followed by 9.00 days on pigeon pea, 8.67 days on green gram, 8.33 days on kabuli gram and the minimum male longevity period of 8.00 days was recorded on lentil. In case of female beetles, the maximum duration of 11.00 days was recorded on cowpea and black gram, followed by 10.67 days on chickpea and pigeon pea, 10.00 days on green gram, 9.67 days on kabuli gram and minimum female longevity period of 9.33 days was recorded on lentil. (Table 1)

Total life period (Days)

The total life period of pulse beetle recorded on different pulses which were ranged from 42 to 54 days in male beetles and from 42 to 52 days in female beetles. The shortest life cycle of pulse beetle, *C. chinensis* was recorded on green gram (42.67 days for male and 44.00 days for female) followed by cowpea (44.33 days for male and 46.00 days for female), lentil (44.67 days for male and 46.00 days for female), chickpea (46.33 days for male and 47.67 days for female), pigeon pea (48.33 days for male and 50.00 days for female), kabuli gram (49.33 days for male and 50.67 days for female). The longest life cycle of male and female pulse beetle was recorded on black gram i.e. 53.67 and 55.33 days, respectively. (Table 1)

Fecundity of pulse beetle

The mean number of eggs laid by female pulse beetle recorded on different pulses varied from 73.33 to 97.67, The maximum mean number of eggs per female recorded on cowpea was 97.67 followed by 97.33 on green gram, 95.67 on pigeon pea, 89.00 on chickpea, 86.33 on black gram and 78.67 days on kabuli gram. The minimum mean number of eggs per female observed 73.33 on lentil. (Table 1)

Adult survival (%)

The mean adult survival observed on different pulses which were ranged from 72.95 to 90.37 per cent. The maximum adult survival of 90.37 per cent on chickpea followed by 86.77 per cent on green gram, 84.87 per cent on cowpea, 83.14 per cent on pigeon pea, 81.34 per cent on kabuli gram, 79.85 per cent on lentil and minimum on black gram with 72.95 per cent. (Table 1)

Raina (1970) [7] and Dhepe *et al*. (1993) [4] also recorded the similar results, confirming the present findings. The results of present investigation confirmed by the finding of Rathee (2008) [8] who also reported the similar fecundity of pulse beetle on different hosts with maximum egg laying on cowpea and minimum on lentil with incubation period between 3 to 7 days with minimum period on lentil (4.0) and maximum on black gram (4.6).Similary, Jaiswal *et al*. (2019) [6] also reported that the order of preference for oviposition on different pulses for C. chinensis was Cajanuscajan (red gram) >Vigna radiate (green gram) >Vignaunguiculata(cowpea) >Cicerarietinum (chickpea) >Vignamungo (black gram) which is in alignment with the findings of present investigation.

Table 1: Biology of pulse beetle, *Callosobruchus chinensis* on various pulses during 2020-21

Pulses	Incubation period (day)		Larval – pupal period (day)		Pre oviposition period (day)	Oviposition period (day)	Post oviposition period (day)	Adult longevity period (day)		Total life period (day)				Fecundity (no. of eggs/ female)	Adult Survival (%)
								Male	Female	Male		Female			
	Range	Mean	Range	Mean						Range	Mean	Range	Mean		
Green gram	4-5	4.33	17-20	18.67	0.67	7.33	3.00	8.67	10.00	42-44	42.67	42-46	44.00	97.33 (9.89)*	86.77 (68.69)**
Black gram	4-6	5.00	25-28	26.33	2.00	7.33	3.67	9.33	11.00	52-54	53.67	54-57	55.33	86.33 (9.32)	72.95 (58.68)
Chickpea	4-6	4.67	20-23	21.67	1.67	7.00	2.00	9.33	10.67	45-48	46.33	46-50	47.67	89.00 (9.46)	90.37 (71.96)
Cowpea	4-5	4.33	17-20	18.33	1.00	7.67	3.67	9.33	11.00	42-47	44.33	44-47	46.00	97.67 (9.91)	84.87 (67.57)
Pigeon pea	4-5	4.67	18-23	21.00	1.67	8.33	3.67	9.00	10.67	47-50	48.33	48-51	50.00	95.67 (9.81)	83.14 (65.92)
Lentil	4-5	4.33	19-22	20.33	1.33	7.33	3.33	8.00	9.33	42-49	44.67	43-51	46.00	73.33 (8.59)	79.85 (63.64)
Kabuli gram	4-5	4.67	25-27	26.00	2.00	6.00	2.33	8.33	9.67	48-50	49.33	48-52	50.67	78.67 (8.90)	81.34 (64.42)
S.Em ±	-	0.488	-	0.968	0.398	0.471	0.418	0.418	0.630	-	1.162	-	1.397	0.111	2.170
C.D. (p =0.05)	-	1.480	-	2.935	1.208	1.430	1.267	1.267	1.911	-	3.523	-	4.238	0.335	6.583

* Figures in parentheses are square root transformed values

** Figures in parentheses are retransformed per cent values

Conclusion

The result of the experiment on host preference by the pulse beetle, *Callosobruchus chinensis* revealed that shortest life cycle of pulse beetle was observed on green gram, resulting in more number of generations as compared to other host, the shortest life cycle resulted in more number of generations and comparatively more damage during storage.

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