

Comparative Biology of Pulse Beetle (*Callosobruchus maculatus* Fabricius) on Different Stored Pulses

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ABSTRACT

The comparative biology of *C. maculatus* was studied on five different pulses, viz., cowpea, mungbean, pigeonpea, chickpea and field pea under controlled conditions at Pulses Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India. The incubation period of pulse beetle on different hosts ranged from 4.52 to 6.00 days, while minimum (4.52 ± 0.51 days) in cowpea and maximum (6.00 ± 0.91 days) in chickpea. Larval duration ranged from 13.76 to 19.00 days on different hosts which were minimum (13.76 ± 1.94 days) in cowpea and maximum (19.00 ± 0.91 days) in field pea. Pupal duration ranged from 5.68 to 9.00 days in different hosts with a minimum (5.68 ± 0.80

days) in cowpea and maximum (9.00 ± 0.82 days) in field pea. Total developmental period varied from 23.96 to 33.00 days on different hosts. Minimum total developmental period (23.96 ± 2.23 days) was noticed in cowpea and maximum (33.00 ± 1.89 days) in field pea. The ratio of male and female was quite different among the hosts. It was 1:1.07, 1:0.91, 1:0.88, 1:0.76 and 1:0.89 for cowpea, mungbean, pigeonpea, chickpea and field pea, respectively. No significant difference in adult longevity was observed among different hosts. Adult longevity varied between 8.16 and 9.84 days, being lowest in cowpea and maximum in field pea. Life span duration was shortest on cowpea (32.12 days) and prolonged on field pea (42.84 days).

Keywords Biology, Pulse beetle, Cowpea, Mungbean, Field pea.

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INTRODUCTION

Pulses are the “Wonderful gift of nature” that play an essential role in the Indian economy and diet both. After grains and oilseeds, it is the third most important segment of Indian agriculture. In most vegetarians around the world, pulses are the main source of nutritional protein and minerals. Additionally, biological nitrogen fixation in the soil helps to preserve soil fertility, which is essential for sustainable agriculture. Pulses play a vital role in the diet of cattle by producing green fodder concentrate and numerous byproducts. Pulses suffer losses both qualitative and quantitative from the attack of storage pests and the

factors responsible may be biological (insects, rodents, birds) or physical such as temperature, relative humidity, grain moisture, storage structure.

According to an estimate, the post harvest losses in pulses, from harvesting to milling and storage to transport vary from 4 to 8% (Vishwakarma *et al.* 2019). Pulse beetles do not attack all kinds of pulses to the same amount. According to Neelima (2018) the per cent of seed infestation in highest in cowpea (46%) followed by chickpea (43.8%), urd (43.6%), Kabuli gram (40.2%), red gram (33.2%), mung (29%), lentil (23%), guar (20%), pea (19.6%) and soybean (10%) was less preferred. This pest infests mostly all pulses in the storehouses and grain shops and causes a loss in seed weight and viability, decreases germination potential and reduces the market as well as the nutritional value of the commodity. Knowledge of the host preference and biology of the pest species is essential to minimize the incidence. The pulse beetles have a short developmental period and a high degree of reproductive capacity. Therefore, the incidence reaches a high degree within a short period and the damaged seed is unfit for consumption as well as for seed and storage purposes. Therefore, the present study aims to check the development of the bruchid beetle, *C. maculatus* on different pulse varieties.

MATERIALS AND METHODS

A stock culture of pulse beetle, *C. maculatus* was maintained on pigeonpea seeds at 27 ± 2 °C temperature in BOD incubator. A laboratory experiment was conducted on the biology of *C. maculatus* on different pulses viz., cowpea (GC 5), mungbean (GM 4), pigeonpea (GT 103), chickpea (GJG 3) and field pea (GDF 4) at Pulses Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during 2021-22.

To study the biology of pulse beetle uninfected and healthy 50 g seed was kept in plastic vials and a single pair (one male and one female) of newly emerged pulse beetle was released and wrapped with a muslin cloth to prevent the escape of the beetles and kept in a BOD incubator at 27 ± 2 °C temperature. Dead adults were removed daily. Eggs laid on each

day were kept in separate containers covered with a muslin cloth. Separated seeds were examined daily under the stereo zoom microscope. The same procedure was repeated for different pulses.

Observations were recorded on the number of eggs laid by single female (fecundity), incubation period, larval duration, pupal duration and longevity of adults. The incubation period was determined based on the transparency of the eggshell. The appearance of a black spot on the egg indicated that the egg was ready to hatch. The hatched larvae bore the grain below the lower surface of the eggs and remained inside the grain. The appearance of capped exit hole (window or transparent spot) on the grain was a sign of pupation. The adults emerged by cutting the windows in the seed. The observations on number of eggs laid (fecundity), incubation period (days), larval period (days), pupal period (days), developmental period (days), adult longevity (days), sex ratio and total life span (days) were recorded.

RESULTS AND DISCUSSION

Studies on biology of the pulse beetle showed the significant effects of different pulses on the *C. maculatus*. Freshly laid eggs of *C. maculatus* were tiny, oval to spindle shaped, whitish, smooth and translucent in appearance. The eggs were laid individually by females on the surface of the seed. The data on fecundity presented in Table 1 showed that the average number of eggs laid by a single female on different hosts varied between 58.04 and 79.80 eggs per female with significantly maximum eggs (79.80 ± 7.32) were noticed on cowpea and minimum eggs (58.04 ± 3.06) were recorded on field pea. However, the average number of eggs laid by a single female on mungbean, pigeonpea and chickpea were 74.60 ± 3.99 , 67.00 ± 3.89 and 66.68 ± 3.82 eggs, respectively. The present findings were in agreement with Chudasama (2015) revealed that among different hosts significantly maximum fecundity was observed in cowpea (80.08 ± 8.50 eggs). Similarly, Sindhura and Godhani (2020) also found that in cowpea, an average of 81.16 ± 9.10 eggs per single female. According to the findings of Sharma *et al.* (2016), the average number of eggs laid by *C. maculatus* on green gram was 73.10 ± 3.10 eggs. Sekar *et al.* (2021) observed that the average

fecundity of *C. maculatus* on pigeonpea was 71.20 ± 3.56 eggs while, Sekender *et al.* (2020), the mean number of eggs laid by *C. chinensis* on field pea was 70.20 ± 7.53 eggs. The possible reason for variation in egg laying on pulses like cowpea, pigeonpea and green gram might be due to their smaller seed size, seed coat texture and smooth surface compared to other pulses (chickpea and field pea).

Incubation period on different pulses ranged from 4.52 to 6.00 days (Table 1). Significantly minimum incubation period (4.52 ± 0.51 days) in cowpea with a range of 4.00 to 5.00 days, while the significantly maximum (6.00 ± 0.91 days) was in chickpea with a range of 5.00 to 7.00 days. . However, the mean incubation period for mungbean, pigeonpea and field

pea were 5.32 ± 0.56 , 5.56 ± 0.77 and 5.00 ± 0.82 days, respectively. These results are in accordance with Patel *et al.* (2005) who reported that the incubation period in cowpea varied between 4.00 to 5.00 days. Similarly, Sharma *et al.* (2016) found that the incubation period in cowpea varied between 4.00 to 5.00 days. As per the findings of Sekar *et al.* (2021), the incubation period in mungbean varied from 4.00 to 6.00 days. While, Hosamani *et al.* (2018) found that the incubation period in pigeonpea varied between 4.00 and 5.00 days. According to the studies by Sharma *et al.* (2016), the mean incubation period of *C. maculatus* on field pea was 4.70 ± 0.80 days. According to the results of Sekender *et al.* (2020), the mean incubation period of *C. chinensis* on chickpea and field pea was 5.40 ± 0.29 and 4.70 ± 0.25 days, respectively.

Table 1. Comparative biology of *C. maculatus* on different pulses.

Stages	Cowpea			Mungbean			Pigeonpea		
	Min	Max	Av \pm SD	Min	Max	Av. \pm SD.	Min	Max	Av \pm SD
Fecundity (eggs/female)	68	92	79.80 ± 7.32	69	80	74.60 ± 3.99	61	72	67.00 ± 3.89
Incubation period (days)	4	5	4.52 ± 0.51	4	6	5.32 ± 0.56	5	7	5.56 ± 0.77
Larval period (days)	12	17	13.76 ± 1.94	13	15	14.00 ± 0.87	14	16	15.00 ± 0.82
Pupal period (days)	5	7	5.68 ± 0.80	5	7	6.00 ± 0.82	6	8	7.00 ± 0.82
Total developmental period (days)	21	29	23.96 ± 2.23	22	28	25.32 ± 1.70	26	31	27.56 ± 1.50
Adult longevity (days)	7	9	8.16 ± 0.75	8	11	9.60 ± 1.00	8	11	9.68 ± 1.14
Sex ratio (Male:Female)		1:1.07			1:0.91			1:0.88	
Total life span (days)	28	38	32.12 ± 2.54	30	39	34.92 ± 2.16	34	41	37.24 ± 2.11

Table 1. Continued.

Stages	Cnicketpea			Field Pea		
	Min	Max	Av \pm SD	Min	Max	Av. \pm SD
Fecundity (eggs/female)	59	70	66.68 ± 3.82	53	62	58.04 ± 3.06
Incubation period (days)	5	7	6.00 ± 0.91	4	6	5.00 ± 0.82
Larval period (days)	17	19	18.12 ± 0.78	18	20	19.00 ± 0.91
Pupal period (days)	6	8	6.88 ± 0.83	8	10	9.00 ± 0.82
Total developmental period (days)	28	34	31.00 ± 1.80	30	36	33.00 ± 1.89
Adult longevity (days)	8	12	9.48 ± 1.00	9	12	9.84 ± 1.07
Sex ratio (Male:Female)		1:0.76			1:0.89	
Total life span (days)	38	46	40.48 ± 1.87	39	47	42.84 ± 2.21

No. of individuals observed =25, Min- Minimum, Max- Maximum, Av- Average, SD- Standard Deviation.

The larva was apodous, stout, creamy color with a brown color head and “C” shaped scarabeiform. Larva used its mandibles to cut through the seed coat. The mean larval period ranged from 13.76 to 19.00 days in different pulses. Significantly minimum (13.76 ± 1.94 days) larval period was observed in cowpea ranging from 12.00 to 17.00 days, while the significantly maximum (19.00 ± 0.91 days) was noticed in field pea ranging from 18.00 to 20.00 days. While, the mean larval period for mungbean, pigeonpea and chickpea were 14.00 ± 0.87 , 15.00 ± 0.82 and 18.12 ± 0.78 days, respectively. These results are in concurrence with Mehta and Negi (2020) that the average larval period of cowpea was 13.48 ± 0.47 days. According to the results of Hosamani *et al.* (2018), the larval period in mungbean and pigeonpea varied from 12.00 to 19.00 days and 13.00 to 20.00 days, respectively. According to the findings of Mehta and Negi (2020), the average larval period on chickpea was 17.62 ± 0.48 days.

The pupa of the beetle was light cream in color and as the pupal duration increased the colour changed from light cream to dark brown. The various appendages were held close to the body (Exarate type). In the present experiment, the significant differences in the pupal period on different hosts were recorded. Mean pupal period ranged from 5.68 to 9.00 days in different hosts. Significantly, minimum (5.68 ± 0.80 days) pupal period was observed in cowpea with a range of 5.00 to 7.00 days, while a significantly maximum (9.00 ± 0.82 days) was noticed in field pea with a range of 8.00 to 10.00 days. However, the mean pupal period for mungbean, pigeonpea and chickpea were 6.00 ± 0.82 , 7.00 ± 0.82 and 6.88 ± 0.83 days, respectively (Table 1). These results were in accordance with Hosamani *et al.* (2018) revealed that the pupal period in cowpea varied from 7.00 to 8.00 days with an average of 6.00 ± 0.45 days, but slightly differed in mungbean, red gram and chickpea which varied from 6.00 ± 0.50 , 8.00 ± 0.32 and 6.00 ± 0.39 days, respectively. Mehta and Negi (2020) recorded that the mean pupal duration of *C. chinensis* on chickpea was 6.94 ± 0.64 days. The variations in the larval and pupal period of *C. maculatus* on pulses reported by authors might be due to differences in temperature, relative humidity and different pulses evaluated.

Total developmental period varied from 23.96

to 33.00 days. Significantly lowest (23.96 ± 2.23 days) developmental period was recorded in cowpea which varied from 21.00 to 29.00 days and maximum (33.00 ± 1.89 days) in field pea which ranged from 30.00 to 36.00 days, respectively. While, the mean developmental period for mungbean, pigeonpea and chickpea were 25.32 ± 1.70 , 27.56 ± 1.50 and 31.00 ± 1.80 days, respectively. Similar results were observed by Chudasama (2015) that total developmental period of *C. maculatus* was 22.14 ± 1.02 and 34.67 ± 1.09 days on cowpea and chickpea. According to Jaiswal *et al.* (2018), the total developmental period of chickpea varied between 28.00 to 40.00 days with an average of 32.85 ± 3.42 days. Jaiswal *et al.* (2019) also recorded the mean developmental period in chickpea to be 31.00 days. Sindhura and Godhani (2020) reported the total developmental period of *C. maculatus* ranged from 22.00 to 27.00 days on cowpea with a mean of 22.32 ± 2.88 days. According to the findings of Sekar *et al.* (2021), the mean developmental period in mungbean, pigeonpea and chickpea varied from 25.00 to 28.00, 25.00 to 26.00 and 30.00 to 34.00 days, respectively.

In the present study, adult longevity of different hosts was more or less similar and had no significant differences. The mean adult longevity ranged from 8.16 to 9.84 days in different pulses. Significantly minimum adult longevity was observed in cowpea (8.16 ± 0.75 days) with a range of 7.00 to 9.00 days, while significantly maximum was recorded in field pea (9.84 ± 1.07 days) which varied from 9.00 to 12.00 days. While, the average adult longevity for chickpea, mungbean and pigeonpea was 9.48 ± 1.00 , 9.60 ± 1.00 and 9.68 ± 1.15 days, respectively. The present findings are in close agreement with Hosamani *et al.* (2018), who also recorded the adult longevity in cowpea, mungbean and chickpea with an average of 9.00 ± 0.30 , 10.00 ± 0.69 and 9.00 ± 0.38 days, respectively. Sekar *et al.* (2021) found that adult longevity in pigeonpea varied from 8 to 11 days with an average of 9.80 ± 0.58 days. According to the results of Shir (2019), the average adult longevity of *C. chinensis* in field pea was 9.00 ± 1.00 days. The results of Falke *et al.* (2021) also recorded that the average adult longevity of *C. chinensis* in cowpea and mungbean were 8.67 and 9.67 days, respectively.

The ratio of male and female adults was quite

different on pulses. The data on sex ratio showed that more females were produced than males when *C. maculatus* was provided with cowpea as a host while the sex ratio was 1:1.07; whereas, more males were produced than females when *C. maculatus* provided with mungbean, field pea, pigeonpea and chickpea as a host with a sex ratio of 1:0.91, 1:0.89, 1:0.88 and 1:0.76, respectively. According to the findings of Sindhura and Godhani (2020), higher numbers of *C. maculatus* females were produced with cowpea as the host with sex ratio of 1:1.1, while the sex ratio was 1:0.80 for mungbean and 1:0.70 for chickpea. Sekar *et al.* (2021) recorded that the sex ratio of *C. chinensis* was 1:0.87 in mungbean while, it was 1:0.93 in red gram. Jaiswal *et al.* (2018) found that *C. chinensis* produced more males than females in chickpea, resulted with sex ratio of 1:0.88. Sharma *et al.* (2016) reported more males of *C. maculatus* as compared to females in field pea with a sex ratio of 1: 0.89. A similar result was also found by Sekender *et al.* (2020) who recorded more male pulse beetles emerged as compared to females on field pea.

In the present experiment, significant differences in the total life cycle duration of *C. maculatus* on different pulses were observed. The total life cycle duration ranged from 32.12 to 42.84 days in different hosts. Significantly least (32.12 ± 2.54 days) duration of the total life cycle was observed in cowpea with a range of 28.00 to 38.00 days, while the significantly high (42.84 ± 2.21 days) was found in field pea with a range of 39.00 to 47.00 days. However, the total life cycle duration for mungbean, pigeonpea and chickpea were 34.92 ± 2.16 , 37.24 ± 2.11 and 40.48 ± 1.87 days, respectively. The results of the present study are at par with the findings of Patel *et al.* (2005) revealed that on cowpea, the pulse beetle completes its life cycle with an average of 34.02 days, which varied from 28.00 to 40.00 days; while on mungbean, pigeonpea and field pea completed its life cycle on 33.51, 36.70 and 43.85 days, respectively. Jaiswal *et al.* (2019) reported that total life cycle duration in mungbean and pigeonpea varied from 31.00 to 37.00 and 34.00 to 39.00 days with an average of 35.90 and 37.75 days, respectively. Shir (2019), observed the mean total life cycle duration in field pea was 41.00 ± 9.00 days.

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