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Biology of Pulse Beetle, *Callosobruchus chinensis* Linn. on different varieties of Pigeonpea

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ABSTRACT: In different varieties of pigeonpea, seed surface, seed coat thickness and seed size have been linked with mechanism of resistance. The overall results indicated that different biological and life fecundity parameters of *C. chinensis* varied significantly when reared on different varieties of pigeonpea. The mean incubation period was 4.26 days on BSMR-853 followed by BDN-711 (4.35 days), BDN-708 (4.41 days) and BDN-716 (4.65 days). The significantly highest egg hatch was observed on BSMR-853 (96 per cent) followed by BDN-711 (93 per cent), BDN-708 (92 per cent) and BDN-716 (88 per cent). The significantly shortest larval-pupal duration was noticed on BSMR-853 (19.93 days) followed by BDN-711 (20.66 days), BDN-708 (21.84 days) and BDN-716 (22.20 days). Significantly highest growth index was noticed on BSMR-853 (2.75) followed by BDN-711 (2.70), BDN-708 (2.60) and shortest on BDN-716 (2.43). The significantly minimum total developmental period was observed on BSMR-853 (24.17 days) followed by BDN-711 (25.02 days), BDN-708 (26.26 days) and maximum on BDN-716 (26.81 days). Significantly highest adult emergence was observed in the case of those grubs which were reared on BSMR-853 (96.84 per cent) followed BDN-711 (95.73 per cent), BDN-708 (94.49 per cent) and lowest on BDN-716 (88.83 per cent). The significantly highest adult longevity was noticed on BSMR-853 (10.70 days) followed by BDN-711 (10.34 days), BDN-708 (9.69 days) and BDN-716 (9.68 days). Significantly lowest total life cycle duration was noticed on BSMR-853 (34.87 days) followed by BDN-711 (35.37 days), BDN-708 (35.95 days) and BDN-716 (36.47 days). The significantly highest oviposition period was observed on BSMR-853 (7.20 days) followed by BDN-711 (6.80 days), BDN-708 (6.00 days) and BDN-716 (5.60 days). The fecundity (eggs per female) was highest on BSMR-853 (88.20) followed by BDN-711 (82.60), BDN-708 (74.60) and BDN-716 (69.40). Hence, BDN-716 was the most resistant host for the development of *C. chinensis* as compared to BDN-711, BDN-708 and BSMR-853.

Keywords: Pulse beetle, biology, pigeonpea, varieties, *C. chinensis*.

INTRODUCTION

Bruchids are serious pest of stored grain pulses all over the world. It is commonly known as pulse beetle having single genus *Bruchus* with many species. Presence of only one species of genus *Bruchus* renamed as *Callosobruchus chinensis* is common in India, has been reported by Raina (1970). It is a serious pest of pulses like Gram, Arhar, Moong etc. Pest cause severe damage to these pulses due to flying habit, beetle starts infesting the plant in field as the grub attacks the whole seed by remaining inside the seed. It is very difficult to observe the damage until the adult emerges by breaking the seed coat (Singh and Jambunathan 1990). In India found three predominant pest species of pulse beetle *C. maculatus*, *C. analis* and *C. chinensis* (Dias and Yadav 1988). The insects spend its entire immature stage in individual legume seeds, where they cause weight loss, decrease in germination potential and diminish the market as well as nutritional value of the commodity (Jat *et al*., 2013).

Various biological parameters of the Bruchid are affected by seed attributes that could exist physically or chemically. In different pulses, seed surface, seed coat thickness and seed size have been linked with mechanism of resistance. In addition, the Bruchids have their ovipositional preference on basis of seed surface, colour, texture, volume and nutritional value of seed (Singh *et al*., 1980). The present study was undertaken to determine the biology on four varieties of pigeonpea, aiming at selecting variety with inherent resistance source against *C. chinensis*.

REVIEW OF LITERATURE

Sekender *et al*. (2020) observed the longest incubation period of pulse beetle was observed in gram, 5.4 $\pm$ 0.29 days and the shortest period being observed in mung, 4.6 $\pm$ 0.25 days.

Sindhura and Godhani (2020) reported 91 per cent hatchability of eggs of *C. maculatus* on cowpea, 88 per cent on Chickpea and 89 per cent found on green gram.

Sindhura and Godhani (2020) reported the larval + pupal period of *C. maculatus* ranged from 18 to 23 days in cowpea (19.88 $\pm$ 1.59 days), 23 to 29 days in

chickpea (28.02 ± 1.98 days) and 22 to 29 days in green gram (26.60 ± 2.56 days).

Waghmare and Bantewad (2020) observed 15 different chickpea cultivars and reported significantly lowest per cent adult emergence was recorded in ICCV-86111 (67.67 per cent) which was at par with PG-805-17-5 (68.33 per cent) followed by AKG-1303 (68.33 per cent), PG 0819-43 (70.00 per cent), BDNG 801 (70.00 per cent), Vikram (70.00 per cent), AKG 1109 (71.67 per cent) and BDNG 797 (73.33 per cent). The highest per cent adult emergence was recorded in ICCV-3137 (82.33 per cent) followed by Jaki-9218 (81.00 per cent), Saki-9516 (80.00%), PG 13107 (78.33 per cent), AKG 1401 (76.67 per cent), BDNG 804 (76.67 per cent) and BDNG 2010-1 (76.67 per cent) and were found at par with each other. Thus, the results indicate that seed size and seed colour had not much influence on per cent adult emergence. However, medium to bold seeded varieties with smooth surface had some influence on the adult emergence.

Yewale *et al*. (2020) reported the growth index ranged from 2.74 to 3.06 in different varieties of green gram. PM-302-46 proved to be most nutritious to *C. maculatus* recording high growth index of 3.06. The least nutritious variety was BM-4 which recorded 2.74 growth index and it was at par with BM-2003-1 (2.78), Kopargaon (2.79) and BPMR-145 (2.80).

Mehta and Negi (2020) reported the total developmental period of *C. chinensis* (egg to adult emergence) varied with maximum being with black gram 34.81 days in the first generation, which decreased in the second generation in all three pulses. It varied form 26.43 days in chickpea to 31.81 days in black gram.

Gopi and Singh (2020) studied the mean duration of total life cycle of *C. chinensis* was (32.80 ± 2.28 days) which ranged between 30 to 35 days on six different greengram varieties.

Dalal *et al*. (2020) reported the mean male and female longevity were 8.43 and 12.37 days, which were ranged from 7-9 and 10-14 days, respectively on blackgram.

Sindhura and Godhani (2020) reported more females of *C. maculatus* were produced on cowpea with a sex ratio 1: 1.1 followed by green gram 1: 0.8 and chickpea 1: 0.7.

Dalal *et al*. (2020) reported the mean fecundity of *Callosobruchus chinensis* female on blackgram variety Nirali seeds was 89.30 eggs and ranged from 81 to 97 eggs.

Sindhura and Godhani (2020) reported the fecundity of *C. maculatus* ranged from 70.08 to 83.08 eggs in laboratory. Highest found in green gram (83.08 ± 5.03 eggs) followed by cowpea (81.16 ± 9.10 eggs) and in chickpea (70.08 ± 4.91 days).

MATERIALS AND METHODS

The present studies on the biology and life-fecundity of pulse beetle, *Callosobruchus chinensis* Linn. was carried out on different varieties of pigeonpea *viz*., BDN-708, BDN-711, BDN-716 and BSMR-853 at Department of Agriculture Entomology, College of Agriculture, Latur during 2020-21. The initial culture of the *C. chinensis* was maintained on disinfected pigeonpea seeds at room temperature. A single pair of *C. chinensis* was obtained from the stock culture maintained at Department of Agriculture Entomology, College of Agriculture, Latur. Clean seeds of pigeonpea were sterilized at temperature of 55°C for 4 hours in the oven to eliminate the hidden infestation. Twenty-five pairs of one to two days old beetles from the initial culture were released in wide mouth cylindrical plastic box measuring 20 cm × 15 cm containing 250 g seeds of pigeonpea. The boxes were covered with muslin cloth and fasten with rubber band. Subsequently, adult emerged from this culture were used for further study. Necessary care like use of forceps and camel hairbrush was taken in handling the insects and grains.

The sexes were separated on the basis of morphological characters (Southgate, 1958), the male had pectinate antennae, while that of female had serrate (Raina, 1970). The apical regiment will be found elongate and oblong in male and bluntly rounded or ovate in female. Antennal segments will be deeply serrated in male. The serration became more prominent from the fourth segment and onward in male and from fifth segment in female. In male the antennae moved in right and left direction and they were curved towards each other. In female it moved forward and backward and they were straight. Male showed no response to touch, where's females showed the response. The adult male and female measured about 3.2 to 3.36 mm and 3.43 to 3.56 mm in length, respectively (Khare, 1994).

The studies on biology of pulse beetle, *C. chinensis*were carried out in a completely randomized design with five replications under laboratory conditions on four different pigeonpea varieties BDN-708, BDN-711, BDN-716 and BSMR-853 obtained from Agricultural Research Station, Badnapur Dist. Jalna during 2020-21. Twenty-five pairs of one to two days old adults of *C. chinensis* were released for egg laying in rounded plastic boxes (21 cm × 15 cm) containing grains of the pigeonpea variety under study. The grains containing the eggs were collected on next day morning. In order to facilitate the observations, only one egg was kept on each grain, while others were removed with the help of a needle. Such one hundred grains were kept individually in plastic vials (6.5 cm × 2.5 cm) under laboratory condition at fluctuating room temperature ranging from 21.1 to 33.9°C and relative humidity of 67 to 97 per cent. The observations will be taken daily in the morning. The observation on per cent hatching of eggs, incubation period, larval + pupal period, longevity of male and female, growth index and sex ratio were recorded.

The growth index was calculated by using Singh and Pant's (1955) formula.

$$\text{Growth index} = \frac{S}{T}$$

Where,

S = Percentage of adult emergence

T = Average developmental period (days)

RESULTS AND DISCUSSION

A. The incubation period

The significantly higher incubation period (4.65 days) was observed when *C. chinensis* reared on BDN-716. The shortest incubation period (4.26 days) was noticed in BSMR-853 however, it was at par with pigeonpea variety BDN-708 (4.41 Days). Which is quite similar Jaiswal *et al*. (2019) recorded the incubation period of *C. chinensis* varied from 3.85 to 4.15 days on different hosts, it being maximum on chickpea (4.15 days) and green gram (4.10 days) followed by cowpea (4.00 days) and red gram (4.00 days).

B. Percentage egg hatched

The data (Table 1) revealed that the highest egg hatchability was recorded in pigeonpea variety BSMR-853 (96 per cent) however, it was at par with on BDN-711 (93 per cent) and BDN-708 (92 per cent). Whereas Sharma *at al*. (2016) reveled that hatching of eggs in pulse beetle ranged from 98.1 to 94.3 per cent.

C. Larval-pupal duration

The significantly shorter larval-pupal duration of *C. chinensis* found on pigeonpea variety BSMR-853 (19.93 days). The highest larval-pupal duration was noticed on pigeonpea variety BDN-716 (22.20 days) and it was at par with larval-pupal duration observed on BDN-708 (21.84 days). While, Jaiswal *et al.* (2019), documented that the mean larval-pupal duration of *C. chinensis* varied from 24.90 to 26.70 days on different hosts being maximum on chickpea (26.70 days) and red gram (26.45 days) followed by green gram (25.60 days) and cowpea (25.20 days).

D. The growth index

The highest growth index (2.75) was recorded on pigeonpea variety BSMR-853 however it was at par with BDN-711 (2.70). The significantly lowest growth index (2.43) was observed in pigeonpea variety BDN-716. Waghmare and Bantewad (2020) exhibited that the growth index of *C. chinensis* was ranged from (2.64 to 2.79) on 15 different chickpea cultivars. Yewale *et al*. (2020) revealed that the growth index ranged from 2.74 to 3.06 in different varieties of green gram.

E. The total developmental period (egg to adult emergence)

The significantly shorter development period (24.17 days) was found in BSMR-853. The longest developmental period was observed on BDN-716 (26.81 days) and it was at par with development period on BDN-708 (26.26 days). The results of present investigation are parallel with the findings of Singh and Mohan (2018) who showed that the total developmental duration of *C. chinensis* on under controlled conditions varies from 21-25 days in bold variety and 26-32 days in smaller variety.

Table 1: The incubation period, egg hatchability, larval-pupal period and growth index of *C. chinensis* on different varieties of pigeonpea.

Different varieties	Incubation Period (days)	Egg hatchability (per cent)	Larval-Pupal period (days)	Growth index
BDN-708	4.41	92 (73.57)*	21.84	2.60
BDN-711	4.35	93 (74.66)	20.66	2.70
BDN-716	4.65	88 (69.73)	22.20	2.43
BSMR-853	4.26	96 (78.46)	19.93	2.75
S. E. ±	0.05	1.80	0.20	0.04
C.D. at 5%	0.16	5.41	0.59	0.14
C.V. (%)	2.64	4.37	2.11	4.07

*Figures in parentheses indicate arcsine transformed values.

Table 2: The mean developmental period and life-cycle duration of *C. chinensis* on different varieties of pigeonpea.

Different varieties	Developmental Period (days)	Life-cycle duration (days)		
		Mean	Male	Female
BDN-708	26.26	35.95	34.38	37.31
BDN-711	25.02	35.37	34.10	36.63
BDN-716	26.81	36.49	35.16	37.61
BSMR-853	24.17	34.87	33.75	36.02
S. E. ±	0.18	0.27	0.30	0.25
C.D. at 5%	0.54	0.80	0.90	0.75
C.V. (%)	1.56	1.67	1.96	1.53

F. The total life cycle duration

The significantly shorter life cycle duration (34.87 days) was reported on pigeonpea variety BSMR-853. The longer life cycle duration (36.49 days) was found on BDN-716 which was at par with BDN-708 (35.95 days). Similar Patel *et al*. (2005) who determined that the average duration of *C. chinensis* life-cycle varied from 33.51 to 43.85 days among different grain pulse, in pigeonpea he observed average life-cycle is 36.70 days.

G. The adult emergence

The data (Table 3) revealed that highest adult emergence (96.84 per cent) was noticed on BSMR-853 and it was at par with BDN-711 (95.73 per cent) and BDN-708 (94.49 per cent). The significantly lowest adult emergence was observed in BDN-716 (88.83 per

cent).Accordance with the findings of Tania *et al*. (2011) who exhibited that the per cent adult emergence of *C. chinensis* was to the extent 97.07 to 93.79 per cent in different mung varieties.

Table 3: The per cent adult emergence, adult longevity and sex ratio of*C. chinensis* on different varieties of pigeonpea.

Different varieties	Adult emergence (%)			Adult longevity (days)			Sex ratio
	General	Male	Female	Mean	Male	Female	
BDN-708	94.49 (76.42)*	46.72 (43.12)	47.77 (43.73)	9.69	8.70	10.68	1:1.02
BDN-711	95.73 (78.07)	43.98 (41.54)	51.75 (46.00)	10.34	9.22	11.36	1:1.17
BDN-716	88.83 (70.48)	40.70 (39.64)	48.12 (43.92)	9.68	8.65	10.55	1:1.19
BSMR-853	96.84 (79.76)	43.45 (41.24)	53.38 (46.94)	10.70	9.48	11.68	1:1.21
S.E ±	1.66	0.82	0.99	0.21	0.20	0.24	
C.D at 5 %	4.98	2.45	2.96	0.65	0.60	0.73	
C.V. (%)	3.96	4.19	4.39	4.77	4.96	4.92	

*Figures in parentheses indicate arcsine transformed values

H. The adult longevity

It revealed that highest adult longevity (10.70 days) observed in pigeonpea variety BSMR-853 and it was at par with BDN-711 (10.34 days). The lowest longevity reported in BDN-716 (9.68 days) which was at par with BDN-708 (9.69 days).The results of present investigation got the support from the findings of Patel *et al.* (2005) who concluded that the adult longevity on red gram ranged from 8-14 days with mean 12.07 days.

I. The sex ratio

The maximum sex ratio of male: female was recorded on BSMR-853 (1:1.21) followed by BDN-716 (1:1.19), BDN-711 (1:1.17) and minimum found on BDN-708 (1:1.02). Sindhura and Godhani (2020) noticed that the sex ratio of pulse beetle highest on cowpea 1:1.1 followed by green gram 1:0.8 and chickpea 1:0.7.

J. The pre-oviposition period and ovipositional period

The data on pre oviposition period (Table 4) vary significantly. The highest pre-oviposition period (7.60 hours) observed in BSMR-853. The pre oviposition period observed in BSMR-853 was at par with BDN-708 (7.53 hours) and BDN-711 (7.46 hours). The significantly longer oviposition period (7.20 days) was recorded in BSMR-853 and significantly lowest oviposition period in BDN-716 (5.60 days). Similar studied founded Sindhura and Godhani (2020) that the pre-oviposition period ranged from4 to 10 hours and ovipositional period varied 5 to 10 days on three different pulses.

Table 4: The pre-oviposition, oviposition period and fecundity of*C. chinensis* on different varieties of pigeonpea.

Different varieties	Pre-oviposition period (hours)	Oviposition period (days)	Fecundity Per female
BDN-708	7.53	6.00	74.60
BDN-711	7.46	6.80	82.60
BDN-716	7.29	5.60	69.40
BSMR-853	7.60	7.20	88.20
S. E. +	0.07	0.13	1.67
C.D. at 5%	0.22	0.38	4.50
C.V. (%)	2.17	4.45	4.74

K. The fecundity

The data revealed that significantly highest fecundity was recorded on pigeonpea variety BSMR-853 (88.20 eggs) and significantly lower fecundity observed in BDN-716 (69.40 eggs). Similar Dalal *et al*. (2020) reported the mean fecundity of *C. chinensis* female on blackgram variety Nirali was 89.30 eggs and ranged from 81 to 97 eggs.

CONCLUSIONS

The significantly higher incubation period (4.65 days) was observed when *C. chinensis* reared on BDN-716. The shortest incubation period (4.26 days) was noticed in BSMR-853 which was at par with BDN-708 (4.41 days). The highest egg hatchability observed in BSMR-853 (96 per cent) and lowest hatchability in BDN-716 (88 per cent). The significantly shorter larval-pupal duration of *C. chinensis* was found in BSMR-853 (19.93 days) whereas, higher larval-pupal duration (22.20 days) was recorded on BDN-716 and it was at par with larval-pupal duration observed in BDN-708 (21.84 days). The highest growth index (2.75) was recorded on pigeonpea variety BSMR-853 and it was at par with BDN-711 (2.70). The significantly lowest growth index (2.43) recorded in BDN-716.

The significantly shorter developmental period (24.17 days) was found in BSMR-853. The longest developmental period (26.81 days) was observed in BDN-716 which was at par with BDN-708 (26.26 days). The significantly shorter life cycle duration

(34.87 days) was reported on BSMR-853. The longer life cycle duration (36.49 days) was found in BDN-716 which was at par with BDN-708 (35.95 days). The highest adult emergence (96.84 per cent) was noticed in BSMR-853 however, it was at par with BDN-711 (95.73 per cent) and BDN-708 (94.49 per cent). The significantly lowest adult emergence (88.83 per cent) observed in BDN-716. The highest male beetle emergence was observed in BDN-708 (46.72 per cent) and incase of females it was highest in BSMR-853 (53.38 per cent). The highest adult longevity (10.70 days) observed on BSMR-853 and was at par with BDN-711 (10.34 days). The lowest longevity reported in BDN-716 (9.68 days) which was at par with BDN-708 (9.69 days). The maximum sex ratio of male: female was recorded on BSMR-853 (1: 1.21) followed by BDN-716 (1: 1.19), BDN-711 (1: 1.17) and minimum on BDN-708 (1: 1.02).

The significantly longer oviposition period (7.20 days) was found on BSMR-853 and significantly lowest oviposition period (5.60 days) on BDN-716. The significantly highest fecundity (88.20 eggs) was noticed on BSMR-853 and significantly lowest fecundity (69.40 eggs) on BDN-716.

FUTURE SCOPE

Future scope of this study is to take more varieties or genotype with biochemical analysis to find resistance or susceptible factor.

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Conflict of Interest. None.

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