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Sekar S
Assistant Professor, Entomology, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Thiruvengadam K
Assistant Professor, Entomology, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Naveena K
UG Students, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Nelson S
UG Students, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Nivetha T
UG Students, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Oviya T
UG Students, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Pavithra M
UG Students, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Chozhan K
The former Dean, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Corresponding Author:
Sekar S
Assistant Professor, Entomology, RVS Agricultural College, Thanjavur, Tamil Nadu, India

Growth and development of pulse beetle, *Callosobruchus chinensis* [L] on pulses

Sekar S, Thiruvengadam K, Naveena K, Nelson S, Nivetha T, Oviya T, Pavithra M and Chozhan K

Abstract
Laboratory experiments were conducted to study the comparative growth and developmental biology of *Callosobruchus chinensis* in the laboratory at RVS Agricultural College, Thanjavur on different pulses. *i.e.,* Five pulses [green gram (*Vigna radiata*), black gram (*Vigna mungo*), chickpea (Desi) (*Cicer arietinum*), cowpea (*Vigna sinensis*) and red gram (*Cajanas cajan*). Red gram received the highest number of eggs (71.20 ± 3.56 no. of eggs/ female) while minimum number of eggs laid on chick pea (27.80±2.33 no. of eggs/ female). Oviposition period and incubation period of eggs on different pulses shows non-significant. Hatchability per cent of egg were high (91.20 ± 1.32%) on black gram (91.20 ± 1.32%) and low on chickpea (79.20 ± 5.03%). The duration of larval - pupal was the highest on chick pea (27.80 ± 0.58 days) and the lowest on red gram (21.60 ± 0.40 days). Total life cycle of pulse beetle, *Callosobruchus chinesis* was less on red gram (25 .80 ± 0.20 days) and prolonged on chickpea (32.00 ± 0.89 days). Maximum adult longevity was observed on red gram (9.80 ± 0.58 days) least on black gram (7.60 ± 0.40 days) . No significant differences in sex ratio of pulse beetle among the different pulses were observed. The highest survival per cent was recorded in red gram (88.4 ± 5.37%) followed black gram (83.6 ± 5.52%) and low in chickpea (62.8 ± 5.26%). Green gram had minimum per cent of grain weight loss (24.61 ±6.27). The highest per cent grain weight loss was observed in red gram (32.37 ±4.59%).

Keywords: growth parameters, life cycle, pulse beetle and pulses

Introduction
Pulses play a vital role in the diet of common people of Asian countries including Bangladesh. Because pulses are the rich source of protein, several amino acids, minerals and certain vitamins, and are available to the poor people at a reasonable price. Pulses are also known as "Poor man's meat" (Sharma, 1984) [10]. Daily protein requirement per adult is by consuming only 56 g of pulses (Susmita, 2016) [11]. Unfortunately, in storage, pulses suffer enormous losses due to pest attack. Among the insect pests, *C. chinensis* L. is the most serious pest of pulses and is known to be prolific and rapid in breeding, and can quickly cause a serious quantitative reduction as well as diminish nutritive value of stored grains. This insect is cosmopolitan in distribution but is more widely spread throughout the tropical and sub-tropical regions (Mensah, 1986) [5]. In India, usually synthetic chemical insecticides and fumigants are used to protect the pulses from the infestation of pulse beetle in storage. But the use of chemical insecticides causes several problems like resistance and toxic residues in food. However, the use of chemical pesticides not only involves potential health hazards, residues, pollution and contamination, but also beyond the financial capability of the farmers (Khaire *et al.,* 1993). It is an urgent need to find out a safe and sound alternative to chemical insecticides to protect the stored products in storage. The present study has been undertaken to evaluate the degree of susceptibility of the selected genotypes of these pulses to *C. chinensis.*

Materials and Methods
Mass culturing was carried out in the laboratory at RVS Agricultural College Twenty adults of *C. chinensis* were confined in jars containing 50 g of green gram seeds and mouth of the jar was covered with khada cloth. The jars were maintained at 27±5 °, 60± 5 per cent RH for four weeks. After four weeks, freshly emerged adults were used for conducting the experiments.

To study the comparative developmental biology of *C. chinensis* on different pulses, a laboratory experiment was conducted in the laboratory in completely randomized block design

with six treatments i.e., green gram (*Vigna radiata*), black gram (*Vigna mungo*), chickpea (Desi) (*Cicer arietinum*), cowpea (*Vigna sinensis*), pea (Pisum sativum)] and red gram (*Cajanas cajan*). Under each treatment, plastic containers (each 9x4 cm) were taken and each filled with 50 g conditioned grains. Five virgin pairs of newly emerged adults (0-24 h old) of *C. chinensis* were isolated from stock culture using key of sex differentiation (Raina, 1970) [7] and introduced into each of the plastic containers. The mouth of the plastic container was wrapped with a muslin cloth to allow aeration and to prevent escape of the beetles. The data on different parameters viz., fecundity, oviposition period, adult longevity, sex ratio, survivorship and weight loss were recorded repletion-wise. From each repetition, 30 grains each with one freshly laid egg on it (others were removed with the help of a needle) were picked up and kept in glass vial. Observations were made daily to record data on incubation period, hatchability, larval-pupal period, adult and total life period. Dead adults were removed daily. The parameter-wise data were subjected to ANOVA.

Results and Discussion

The female beetle started laying eggs after 24 hours of emergence. Maximum eggs were laid on first day of oviposition and it subsequently with the passage of time. The egg was clear, shiny and oval to spindle shaped. Maximum eggs were laid on red gram (71.20 ± 3.56 no. of eggs/ female) and minimum on chickpea (27.8±2.33 no. of eggs/ female) (Table 1). Based on the fecundity, the order of host preference by *C. chinensis* was redgram >cowpea > black gram >green gram > chick pea. In the present study, significant variations in fecundity of *C. chinensis* among the pulses might be due to different nutritional composition of different pulses. These results are in conformity with those of Mehta and Chandel (1990) [4] who reported that higher number of eggs were laid on cowpea (15.33 eggs/seed) followed by green gram (5.67 eggs/seed). The possible reason for higher egg laying on some pulses (Cowpea, Pigeonpea, green gram, and black gram) might be due to their larger seed size and smooth surface in comparison to other pulses (chickpea and pea) as reported by SatyaVir (1980) [8]. The oviposition period of *C. chinensis* on various pulses varied from 4 to 6 days but which show no significant difference among pulses. These results on par with Sharma *et al.* (2016) [9] who reported the differences among these three pulses were non-significant (Table. 1). The hatchability of eggs was ranged from 91.2 to 79.2 per cent. Based on percentage on hatchability of eggs, the order of pulses were black gram >green gram >cowpea >red gram >chickpea. The egg period ranges between 3 to 7 days which did not differ significantly. These results were in conformity with the findings of Dhepe *et al.* (1993) [3], Chandra and Ghosh (2006) [2] and Varma and Anandhi (2010) [12]. The larval - pupal period varied between 21 to 29 days and on an average it varies from 21.60 ± 0.40 to 27.80 ± 0.58 days. The duration of larval - pupal was the highest on chick pea (27.80 ± 0.58 days) and the lowest on red gram (21.60 ±0.40 days) followed by green gram (22.20 ±0.58 days) (Table. 2). However, Chandra and Ghosh (2006) [2] who observed the larval-pupal period of *C. Maculates* on different pulses and reported it to be 34.02 on black gram, 21.98 on bengal gram and 28 days on pea which are in close conformity with the present findings. The variations in larval-pupal period of *C. maculates* on pulses reported by different scientists might be due to differences in temperature, relative humidity and variety of the pulse used.

The total life period was calculated from the day of oviposition to adult emergence. It was minimum of 25 .80 ± 0.20 days on red gram and maximum of 32.00 ± 0.89 days on chickpea (Table 3). Based on total life cycle of *C. chinensis* on various pulses, the order of pulses were chickpea >black gram >cowpea > greengram >red gram. However, it is evident from the literature that higher seed weight and thick seed coat prolonged developmental period (Chakraborty *et al.*, 2004) [1]. In spite of higher nutrition, the development is retarded because of thick seed coat which creates obstruction for penetration of young larvae inside the seed and emergence of adult from the seed. Adult longevity was significantly high on red gram (9.80 ± 0.58 days) while per cent adult emergence were significantly low on black gram (7.60 ± 0.40 days). Earlier Patel *et al.* (2005) [6] observed that the adult longevity was more on pea (14.83 days) followed by Bengal gram (12.83 days) and red gram (12.07 days) and shortest duration was observed on grass pea (11.45 days) followed by cowpea, green gram and lentil. No significant different observed among pulses which corroborate with earlier findings. The survivalship was maximum on red gram (88.4±5.37) and minimum on chickpea (62.8±5.26) (Table 4). Based on the survivalship of pulse beetle on pulses, the order were red gram>black gram>cowpea>green gram>chickpea. The per cent grain weight loss caused due to feeding of grubs was recorded on 45th day of insect confinement and results presented in Table 4. Green gram had minimum per cent of grain weight loss (24.61 ±6.27). The highest per cent grain weight loss was observed in red gram (32.37 ±4.59%) (Table 4).

Table 1: Fecundity, oviposition period of *Callosobruchus chinensis* (F.) on various pulses

Pulses	Fecundity (no. of eggs/ female)		Oviposition period (days)	
	Range	Mean	Range	Mean
Chickpea	20-32	27.80±2.33 ^{d}	4-6	4.80±0.37
Cowpea	49-67	59.40±3.39 ^{b}	4-6	4.60±0.40
Black gram	49-60	53.40±2.06 ^{bc}	4-6	4.80±0.37
Green gram	40-54	46.20±2.58 ^{c}	4-6	4.60±0.40
Red gram	62-82	71.20±3.56 ^{a}	4-6	5.40±0.24
SE.d	4.02		NS	
CD (0.05)	8.38			
CD(0.01)	11.44			

Table 2: Incubation period, hatchability and larval-pupal period of *Callosobruchus chinensis* (F.) on various pulses

Pulses	Incubation period (days)		Total hatchability (%)	Larval – pupal period (days)	
	Range	Mean	Mean	Range	Mean
Chickpea	3-5	4.20 ±0.37	79.20 ±5.03 ^{c}	26-29	27.80±0.58 ^{a}
Cowpea	4-6	4.60 ±0.4	86.80 ±0.37 ^{abc}	22-24	23.40±0.40 ^{c}
Black gram	3-5	3.80 ±0.37	91.20 ±1.32 ^{a}	24-27	25.20±0.58^{b}
Green gram	4-5	4.40 ±0.24	89.20 ±1.11 ^{ab}	21-24	22.20±0.58^{cd}
Red gram	3-5	4.20 ±0.37	80.80 ±4.49 ^{bc}	21-23	21.60±0.40 ^{d}
SE.d	NS		4.4091	0.7321	
CD (0.05)			9.1972	1.5272	
CD(0.01)			12.5459	2.0832	

Table 3: Total life period (egg to adult), adult longevity and sex ratio of *Callosobruchus chinensis* (F.) on various pulses

Pulses	Mean developmental period (Days)		Adult longevity (days)		Sex ratio
	Range	Mean	Range	Mean	Mean
Chickpea	30-34	32.00 ± 0.89 ^{a}	6-7	7.80 ± 0.58^{bc}	1:0.78
Cowpea	26-30	28.00 ± 0.71 ^{bc}	8-11	9.20 ± 0.49 ^{ab}	1:0.85
Black gram	28-30	29.00 ± 0.32 ^{b}	7-9	7.60 ± 0.40^{c}	1:0.86
Green gram	25-28	26.60 ± 0.51 ^{cd}	7-10	8.40 ± 0.60^{abc}	1:0.87
Red gram	25-26	25 .80 ± 0.20 ^{d}	8-11	9.80 ± 0.58^{a}	1:0.93
SE.d	0.8246		0.7589		NS
CD (0.05)	1.7201		1.5831		
CD (0.01)	2.3464		2.1596		

Table 4: Survivalship and weight loss of *Callosobruchus chinensis* (F.) on various pulses

Pulses	Survivalship (%)	Weight loss (%)
	Mean	Mean
Chickpea	62.8±5.26 ^{d}	26.35 ±3.31 ^{c}
Cowpea	77.4±1.71 ^{bc}	26.95 ±2.12 ^{bc}
Black gram	83.6±5.52 ^{ab}	25.44 ±3.13 ^{ab}
Green gram	75.2±4.16 ^{c}	24.61 ±6.27 ^{abc}
Red gram	88.4±5.37 ^{a}	32.37 ±4.59 ^{a}
SE.d	3.91	4.91
CD (0.05)	8.16	10.26
CD(0.01)	11.13	13.99

Conclusion

From the present findings, the pulse beetle, *C. chinensis* resulted in higher susceptibility in red gram and marked the lowest susceptibility in chickpea *C. chinensis* also showed maximum number of egg deposition and highest damage in shiny surface area of red gram seed. Number of laid eggs also varied according to the surface area of seed, and chemical composition of seed also has significant contributions in influencing the egg deposition and damage of seed.

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