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Fecundity and survival of pulse beetle (*Callosobruchus chinensis* L.) on green gram

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Abstract
The study aimed to investigate the fecundity and survival of the pulse beetle *Callosobruchus chinensis* Linnaeus on two varieties of green gram, CD 6-52 and CD 6-53. The experiment was conducted at the Post Graduate Laboratory in the Department of Agricultural Entomology, College of Agriculture, Latur, during the 2023-2024 period. When reared on the CD 6-52 and CD 6-53 varieties, the survival rates of the immature stages were recorded as 0.59 and 0.49 per individual, respectively, with a developmental time of 31 days for each. The net reproductive rate (R0) was found to be 26.40 and 16.83 females per generation for CD 6-52 and CD 6-53, respectively. The mean generation time (T) was 40.16 and 40.32 days for the two varieties, while the intrinsic rate of increase (rc) was 0.081 and 0.070 females per female per day, respectively, and the finite rate of increase (λ) was 1.20 and 1.17 females per female, respectively. On CD 6-52, the stable-age distribution of *C. chinensis* in the egg, larval-pupal, and adult stages was 62.09%, 36.90%, and 1.00%, respectively, whereas for CD 6-53, the distribution was 59.70%, 39.09%, and 1.20%, respectively.

Keywords: Green gram, pulse beetle, *C. chinensis*, survival, life-fecundity tables

Introduction
Mung bean seeds are an excellent source of essential amino acids, protein, and are easily digestible. This crop, known for its short growth period of 70-90 days, is highly effective in intensive cropping systems. Mung beans contain 51% carbohydrates, 26% protein, 4% minerals, and 3% vitamins (Yadav *et al.*, 1994) [16]. The sprouts of mung beans are considered a high-quality vegetable, rich in vitamin C and iron. However, insect pests pose a significant threat to pulse production, causing considerable damage both in the field and during storage. Various pests, particularly storage insects, can significantly affect mung bean yield. Among the most damaging pests are the bruchids from the *Callosobruchus* genus (Coleoptera: Bruchidae) (Paikaray *et al.*, 2021) [11]. The most harmful bruchid species to green gram are *Callosobruchus chinensis* (Linn.), *C. maculatus* (Fabricius), and *C. analis*, all belonging to the Coleoptera order, Bruchidae family. *Callosobruchus chinensis* is a major pest that causes both quantitative and qualitative losses to stored green gram. The larvae feed on the cotyledons, leading to a significant reduction in seed weight and viability. This feeding also compromises the biochemical quality of seeds, decreasing their storability. Bruchid larvae feed on the seed contents, reducing the seed's utility, making them unsuitable for planting or human consumption (Ali *et al.*, 2004) [1]. The larvae stage of these insects causes more damage compared to other life stages (Gbaye *et al.*, 2011) [5]. In response to this, legumes have evolved various toxic compounds to kill or deter bruchids. In turn, the bruchids have developed adaptive strategies to overcome the effects of these toxic substances. These interactions between bruchids and legumes are highly specific, with each bruchid species typically feeding on a very limited number of seed species (Somta *et al.*, 2007) [13].

Materials and Methods
Laboratory experiments were carried out to examine the fecundity tables of *Callosobruchus chinensis* Linnaeus on two varieties of green gram under controlled conditions at the Post Graduate Laboratory, Department of Agricultural Entomology, College of Agriculture, Latur, during the 2023-24 period. *C. chinensis* was separately reared on the varieties CD 6-52 and CD 6-53.

Newly emerged adults were paired and placed in plastic vials (6.5 cm x 2.5 cm) with a 1:1 sex ratio, each containing fifty grains of the respective green gram variety. The grains, once egg-laden, were replaced daily with healthy grains, and the total number of eggs laid by each female was recorded until the female's death. The life-fecundity tables for *C. chinensis* were created by studying a batch of 100 eggs, with 20 eggs in each replicate. Immediately after hatching, larvae began burrowing into the seeds. Daily observations were made on various parameters such as egg hatching, larval and pupal development, successful adult emergence, female fecundity, and age-specific mortality in the life stages (egg, larva-pupa, and adult). The total number of adults emerging each day was moved to separate cages in a 1:1 ratio to measure age-specific fecundity. For further egg laying, healthy, sterilized grains were placed in the plastic vials (6.5 cm x 2.5 cm).
The number of female births (mx) was determined by dividing the number of eggs laid per female by two, assuming a 1:1 sex ratio (Southwood, 1968) [14]. The life-fecundity tables under laboratory conditions were constructed using the columns proposed by Birch (1948) [3], further detailed by Howe (1953) [6], and Atwal and Bains (1974) [2]. In these tables, *x* represents the pivotal age in days, *lx* indicates the survival rate of females at age *x*, and *mx* refers to the age-specific birth rate for females at age *x*.

Net Reproductive Rate (R_0): The net reproductive rate (R_0) represents the rate at which a population increases per generation, specifically in terms of the number of females produced. The values for 'x', 'lx', and 'mx' were derived from the data in the life tables. The net reproductive rate, denoted as R_0, is calculated by summing the products of 'lx' and 'mx' (Lotka, 1925) [8]. The number of times a population will multiply each generation is computed using the following formula:

$$R_0 = \Sigma lxmx$$

Mean Generation Time (T_a): The mean generation time (T_a) refers to the average age of mothers in a cohort when their female offspring are born. This value is determined using the following calculation:

$$T_c = \frac{\sum l_x m_x x}{R_0}$$

Innate Capacity for Increase in Numbers (r_a): The survival rate of individuals and the average number of female offspring produced at each age interval were recorded. Based on the data from the life table, the intrinsic rate of increase in numbers, denoted as r_a, was calculated using the following formula (Loughlin, 1965) [9].

$$r_c = \frac{\ln R_0}{T_c}$$

The intrinsic rate of increase (r_m) was calculated from the arbitrary value of r_m by selecting three trial values on either side, with differences in the second decimal place. These values were then interpolated using the formula provided by Birch (1948) and Watson (1964) [3, 15].

Σ e 7-rmx lxmx= 1096.6

A table was created with the columns 'X' and 'lxmx' for each trial value of r_m. The three trial values of $\Sigma\, e^{7}\text{-}r_m lxmx$ were plotted on the horizontal axis, with their corresponding arbitrary r_m values on the vertical axis. These points were then connected by a line, which intersected a vertical line drawn from the desired value of $\Sigma\, e^{7}\text{-}r_m lxmx = 1096.6$. The point of intersection provided the accurate value of the true r_m, rounded to three or four decimal places.

The precise generation time (T): was calculated from the equation:

$$T = \frac{\ln R_0}{r_m}$$

The finite rate of natural increase (λ): The finite rate of natural increase (λ) i.e., females per female per day were calculated as:

λ= anti loge rm

Stable age-distribution
The stable age distribution (the percentage distribution of different age groups) refers to the distribution that a population would achieve if it follows a stable age schedule of birth and death rates (*mx* and *lx*) in a confined environment. The stable age distribution was determined using the value of r_m and the age-specific mortality rates of both immature and mature stages. The *lx* (life-table age distribution) was calculated from the *lx* table using the following formula:

$$L_x = \frac{I_x + I_{x+1}}{2}$$

The *lx* value was multiplied by $e^{-}{}_{rm}(x+1)$, and the percentage distribution for each pivotal age (*x*) was determined. By summing up the percentages for each pivotal age across the respective stages—egg, larva, pupa, and adult—the expected percentage distribution for each stage in the stable age distribution was calculated.

Table 1: Survival of life-stages of *C. chinensis* during development on CD 6-52 and CD 6-53 Survival of life- stages of *C. chinensis* during development on CD 6-52

Number of eggs observed	Number of survived life-stages			
	Eggs (0-6 days duration)	Larvae-pupal (7-31 days duration)	Adults	
			Male	Female
20	16	11	5	6
20	18	12	5	7
20	17	13	6	7
20	17	11	5	6
20	16	12	6	6
100	84	59	27	32

Table 2: Survival of life-stages of *C. chinensis* during development on CD 6-53

Number of eggs observed	Number of survived life-stages			
	Eggs (0-5 days duration)	Larvae-pupal (6-31 days duration)	Adults	
			Male	Female
20	15	09	4	5
20	17	09	4	5
20	13	11	5	6
20	15	10	5	5
20	14	10	4	6
100	74	49	22	27

Table 3: Population growth statistics of *C. chinensis* on CD 6-52 and CD 6-53

Parameters	Varieties	
	CD 6-52	CD 6-53
Mean length of generation (days)	40.16	40.32
Innate capacity for increase in numbers (female/female/day)	0.081	0.070
Corrected rm ∑7-ermx lxmx = 1096.60 (female/female/day)	0.082	0.070
Corrected generation time (days)	39.91	40.28
Finite rate of increase in numbers (λ) (female/female/day)	1.20	1.17

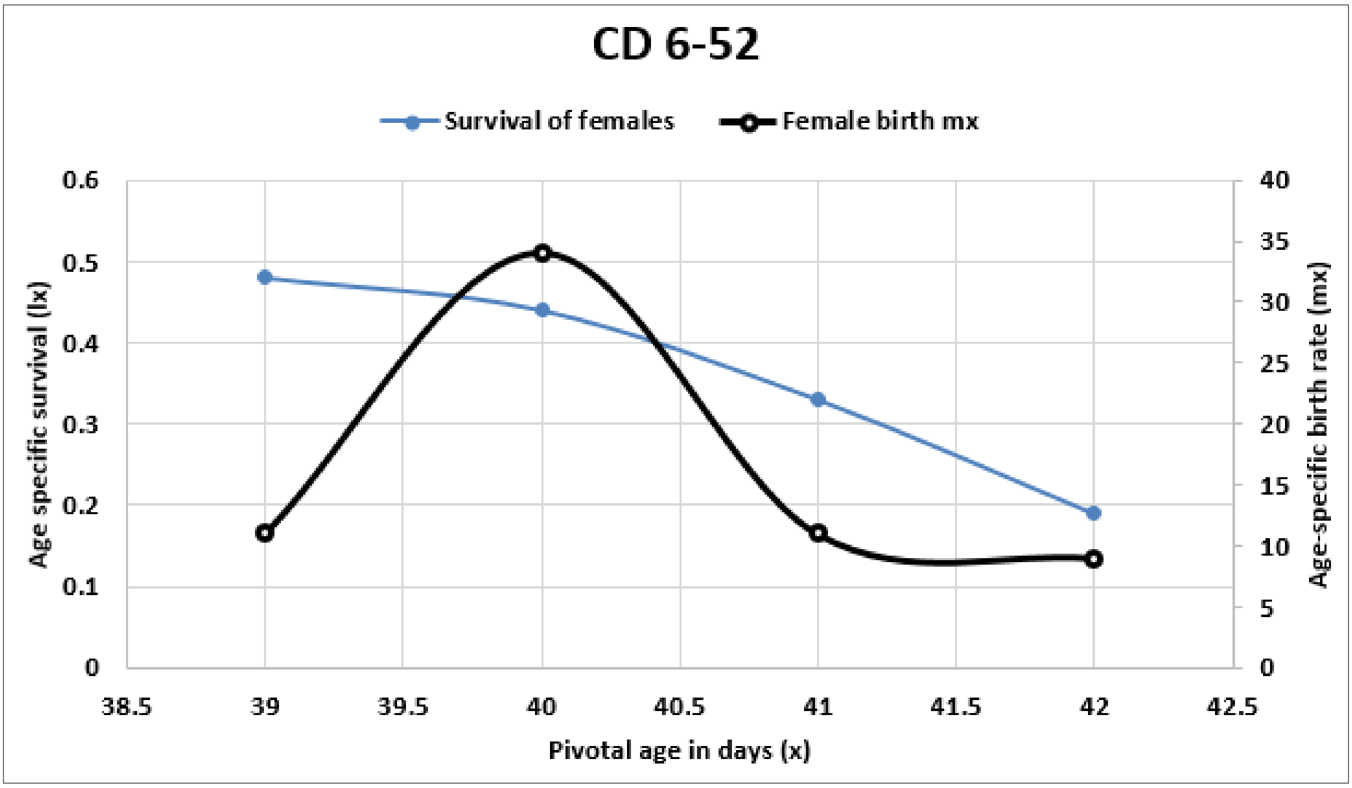

Fig 1: Daily age-specific survival (lx) and birth rate (mx) of *C. chinensis* on CD 6-52

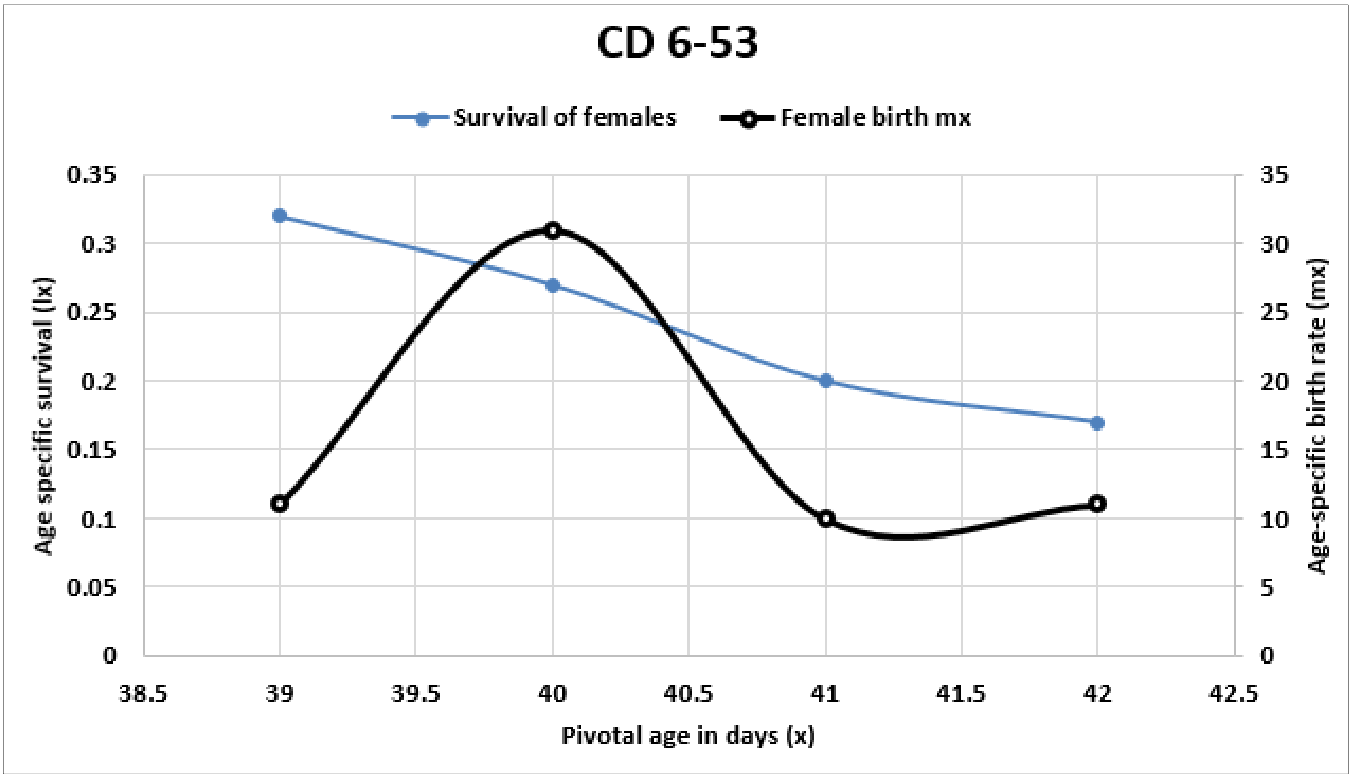

Fig 2: Daily age-specific survival (lx) and birth rate (mx) of *C. chinensis* on CD 6-53

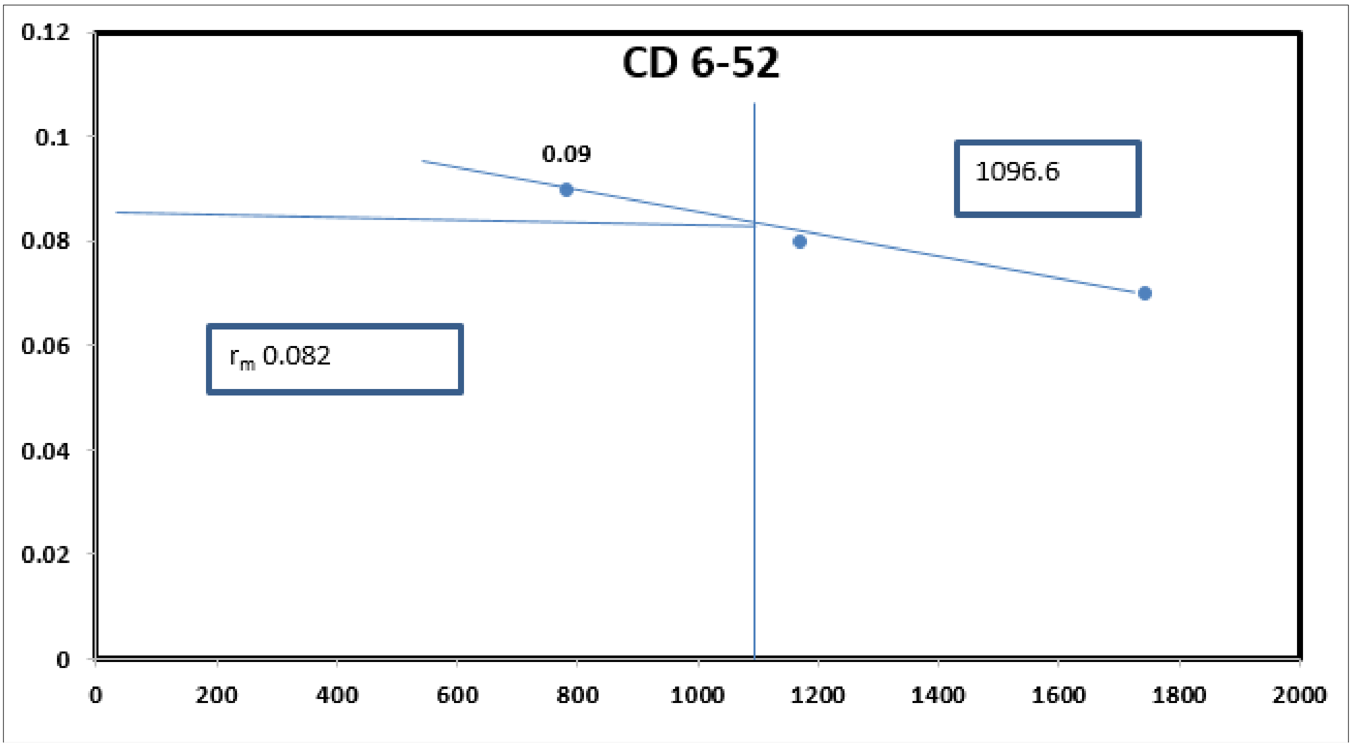

Fig 3: Determination of intrinsic rate of increase (rm) of *C. chinensis* on CD 6-52

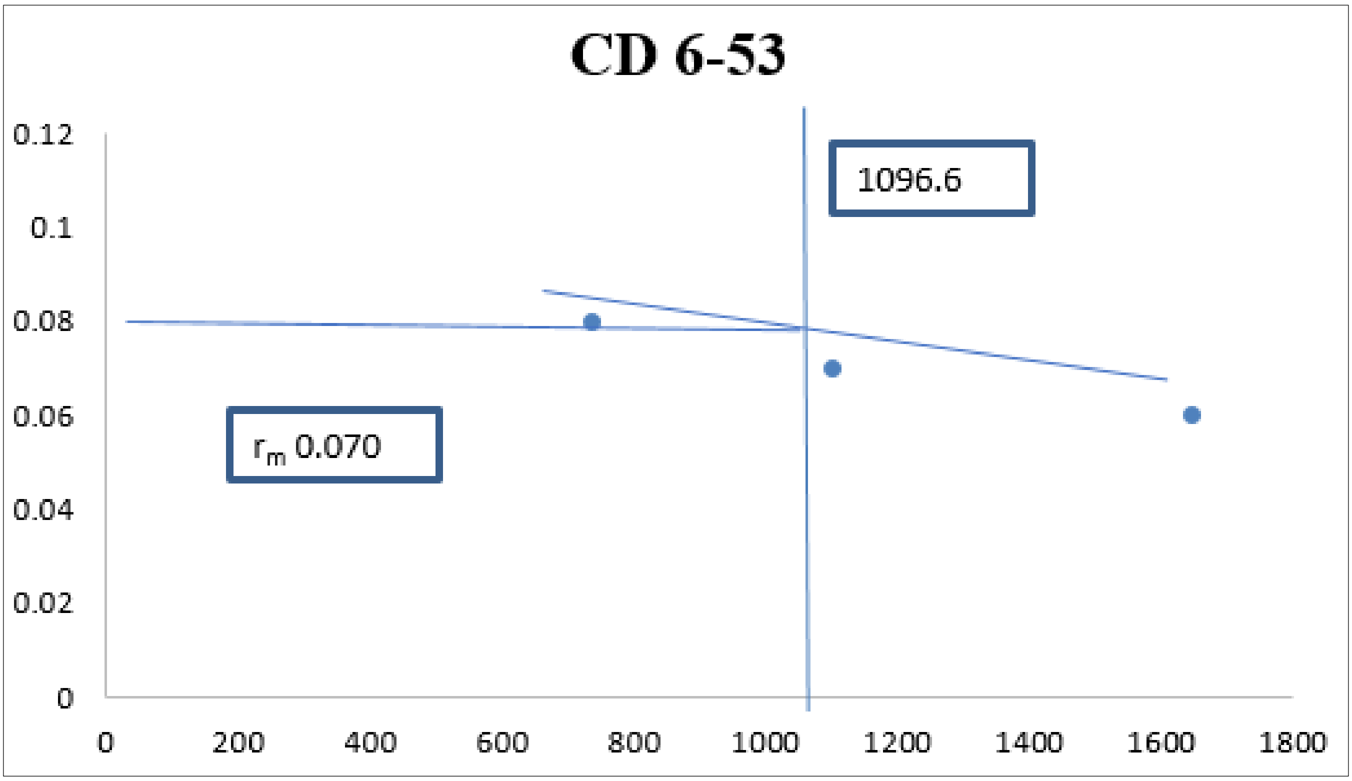

Fig 4: Determination of intrinsic rate of increase (rm) of *C. chinensis* on CD 6-53

Results

In the CD 6-52 variety (Fig. 1), the survival of immature stages (*lx*) of *C. chinensis* was 0.59 per individual within a pivotal age of 31 days. When reared on CD 6-52, *C. chinensis* survived 84% and 59% in the egg and larval-pupal stages, respectively (Table 1). A successful emergence of 27% male and 32% female adults was recorded, with a sex ratio of 1:1.18. The highest female birth rate (*mx* = 34.00) was observed on the second day of oviposition at the 40th day of pivotal age, after which the number of female births declined. The first female mortality occurred on the 39th day (*lx* = 0.48), with mortality gradually increasing thereafter. The females oviposited for six days. The net reproductive rate (R_0) was 26.40 females per female per generation, meaning the *C. chinensis* population could multiply 26.40 times per generation on CD 6-52.

In contrast, on CD 6-53, *C. chinensis* survived 74% and 49% in the egg and larval-pupal stages, respectively, in a cohort of 100 eggs. Successful emergence rates were 22% for males and 27% for females, with a sex ratio of 1:1.22. The highest female birth rate (*mx* = 31.00) was observed on the second day of oviposition at the 40th day of pivotal age, after which female births decreased. The first female mortality occurred on the 39th day (*lx* = 0.32), and mortality steadily increased thereafter. The females oviposited for six days. The net reproductive rate (R_0) was 16.83 females per female per generation, indicating the population could multiply 16.83 times per generation on CD 6-53.

For the CD 6-52 variety, three trial values of 1744.25, 1168.04, and 782.24 were plotted on the horizontal axis against their respective arbitrary r_m (rc) values, differing by the second decimal place (0.07, 0.08, and 0.09) on the vertical axis. The corrected r_m was calculated using the interpolation method, resulting in a value of 0.082 females per female per day (Fig. 3). For CD 6-53, three trial values of 1645.43, 1100.23, and 735.77 were plotted similarly, with arbitrary r_m values of 0.06, 0.07, and 0.08, and the corrected r_m was calculated as 0.070 females per female per day (Fig. 4).

In CD 6-52 (Table 2), the mean length of generation (T_a) was 40.16 days, with an arbitrary intrinsic rate of increase (r_a) of 0.081 females per female per day. The precise generation time (T) was 39.91 days, while the finite rate of increase in numbers (λ) was 1.20 females per female per day. The corrected intrinsic rate of increase (r_m) was 0.082 females per female per day. In CD 6-53, the mean length of generation (T_a) was 40.32 days, with an arbitrary r_a of 0.070 females per female per day. The precise generation time (T) was 40.28 days, and the finite rate of increase (λ) was 1.17 females per female per day. The corrected r_m was 0.070 females per female per day.

The present findings are in agreement with those of Sharma and Sanjta (2023) [12], who reported a net reproductive rate (R_0) of 9.01 females per female on chickpea. Similarly, Naseri *et al.* (2022) [10] observed comparable trends in the life table parameters of *C. maculatus* on the Sari cultivar of soybean, with an R_0 of 14.60. Khedkar *et al.* (2023) [7] reported survival values of immature stages at 0.71 and 0.55 per individual, respectively, within a pivotal age of 31 and 32 days. The net reproductive rate (R_0) was 20.86 and 15.00 females per generation, respectively, with mean generation times of 33.75 and 34.71 days, and r_m values of 0.090 and 0.078 females per female per day. Kazemi *et al.* (2009) found the finite rate of increase (λ) for green gram, cowpea, chickpea, and lentil to be approximately 1.08±0.005, 1.10±0.002, 1.08±0.004, and 1.07±0.007, respectively. Chakraborty and Mondal (2015) [4] reported an r_m value of 0.055 for green gram.

Conclusion

Life tables, which provide data on a species' intrinsic capacity to increase in population, offer valuable insights into the life cycle and traits of various species. The potential for a pest to multiply is determined by its natural ability to grow in number, reflected by the intrinsic rate of increase (r_m) and the net reproductive rate (R_0). Based on the current findings, CD 6-52, with its higher r_m value, appears to be the more suitable host for pest proliferation. In contrast, CD 6-53, having a lower r_m value than CD 6-52, would be a less favorable host for pest growth.

References

1. Ali SM, Mahgoub SM, Hamed MS, Gharib MSA. Infestation potential of *Callosobruchus chinensis* and *C. maculatus* on certain broad bean seed varieties. Egypt J Agric Res. 2004;82(3):1127-1135.
2. Atwal AS, Bains SS. Applied animal ecology. Ludhiana: Kalyan Publishers; 1974. p. 128-135.
3. Birch LC. The intrinsic rate of natural increase of an insect population. J Anim Ecol. 1948;17:15-26.
4. Chakraborty S, Mondal P. Age specific and female fecundity life table of *Callosobruchus chinensis* Linn. on green gram. Int J Pure Appl Biosci. 2015;3(4):284-291.
5. Gbaye OA, Millard JC, Holloway GJ. Legume type and temperature effects on the toxicity of insecticide to the genus *Callosobruchus* (Coleoptera: Bruchidae). J Stored Prod Res. 2011;47(1):8-12.
6. Howe RW. The rapid determination of intrinsic rate of increase of an insect population. Ann Appl Biol. 1953;40:134-155.
7. Khedkar P, Sable A, Bhamare V, Khatake D, Thorat S. Biology of pulse beetle (*Callosobruchus chinensis* L.) on different varieties of chickpea (*Cicer arietinum* L.). Pharma Innov J. 2023;12(12):1065-1067.
8. Lotka AJ. Elements of physical biology. Baltimore: Williams and Wilkins; 1925. p. 355.
9. Loughlin R. Capacity for increase: a useful population statistic. J Anim Ecol. 1965;34:77-91.
10. Naseri B, Hamzavi F, Ebadollahi A, Sheikh F. Physicochemical traits of *Vicia faba* L. seed cultivars affect oviposition preference and demographic parameters of *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae). J Stored Prod Res. 2022;95:101924.
11. Paikaray SS, Sahoo BK, Satapathy SN, Dibyajyoti S. Fecundity and preferential oviposition of pulse beetle, *Callosobruchus chinensis* (L.) on different interspecific progenies of mung bean. Int J Curr Microbiol Appl Sci. 2021;10(3):90-99.
12. Sharma U, Sanjta S. Age specific and fertility life table of *Callosobruchus maculatus* (F.) on chickpea. Indian J Entomol. 2023:1-4.
13. Somta P, Ammaranan C, Ooi PAC, Srinives P. Inheritance of seed resistance to bruchids in cultivated mung bean (*Vigna radiata* L. Wilczek). Euphytica. 2007;155:47-55.
14. Southwood TRE. Ecological methods. London: Methuen & Co. Ltd.; 1968. p. 1-516.
15. Watson TF. Influence of host plant condition on population increase of *Tetranychus telarius* (Linnaeus) (Acarina: Tetranychidae). Hilgardia. 1964;35:273-322.
16. Yadav DS, Parmar KS, Singh VK. Management of pulse crops of sequence cropping. In: Proceedings of the Intercropping Symposium on Pulse Research; 1994 Apr 2-6; New Delhi, India. Indian Abst; 1994. p. 27.