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Life-fecundity tables of Pulse beetle (*Callosobruchus chinensis* L.) on two chickpea varieties

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Abstract
The experiments were conducted with an objective to study the fecundity and survival of pulse beetle *Callosobruchus chinensis* Linnaeus on two chickpea varieties *viz.* BDN-797 and BDN-9-3 at the Post Graduate Laboratory, Department of Agril. Entomology, College of Agriculture, Latur during 2022-2023. *C. chinensis* when reared on chickpea variety BDN-797 and BDN-9-3, the survival values of immature stages as 0.71 and 0.55 per individual, respectively within a pivotal age of 31 and 32 days, the net reproductive rate (R_0) of 20.86 and 15.00, females per generation, respectively, the mean length generation time (T) to the extent of 33.75 and 34.71 days, respectively, innate capacity for increase in numbers (r_m) was 0.090 and 0.078 females per female per day, respectively and finite rate of increase in number (λ) was 1.09 and 1.08 females per female, respectively. On BDN-797, stable-age distribution, of *C. chinensis* in egg, larval-pupal and adult stages was recorded as 60.71, 38.21 and 1.06 percent, respectively, whereas, on BDN-9-3 it was 64.11, 34.97, 0.87 percent, respectively.

Keywords: Chickpea, Varieties, Pulse beetle, *C. chinensis*, life-fecundity tables

Introduction
Globally, pulses are the second most important crop group after cereals serving as a food source for human and animal. Chickpea, (*Cicer arietinum* L.) is a pulse crop belonging to the family Fabaceae and commonly known as gram or Bengal gram. It is significantly important leguminous crops, extensively cultivated as a cool season annual crop under various agro-ecological conditions mainly of rainfed. Being a leguminous crop, it also helps in nitrogen fixation and thereby plays an important role in enhancing the fertility of soil. It fixes atmospheric nitrogen up to the 140 kg/ha/year (Flowers *et al*., 2010) [9]. In addition to proteins, it is a good source of carbohydrates, minerals and trace elements (Huisman and Van der Poel, 1994) [13]. Chickpea seeds are rich in minerals (calcium, potassium, phosphorus, magnesium, iron and zinc), fibre, unsaturated fatty acids and β-carotene (Jukanti *et al*., 2012) [14].

Generally, in storage condition chickpea seed are damaged by many store grain pests. But out of that bruchids, causes significant damage among the rests. It causes damage to the extent of about 50 percent during storage within short duration of three to four months (Caswell, 1981) [4]. Among the bruchids, *Callosobruchus* spp. (Chrysomelidae: Coleoptera) is an important primary pest and major constraint (Mounika *et al*., 2021) [17]. There are three major species of *Callosobruchus* causing Economical losses *viz. C. maculatus, C. chinensis and C. analis*. Of all these, *C. chinensis* (L.) alone causes nearly 55.7 percent of damage in severe infestation (Chaubey, 2008) [6]. Grubs penetrate the pod, covertly residing within the maturing seeds as a hidden infestation (Southgate, 1979) [0]. Larva feeding activities can result in nearly hollowed infested seeds, leaving behind characteristics emergence holes or 'windows' once the adults exit the seeds (Giga and Smith, 1983) [10]. It can infest cultivated host plant as well as few wild legumes both in the field and store (Fahd, 2011) [7]. It is observed that up to 60 percent of weight loss and 45.50 to 66.30 percent loss in protein content of stored pulse seeds occur due to pulse beetle infestation (Golnaz *et al*, 2011; Faruk *et al*, 2011) [11, 8].

Keeping these facts in view, the present experimental work was carried out on life-fecundity tables of *C. chinensis* on different chickpea varieties to investigate the effect of two varieties on growth, development, survival, fecundity and capacity of its population to increase in numbers.

Materials and Methods

The laboratory experiments were conducted to study the fecundity tables of *Callosobruchus chinensis* Linnaeus on two chickpea varieties under laboratory conditions at the Post Graduate Laboratory, Department of Agril. Entomology, College of Agriculture, Latur during the year 2022-2023. *C. chinensis* was reared separately on the varieties BDN-797 and BDN-9-3.

The freshly emerged adults were paired and released in plastic vials (6.5 cm x 2.5 cm) at 1:1 sex ratio containing fifty grains of each chickpea variety. The grains with eggs were replaced daily by healthy grains and the number of total eggs laid by an individual female was recorded till all the females died. The life-fecundity tables of *C. chinensis* were constructed by studying total of 100 eggs in a batches with 20 eggs in each replicate. Soon after hatching, larvae started boring into the seed. The observations on the parameters *viz.* hatching of eggs, development of larvae-pupae, successful adult emergence, fecundity of female and age-specific mortality in life stages *viz.* eggs, larvae-pupae and adults etc. were recorded on daily basis. The total number of adults emerged on each day were transferred to a separate cage in the ratio of 1:1 for the determination of the age-specific fecundity. For further egg laying by the adults, healthy and sterilized grains were kept into plastic vials (6.5 cm x 2.5 cm)

The number of female births (m_x) were calculated by dividing the number of eggs laid per female by two considering the sex ratio of 1:1 (Southwood, 1968) [21]. The life-fecundity tables under laboratory conditions were constructed by using the following column headings proposed by Birch (1948) [3], elaborated by Howe (1953) [12] and Atwal and Bains (1974) [1]. Where, x = pivotal age in days, lx =survival of females at age ‘x’, and m_x = age schedule for female births at age ‘x’.

Net reproductive rate (R_0)- The net reproductive rate (R_o) is the rate of multiplication of the population in each generation measured in terms of females produced per generation. The value of ‘x’, ‘l_x’ and ‘m_x’ was calculated from the data on lifetables. The sum of products ‘$l_x m_x$’ is the net reproductive rate represented by R_o (Lotka, 1925) [15]. The number of times a population would multiply per generation was calculated by the following formula.

$$R_o = \Sigma l_x m_x$$

Mean generation time (T_c): The precise value of cohort generation time (T_c) is the mean age of mothers in a cohort at the birth of female offspring. It was calculated as follows.

$$T_c = \frac{\Sigma\, l_x\, m_x\, x}{R_o}$$

Innate capacity for increase in numbers (rc): The number of individuals survived and mean number of female offspring produced at each age interval were recorded. From the data on lifetable, the arbitrary value of innate capacity for increase in number ‘rc’ was calculated by using following formula (Loughlin, 1965) [16].

$$r_c = \frac{\text{Log}_e\, R_o}{Tc}$$

The intrinsic rate of increase (r_m)

Was then calculated from the value of arbitrary ‘r_m’ by taking three trial values arbitrarily selected on either side of it differing in second decimal place by interpolation with formula given by Birch (1948) [3] and Watson (1964) [22].

$$\Sigma\, e^{7-rmx}\, l_x m_x = 1096.6$$

Table was then constructed with column ‘X’ and ‘lxm_x’ for each trial ‘r_m’. The three trial values of $\Sigma\, e^{7-rmx} l_x\, m_x$ were then plotted on the horizontal axis against their respective arbitrary ‘r_m’ on the vertical axis. The points were joined to give a line which intersected a vertical line drawn from the desired values of $\Sigma\, e^{7-rmx}\, l_x\, m_x = 1096.6$. The point of intersection gave the value of true ‘r_m’ accurate to three or four decimal places.

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

$$T = \frac{\text{Log}_e\, R_o}{r_m}$$

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

$$\lambda = \text{anti}\ \log_e r_m$$

Stable age-distribution

The stable age-distribution (percent distribution of various age groups) is the distribution, which would be reached by a population of stable age-schedule of birth rate and death rate (m_x and l_x) when grown in a limited space. The stable age-distribution was worked out with the knowledge of ‘r_m’ and the age-specific mortality of the immature as well as matures stages. The l_x (life-table age-distribution) was calculated from the 'l_x' table with the formula as follows:

$$lx = \frac{l_x + (l_x+1)}{2}$$

The l_x was multiplied with $e^{-rm\ (x+1)}$ and the percentage distribution of each pivotal age (x) was worked out. By putting together, the percentage under each pivotal age for respective stages *viz.*, egg, larva, pupa and adult, the expected percentage distribution of each stage in a stable age-distribution was calculated.

Results

when reared on BDN-9-3, *C. chinensis* survived (Table 1) to the extent of 71 and 50 percent in egg and larval-pupal stages, respectively. There was successful emergence of 23 percent male and 27 percent female adults and the sex ratio was 1:1.17. Whereas on BDN-797, *C. chinensis* survived to the extent of 82 and 68 percent in egg and larval-pupal stages, respectively in a cohort of 100 eggs. There was successful emergence of 29 and 39 percent male and female adults respectively with the sex ratio of 1:1.34.

Table 1: Survival of life-stages of *C. chinensis* during development on BDN-9-3 and BDN-797 Survival of life- stages of *C. chinensis* during development on BDN-9-3

Number of eggs observed	Number of survived life-stages			
	Eggs (0-6 days duration)	Larvae-pupal (7-32 days duration)	Adults	
			Male	Female
20	15	10	5	5
20	16	10	4	6
20	12	9	4	5
20	14	11	5	6
20	14	10	5	5
100	71	50	23	27

Table 2: Survival of life-stages of *C. chinensis* during development on BDN-797

Number of eggs observed	Number of survived life-stages			
	Eggs (0-6 days duration)	Larvae-pupal (7-31 days duration)	Adults	
			Male	Female
20	17	14	6	8
20	16	13	6	7
20	17	14	6	8
20	16	14	5	9
20	16	13	6	7
100	82	68	29	39

In BDN-9-3 (Fig.1) the survival of immature stages (l_x) of *C. chinensis* was 0.75 (based on one individual) per individual within a pivotal age of 32 days. The numbers of eggs laid per female per day were divided by two to get the number of female births (m_x). The female contributed the highest eggs (m_x=7.1) on the second day of oviposition at 35th day of pivotal age. Thereafter female births decreased. The female mortality was observed on 42th day of pivotal age. The net reproductive rate (R_o) representing the total female births per female per generation was 15.00. Thus, the population of *C. chinensis* would be able to multiply at the rate of 15.00 females per female per generation on BDN-9-3. In BDN-797 (Fig.2) survival of immature stages (l_x) of *C. chinensis* was 0.68 (based on one individual) per individual within a pivotal age of 33 days on BDN-797 variety. The numbers of eggs laid per female per day were divided by two to get the number of female births (m_x). The female contributed the highest eggs (m_x=8.4) on the second day of oviposition at 34th day of pivotal age. Thereafter female births decreased. The female mortality was observed on 38st day of pivotal age the net reproductive rate (R_o) representing the total female births per female per generation were 20.86. Thus, the population of *C. chinensis* would be able to multiply at the rate of 20.86 females per female per generation on BDN-797.The results of present investigations are more or less similar with Sharma and Sanjta (2023) [19] reported that the net reproductive rate (Ro) of 9.01 females/ female on chickpea. Naseri *et al*., (2022) [18] observed the similar trend of different parameters of life table studies of *C. maculatus* on the Sari cultivar of soybean with Ro of 14.60.

Table 3: Population growth statistics of *C. chinensis* on BDN-9-3 and BDN-797

Parameters	Varieties	
	BDN-9-3	BDN-797
Mean length of generation (days)	36.00	34.63
Innate capacity for increase in numbers (female/female/day)	0.075	0.087
Corrected r_m $\sum^{7\text{-ermx}} l_x m_x$ = 1096.60 (female/female/day)	0.078	0.090
Corrected generation time (days)	34.71	33.75
Finite rate of increase in numbers (λ) (female/female/day)	1.08	1.09

In BDN-9-3, three trial values of 1905.35, 1331.44 and 930.6 were plotted on horizontal axis against their respective arbitrary r_m (r_c) differing in the second decimal place on either side of it i.e., 0.06, 0.07 and 0.08 on vertical axis and corrected r_m was calculated by interpolation method. Thus, corrected r_m was calculated as 0.078 females per female per day (Fig. 3). In BDN-797 three trial values of 2033.15, 1493.92 and 1019.95 plotted on horizontal axis against their respective arbitrary r_m (r_c) differing in the second decimal place on either side of it i.e., 0.07, 0.08 and 0.09 on vertical axis and corrected r_m was calculated by interpolation method. Thus, corrected r_m was calculated as 0.090 females per female per day (Fig. 4).

In BDN-9-3 (Table 2) mean length of generation (T_c) was found to be 36.0 days (Table 2). The arbitrary value for intrinsic rate of increase (r_c) was 0.075 female per female per day. The precise generation time (T) was 34.71 days, while the finite rate of increase in numbers (λ) was 1.08 females per female per day. The corrected innate capacity for increase in numbers (r_m) was 0.078 female per female per day. In BDN-797 the mean length of generation (T_c) was found to be 34.63 days. The arbitrary value for intrinsic rate of increase (r_c) was 0.087 female per female per day. The precise generation time (T) was 33.75 days, while the finite rate of increase in numbers (λ) was 1.09 females per female per day. The corrected innate capacity for increase in numbers (r_m) was 0.090 female per female per day. The present investigations are in the line with the findings of Sharma and Sanjta (2023) [19] reported that true of generation (T) time was 63.07 days in chickpea. The actual rate of natural increase (rm) was 0.0348 females per female per day respectively. The finite rate of increase was 1.03 females/ female per day. These results are in accordance with Bidar *et al*. (2021) [2] who evidenced that finite rate of increase to the tune of 1.155 females/ female/ day on chick pea. Chakraborty and Mondal (2015) [5] who reported rm value of 0.055 on the green gram.

The reducing stable age- distribution, population of *C. chinensis* on BDN-9-3 in egg, larval-pupal and adult stages distributed to the extent of 64.14, 34.97 and 0.87 percent, respectively and in BDN-797 was 60.7, 38.08, and 1.01 percent, respectively.

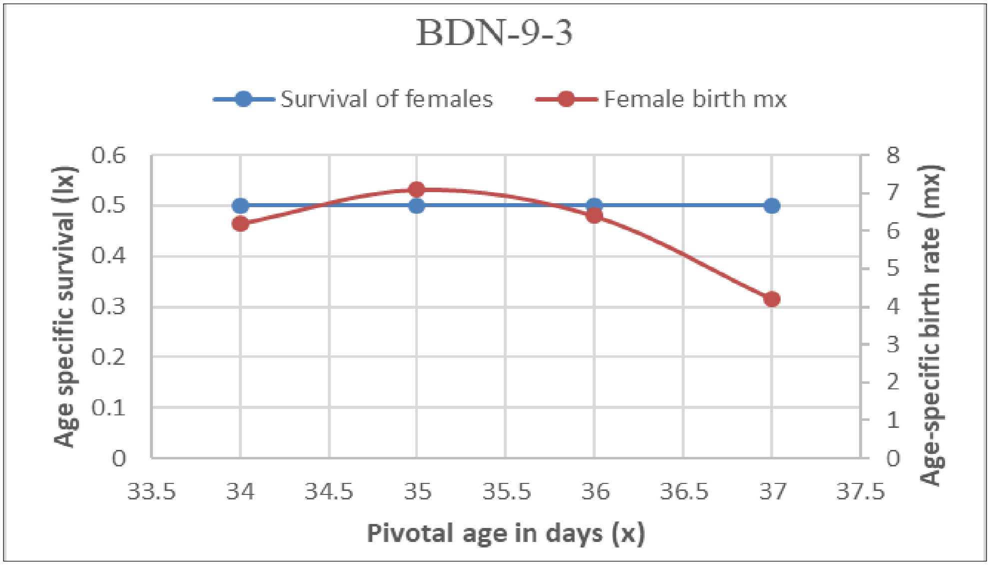

Fig 1: Daily age-specific survival (l_x) and birth rate (m_x) of *C. chinensis* on BDN-9-3

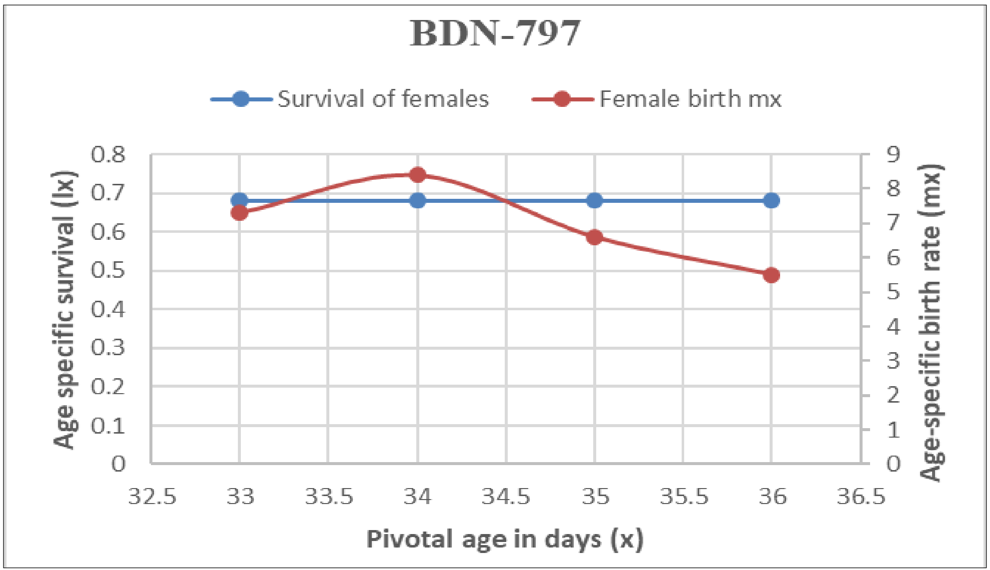

Fig 2: Daily age-specific survival (l_x) and birth rate (m_x) of *C. chinensis* on BDN-797

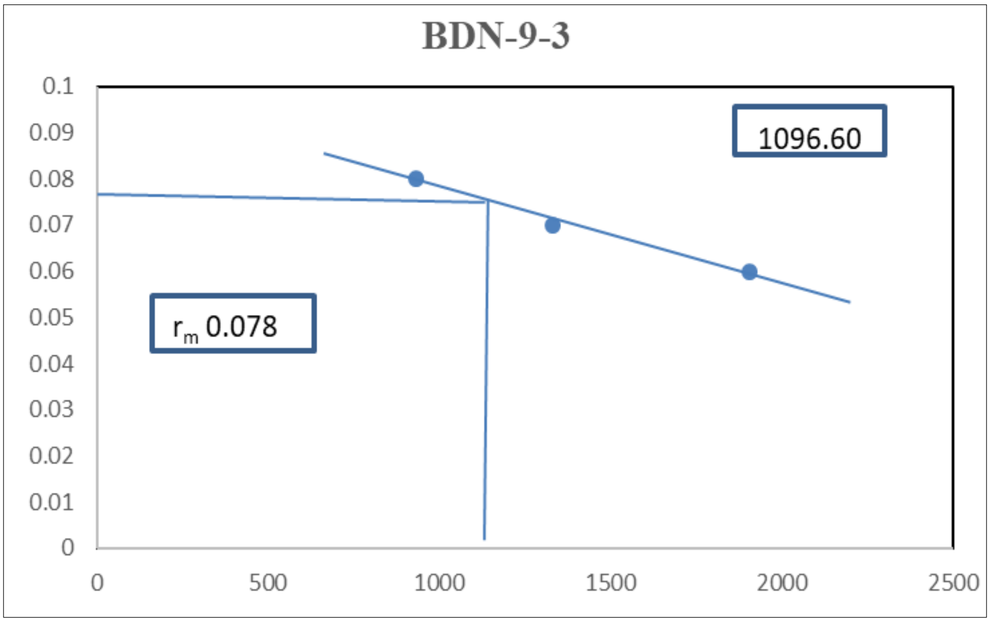

Fig 3: Determination of intrinsic rate of increase (r_m) of *C. chinensis* on BDN-9-3

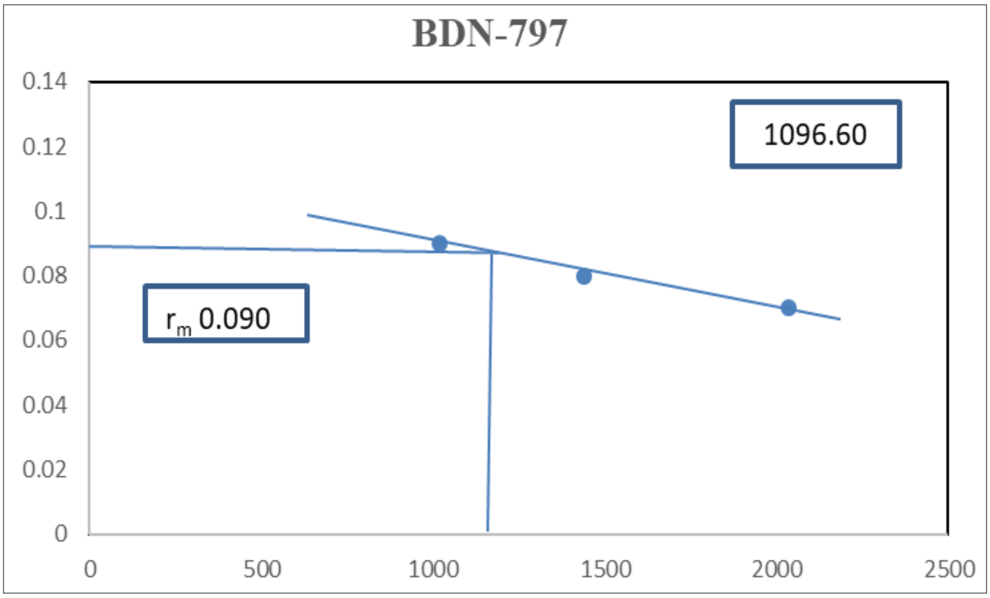

Fig 4: Determination of intrinsic rate of increase (r_m) of *C. chinensis* on BDN-797

Conclusion

Life tables that give data on a specie's innate capacity to increase in population can be used to gain insight into the traits and life cycles of various species. The ability of a pest to multiply based on its natural tendency to increase in population size (r_m) and net reproductive rate (R_O). According to current research, BDN-797 with a high rm value would be the ideal host for pest multiplication. Comparatively, BDN-9-3 with a lower rm value than BDN-797 would be the lesser deal host.

References

1. Atwal AS, Bains SS. Applied animal ecology. Ludhiana: Kalyani Publishers; c1974. pp. 128-135.
2. Bidar F, Razmjou J, Golizadeh A, Fathi SA, Ebadollahi A, Naseri B. Effect of different legume seeds on life table parameters of cowpea weevil, *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae). Journal of Stored Products Research. 2021;1(9):101755.
3. Birch LC. The intrinsic rate of natural increase of an insect population. Journal of Animal Ecology. 1948;17:15-26.
4. Casewll GH. Damage to stored cowpeas in the northern state of Nigeria. Samaru J Agri. Res. 1981;1:11-19.
5. Chakraborty S, Mondal P. Age-specific and female fecundity life table of *Callosobruchus chinensis* Linn. on green gram. International Journal of Pure & Applied Bioscience. 2015;3(4):284-291.
6. Chaubey MK. Fumigant toxicity of essential oils from some common species against pulse beetle, *Callosobruchus chinensis* (Coleoptera: Bruchidae). J. Oleo Science. 2008;57:171-179.
7. Fahd A. Crymazine concentration and host type effect on the biology of the southern cowpea weevil, *Callosobruchus maculatus*. African Journal of Microbiology Research. 2011;5(20):3321-3326.
8. Faruk K, Varol I, Bayram M, Ozdemir A. The effect of carbon dioxide at high pressure under different developmental stages of C. maculatus (F.) hosting on chickpea. Afr. J. Biotech. 2011;10(11):2053-2057.
9. Flowers TJ, Gaur PM, Laxmipathigowda CL. Salt sensitivity in chickpea. Plant Cell Environ. 2010;33:490-509.
10. Giga DP, Smith RH. Varietal resistance and intraspecific competition in the cowpea weevils *Callosobruchus maculatus* and C. chinensis (Coleoptera: Bruchidae). J App. Ecol. 1981;18:755-776.
11. Golnaz S, Hasan M, Iman S. Insecticidal effect of diatomaceous earth against *Callosobruchus maculatus* (F.) under laboratory conditions. Afr. J. Agricult. Res. 2011;6(24):5464-5468.
12. Howe RW. The rapid determination of the intrinsic rate of increase of an insect population. Annals of Applied Biology. 1953;40:134-155.
13. Huisman J, Van der Poel AFB. Aspects of the nutritional quality and use of cool-season food legumes in animal feed. In: Muehlbauer FJ, Kaiser WJ, editors. Expanding the production and use of cool-season food legumes. Dordrecht: Kluwer Academic Publishers; c1994. p. 53-76.
14. Jukani AK, Gaur PM, Gowda CLL, Chibbar RN. Nutritional quality and health benefits of chickpea (*Cicer arientinum* L.): A review. Breeding Journal of Nutrition. 2012;108(Suppl. 1):S11-S26.
15. Lotka AJ. Elements of physical biology. Williams and Wilkins, Baltimore; c1925. p 355.
16. Loughlin R. Capacity for increase: a useful population statistic. Journal Animal Ecology. 1965;34:77-91.
17. Mounika T, Sahoo SK, Chakraborty D. Evaluation of some botanicals against *Callosobruchus chinensis* L. infesting stored chickpea seeds and biochemical analysis of used botanicals. Int. J Bio-resour. Stress manag. 2021;12(6):679-686.
18. 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). Journal of Stored Products Research. 2022;95:101924.
19. Sharma U, Sanjta S. Age-specific and fertility life table of *Callosobruchus maculatus* (F.) on chickpea. Indian Journal of Entomology; c2023. p. 1-04.

20. Southgate BJ. Biology of the Bruchidae. Annual Rev. Entomol. 1979;24:449-473.
21. Southwood TRE. Ecological methods. Methuen and Co. Ltd., London; c1968. pp. 1-516.
22. Watson TF. Influence of host plant condition on population increase of *Tetranychus telarius* (Linnaeus) (Acarina: Tetranychidae). Bilgardia. 1964;35:273-322.