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AGE SPECIFIC AND FERTILITY LIFETABLE OF *CALLOSOBRUCHUS MACULATUS* (F.) ON CHICKPEA

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ABSTRACT

Pulse beetle (*Callosobruchus maculatus*) (F.) is a pernicious pest of different stored grain pulses and decrease the nutritional and economic values of the pulses, which can cause huge losses in terms of quality and quantity. The present study was conducted for determining the rate of multiplication of *C. maculatus* was conducted at ambient temperature and relative humidity under Palampur conditions on preferred host chickpea, *Cicer arietinum*. Under conditions of abundant space and food supply, population of *C. maculatus* increased with 0.03485 (r_m) and 1.035 (λ) per day. The population multiplied 1.276 times in one week and mean time for doubling the population was 19.88 days. True generation time was 63.07 days. Life expectancy of adult was 12.37 days. The results of the study pave ways to create awareness among researchers and farmers about the nature and extent of damage caused by the *C. maculates* in chickpea.

Key words: Life table, survivorship, pulse beetle, *Cicer arietinum*, life expectancy, doubling time, gross reproductive rate, net reproductive rate, finite rate of increase, generation time, potential fecundity, doubling time

A variety of insect-pests wreak havoc on stored grains. Among several grain pests, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) is a prominent pest of stored legume grains, with infestations beginning at pod maturity (Umar and Turaki, 2014). It attacks maturing crops in the field and causes qualitative and quantitative loss in storage**.** It feeds on variety of hosts which include pigeonpea, pea, cowpea, chickpea, blackgram, horsegram, and other legumes (Srivastava and Subramanian, 2016). The pulse beetle, is an economically important pest of stored chickpeas, which produces losses up to 10-30% in a short period of two months (Philips and Throne, 2010). However, in some case the infestation level may reach upto 100 per cent (Govindan et al., 2020). Infestation begins either on mature pods when they are approaching harvest or when in storage. Adult beetle soon after emergence lays eggs on the surface of the seed kept in storage or on pods in the fields. The larva burrows directly into the seeds and larvae's feeding activity can almost entirely hollow out the seeds, leaving a distinctive emergence hole as the adult emerges (Giga and Smith, 1983). Adults do not consume food and larva within the seeds eats the endosperm, causing the seed to be completely destroyed. In storage, beetle populations grow so quickly that it turns the entire stored grains into flour. It is estimated that all the activities of insect pests like feeding on grain, their presence in the cereal grains and products, and the expenditure for the strategies used to destroy them have caused a significant economic loss. If we can save these losses, our stockpiles of food grains could grow enormously, thus enabling us to feed millions of hungry people worldwide (Kalpna et al., 2022).In the ecological studies of any insect-pest, a life table constitute to be an essential analytical tool that provides detailed information on population dynamics to generate simple but more informative statistics. It also includes a detailed summary of survival, development, and life expectancy (Ali and Rizvi, 2007). The collection of data on life-table at particular temperatures and humidity gives an important task for pest management in different environmental conditions. Hence, the age and female fecundity life tables of *C. maculatus* were studied on chickpea grains under laboratory conditions.

MATERIALS AND METHODS

The experiment was conducted under laboratory conditions at Entomology Department of CSKHPKV, Palampur (17-22^{o}C, 55-65%RH) during 2018. At the beginning of the experiments, to synchronize the age of eggs, ten pairs of *C. maculatus* were transferred from the stock culture on 100 g of chickpea seeds. After 12 hr, 50 eggs on seeds were collected for further investigation. The collected eggs were transferred into the container which was covered with the white muslin cloth. The collected eggs were checked daily until the emergence of adults. Duration of adult longevity was also recorded daily until the death of the last female. After the emergence of adults, the females with males were placed into each plastic case containing chickpea. The duration of oviposition and post-oviposition periods as well as longevity, daily fecundity (eggs/ reproduction day), and total fecundity (eggs during reproduction period) were recorded for one generation. The life table was built based on the concepts as studied by Birch (1948), Southwood (1978) and Chakraborty and Mondal (2015). For calculating the age-specific survivorship different parameters viz., age-specific survival (lx) and mortality (dx) were built. In case of age-specific female fertility life table age specific survival (lx) and average number of female offsprings (mx) for each age interval (x) were employed. The other demographic parameters including gross reproductive rate (GRR) or potential fecundity, net reproductive rate (R_0), approximate generation time (T_c), innate capacity for natural increase (r_c), true intrinsic rate of increase (r_m), true generation time (T), finite rate of natural increase (λ), doubling time (DT), and weekly multiplication rate (WR), were calculated using survivorship and fertility schedules.

RESULTS AND DISCUSSION

The various growth parameters of the beetle were worked out. The results revealed the net reproductive rate (R_o) of 9.01 females/ female on chickpea. While true of generation (T) time was 63.07 days. The approximate rate of increase (r_c) was recorded slightly lower than the actual rate of natural increase (r_m) and those were 0.0347 females/ female per day and 0.0348 females per female per day respectively. The finite rate of increase was 1.03 females/ female per day (Table 1). These results are in accordance with Bidar et al. (2021) who observed finite rate of increase to the tune of 1.155 females/ female/ day on chick pea. Similar studies were undertaken by Chakraborty and Mondal (2015) who

Table 1. Age-specific female fertility lifetable of *C. maculatus* on chickpea

x	lx	mx	lxmx	xlxmx	e^{7-rx} lxmx		e^{-rx}.lxmx	
					r=0.036	r=0.034	r=0.036	r=0.034
0	1.00							
1-58	0.62	Immature stages						
59	0.62	Preovioposition period						
60	0.62	2.85	1.767	106.02	223.4713	251.9632	0.203779	0.229761
61	0.62	2.67	1.6554	100.9794	201.9545	228.159	0.184159	0.208054
62	0.62	1.82	1.1284	69.9608	132.7942	150.3252	0.121093	0.137079
63	0.62	1.65	1.023	64.449	116.1334	131.728	0.1059	0.12012
64	0.62	0.94	0.5828	37.2992	63.82142	72.53642	0.058198	0.066145
65	0.62	1.38	0.8556	55.614	90.38223	102.9299	0.082418	0.09386
66	0.62	0.68	0.4216	27.8256	42.96139	49.0236	0.039176	0.044704
67	0.58	1.28	0.7424	49.7408	72.97617	83.44042	0.066546	0.076088
68	0.58	0.72	0.4176	28.3968	39.59761	45.36626	0.036108	0.041369
69	0.54	0.33	0.1782	12.2958	16.29977	18.71174	0.014863	0.017063
70	0.43	0.42	0.1806	12.642	15.93518	18.32982	0.014531	0.016715
71	0.36	0.15	0.054	3.834	4.596195	5.297467	0.004191	0.004831
72	0.29	0	0	0	0	0	0	0
73	0.18	0	0	0	0	0	0	0
74	0.11	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0
		Σmx= 14.89	Σlxmx= 9.0066	Σ=xlxmx= 569.0574	Σ= 1020.923	Σ= 1157.811	Σ= 0.930962	Σ= 1.055787

Fertility life table parameters of *C. maculatus* on chickpea based on above observations are calculated as under:

Gross reproductive rate (GRR) or Potential fecundity= 14.89 females/ female; Net reproductive rate (R_0)= 9.01 females/ female; Approximate generation time (T_c)= 63.18 days; Innate capacity for natural increase (r_c)= 0.0347 females/ female/ day; True intrinsic rate of increase (r_m)= 0.03485 females/ female/ day; True generation time (T)= 63.07 days; Finite rate of natural increase (λ)= 1.035 females/female/day; Weekly multiplication rate (WE)= 1.276 females/female; Doubling time (DT)= 19.88 days

X: pivotal age in days; lx: survival fraction of females; mx: female eggs per female reported rm value of 0.055 on the greengram. Further, on the basis of (r_m) values, the descending order on different food grains for *Callosobruchus chinesis* (L.) was gram (0.097), pea (0.0928), black gram (0.0892) and soybean (0.085) and the finite rate of increase was 1.25, 1.24, 1.22 and 1.23 females/ female/ day on gram, pea, soybean and black gram, respectively (Borude et al., 2012). Overlap between the stages was observed in terms of reproductive value, life expectancy and survival rate of pulse beetles because of the variation in the development period among the individuals (Singh and Boopathi 2022), which signifies the importance of observing the different biological parameters. Naseri et al. (2022) observed similar trend of different parameters of life table studies of *C. maculatus* on the Sari cultivar of soybean with R_o, r_m, and λ with 14.60, 0.061 and 1.06 values, respectively.

The difference in the values of various fertility parameters in respect to the present investigations with some of the previous supporting literature corresponds to the difference in hosts as well the difference in the relative ambient conditions viz. temperature and humidity. It is well documented that for survival and reproduction, this bruchid must rely on materials obtained during the larval stage (Bhoge et al., 2023). Further, the growth parameters of this bruchid is greatly influenced by type of host plant, seed parameters (shape, size, weight, seed surface texture), availability of seeds, strain of the beetle, mating behavior, and generation (Cope and Fox 2003; Kazemi et al., 2009; Ahuchaugu, 2021). Also, in our study, the pre-oviposition period of 1 day was observed and adults started laying eggs after that. This corresponds to the earlier studies which marked no significant pre-ovipositional period for this bruchid and also the adults did not need food or water, and could reproduce immediately after one to two days of emergence (Kazemi et al., 2009; Mohammadi et al., 2020). Life expectancy (ex) of *C. maculatus* was recorded, starting from adult emergence. A gradual decrease in 'ex' was found with the advancement of the age of the insect. On the first day of its emergence as an adult, the expected life was 12.37 days (Fig. 1). These results are in accordance with the findings of Jaiswal et al. (2018), who observed the average lifespan of 10.15 days of pulse beetle. Different workers have reported the life span of adult of pulse beetles from 9.89-15.5 days (Varma and Anandhi, 2010; Sharma et al., 2018; Solanki and Mittal, 2018; Muhammadi et al., 2020); which is more or less similar with the present findings.

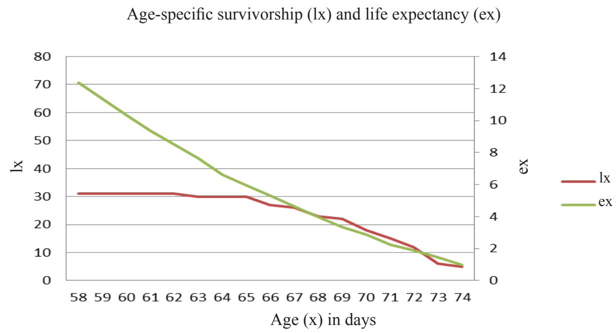

Fig. 1. Age-specific survivorship (lx) and life expectancy (ex) of *C. maculatus* on chickpea

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AUTHOR CONTRIBUTION STATEMENT

US conceived and designed research. US conducted experiments and SS analyzed the data. Both the authors read and approved the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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