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LIFETABLES OF *CHILO PARTELLUS* (SWINHOE) INFESTING RABI SORGHUM

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ABSTRACT

This study on the sorghum spotted stem borer *Chilo partellus* (Swinhoe) was conducted at the Post Graduate Experimental Field of Department of Agricultural Entomology, College of Agriculture, Campus Latur during 2020-21. The results revealed that *C. partellus* passed through three generations on rabi sorghum. The mortality in early instar larval stage was observed due to unknown reasons (17.24, 19.05 and 14.51%, respectively), *Callibracon* sp. (4.16, 11.76 and 8.33%, respectively) and *Cotesia flavipes* (8.69, 6.67 and 9.65%, respectively) in its first, second and third generations. The mortality in late instar larvae was also found owing to unknown reasons (19.4, 14.28, and 11.36%, respectively), *Callibracon* sp. (11.76, 12.49 and 11.43%, respectively) and *C. flavipes* (13.33, 14.28 and 10.26%, respectively) in the first, second and third generations. In first generation, the pupal mortality was not observed, and when noticed it was due to unknown reasons (11.11 and 16.12%, respectively) during second and third generations. The trend index and generation survival were 1.44 and 0.44; 1.48 and 0.38 and; 0 and 0.42 during first, second and third generations, respectively.

Key words: *Chilo partellus*, rabi sorghum, lifetable, mortality, unknown reasons, instars, pupal stage, *Callibracon* sp., *Cotesia flavipes*, parasitoid, trend index, generation survival

Sorghum (*Sorghum bicolour* (L.) Moench) is a warm-season cereal of African origin, and it is ravaged by a number of insect pests viz., shoot fly (*Atherigona soccata* Rondani), stem borers [*Chilo partellus* (Swinhoe) and *Sesamia inferens* Walker], army worms (*Mythimna separata* Walker and *Spodoptera frugiperda* J E Smith), aphids (*Melanaphis sacchari* Zehntner and *Rhopalosiphum maidis* Fitch), midge (*Contarinia sorghicola* Coquillett), earhead caterpillars (*Helicoverpa armigera* Hubner), hairy caterpillars (*Orgyia* sp., *Olene mendosa* Hubner and *Somena scintillans* Walker), shoot bugs (*Peregrinus maidis* Ashmead) and green stink bug (*Nezara viridula* (L.) in Maharashtra. In sorghum fields, >35% crop losses have been reported due to insect pests, estimated to be at $580 million in India (Reddy and Zehr, 2004). In India, *C. partellus* (Swinhoe) (Crambidae: Lepidoptera) is one of the serious insect pests causing 24.3 to 36.3% yield loss (Kaur et al*.,* 2020). The present study explored the fluctuations in the population dynamics through the lifetables for understanding the mortality factors of *C. partellus* on rabi sorghum. This might b helpful to develop the IPM strategies and identify various natural enemies. Study on lifetable is required to understand the influence of abiotic and biotic factors at different life stages (Pathaek and Bhamare, 2019).

MATERIALS AND METHODS

The field experiment comprising forty-eight quadrats each of 2.70 x 3.00 m size was laid out with rabi sorghum at the Research Farm of Department of Agricultural Entomology, College of Agriculture, Latur (MS) during rabi 2020-2021.The popular variety Parbhani Moti was sown at the spacing of 45 x 15 cm in 48 quadrats following recommended package of practices by VNMKV, Parbhani. The field experiment was conducted under pesticide free conditions. The sampling of eggs, early and late instar larvae and pupae of *C. partellus* was done on the basis of development in laboratory reared culture. At each observation, three quadrats of sorghum were carefully examined twice in a week for the number of eggs, larvae and pupae. The field collected eggs, larvae and pupae were brought to the laboratory and reared on sorghum plant parts in plastic vials (measuring 5 cm height and 4 cm dia) and boxes (measuring 15x 20 cm). The food was changed as and when required until adult emergence. The observations were made on the egg, larval and pupal parasitism as well as mortality because of unknown reasons and entomopathogens in early and late larval instars and pupal stage. An interval of four to six days was provided before sampling of next generation after the mean adult emergence of previous generation. This period was considered for completion of act of oviposition by the moth of previous generation. The newly hatched first instar larvae were collected in subsequent generations.

The lifetable was constructed based on Morris and Miller (1954) and Harcourt (1969)/ X= age interval, egg, larva, pupa and adult; lx = number surviving at the beginning of stage noted in 'x' column; dx = number dying within the age interval stated in 'x' column; dxF = mortality factor responsible for 'dx'; 100qx = % mortality; and Sx= survival rate within the age mentioned in 'x'column. The trend index was simply 'lx' for the early instar larvae in the next generation expressed as a ratio of previous generation. It was calculated with the formula N2 / N1 were N2 is equal to the population of early instar larvae in next generation and N1 is equal to the population of early instar larvae in previous generation. The generation survival was an index of population trend without the effect of fecundity and adult mortality; it calculated with the formula N3/ N1- where N3 is equal to population of adult in a generation and N1 is equal to population of early instar larvae in the same generation. A separate budget was prepared to find out the key factors responsible for the changes in the population trend of *C. partellus* on sorghum. The method of key factors analysis developed by Varley and Gradwell (1963; 1965) was used to detect density relationship of mortality factors. By this method, the killing power (K) of such mortality factors or group of mortality factors in each age group was estimated as the difference between the logarithms of population density of the killing power of 'k's.

RESULTS AND DISCUSSION

Chilo partellus completed three regular overlapping generations on rabi sorghum. The results on lifecycle and key mortality factors in 1st, 2nd, and 3rd generation are presented in Table 1 and Fig. 1-3. The mortality in early instar larval stage was- due to unknown reasons (17.24, 19.05 and 14.51%, respectively); *Callibracon* sp. (4.16, 11.76 and 8.33%, respectively); and *Cotesia flavipes* (8.69, 6.67 and 9.65%, respectively) in first, second and third generations. In the late instar it was- due to unknown reasons (19.4, 14.28, and 11.36%, respectively); *Callibracon* sp. (11.76, 12.49 and 11.43%, respectively); and *C. flavipes* (13.33, 14.28 and 10.26%, respectively) in first, second and third generations. In first generation the pupal mortality was not found, while it was- due to unknown reasons (11.11 and 16.12%, respectively) during second and third generations. The trend index and generation survival were- 1.44 and 0.44;

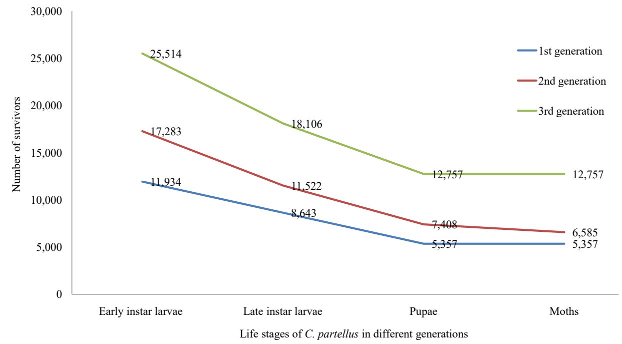

Fig. 1. Survivorship curve of different generations of *C. partellus* sorghum during *rabi* season 2020-21

1.48 and 0.38 and; 0 and 0.42 during first, second and third generations, respectively. The maximum generation mortality during first, second and third generations was noticed from late instar, early instar and late instar larvae (k= 0.221 and k=0.152, respectively). Total K for first, second, and third generation was 0.649, 0.719, and 0.679, respectively (Table 1).

The above results agree with those of Singh et al. (2020) who documented that maximum larval parasitisation of *C. partellus* was recorded by *C. flavipes* (31.64%). Kaur et al. (2020) observed that larvae of *C. partellus* were parasitised (28.6-100, 41.4-50 and 20-80%) by *C. flavipes*. The result indicated that parasitism by *Cotesia* was influenced by age of plants. Hassan et al. (2020) revealed that larval parasitism due to *C. ruficrus* was in the range of 9.77-22.22%; while Dejen et al. (2020) indicated that *C. flavipes* caused less parasitism on stem borers in maize compared to sorghum; *C. flavipes* caused 82% parasitism on *C. partellus.* Rai and Prasad (2019) revealed that *C. flavipes* was the dominant natural enemy with maximum parasitisation of 57%. Sokame et al. (2019) observed that maize stem residues had a higher abundance of *C. flavipes* and *C. sesamiae* parasitoids than wild plants. Kumar (2019) revealed that the major mortality factors of *C. partellus* were the larval parasitoids particularly *C. flavipes* (21.60 to 47%) and unknown causes during early and middle larval stages.

The trend index was positive (>1) and varied in all the generations. Suneel Kumar et al. (2018) observed a peak parasitism of *C. partellus* by *C. flavipes* during 40th SMW in kharif and 4th SMW in rabi. Kumar (2017) revealed that the larval mortality was 37 and 16.07% due to parasitisation and unknown factors, respectively; and mortality of pupae was 11.76% due to diseases while 15.38% failed to emerge into moths. The total mortality (K value) of *C. partellus* was 0.88 due to the effect of biotic and abiotic factors. Patel et al. (2012) showed that *Apanteles* was active from third week of

Table 1. Field lifetable and budget generations of *C. partellus* on sorghum (rabi, 2020-21)

Age interval	No. alive/ ha at the beginning of x	Factors responsible for d_x	No. dying during x	dx as % of l_x	Survivalrate at age X
X	l_x	d_xF	d_x	$100q_x$	S_x
First generation					
Early instar larvae (N_1)	11,934	Unknown reasons	2,057	17.24	0.72
	9,877	*Callibracon* sp.	411	4.16	
	9,466	*Cotesia flavipes*	823	8.69	
Late instar larvae	8,643	Unknown reasons	1,646	19.04	0.62
	6,997	*Callibracon* sp.	823	11.76	
	6,174	*C. flavipes*	823	13.33	
Pupae	5,357	-	-	-	1.00
Moths	5,357	Sex 50% Females	-	-	-
Females x 2 (N_3)	2,675	(Reproducing females=2,675)	-	-	-
Trend index (N_2/ N_1)	17,228 / 11,934	-	1.44	-	-
Generation survival (N_3/ N_1)	5,357 / 11,934	-	0.44	-	-
Second generation					
Early instar larvae (N_1)	17,283	Unknown reasons	3,292	19.05	0.67
	13,991	*Callibracon* sp.	1,646	11.76	
	12,345	*C. flavipes*	823	6.67	
Late instar larvae	11,522	Unknown reasons	1,646	14.28	0.64
	9,876	*Callibracon* sp.	1,234	12.49	
	8,642	*C.flavipes*	1,234	14.28	
Pupae	7,408	Unknown reasons	823	11.11	0.88
Moths	6,585	Sex 50% Females	-	-	-
Females x2 (N_3)	3,292	(Reproducing females=3,292)	-	-	-
Trend index (N_2/ N_1)	25,514 / 17,283	-	1.48	-	-
Generation survival (N_3/N_1)	6,585 / 17,283	-	0.38	-	-
Third generation					
Early instarlarvae (N_1)	25,514	Unknown reasons	3,703	14.51	0.71
	21,311	*C. flavipes, Callibracon* sp.	2,057	9.65	
	19,754		1,646	8.33	
Late instarlarvae	18,106	Unknown reasons	2,057	11.36	0.70
	16,049	*C.flavipes, Callibracon* sp.	1,646	10.26	
	14,403		1,646	11.43	
Pupae	12,757	Unknown reasons	2,057	16.12	0.83
Moths	12,757	Sex 50% Females	-	-	-
Females x2 (N_3)	5,350	(Reproducing females=5,350)	-	-	-
Trend index (N_2/N_1)	0 / 25,514	-	0	-	-
Generation survival (N_3/N_1)	10,700 / 25,514	-	0.42	-	-

S. No.	Age interval	'k' values of generations of *C. partellus* 1st	2nd	3rd
1.	Early instar larva	-	-	-
2.	Late instar larva	0.140	0.221	0.149
3.	Pupa	0.208	0.146	0.152
4.	Adults	0.000	0.051	0.077
5.	Reproducing females	0.301	0.301	0.301
	Total 'K'	0.649	0.719	0.679

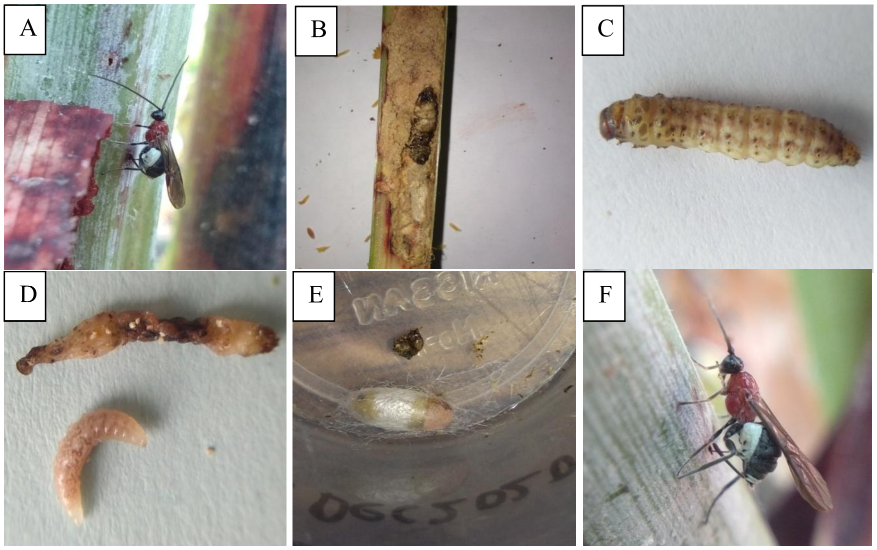

Fig. 2. Parasitisation of *C. partellus* larva by *Callibracon* sp. A. Parasitisation by *Callibracon* sp B. Parasitised larva in stem C. Parasitised larva D. Grub of *Callibracon* sp. E. Cocoon of *Callibracon* sp. F. Adult of *Callibracon* sp.

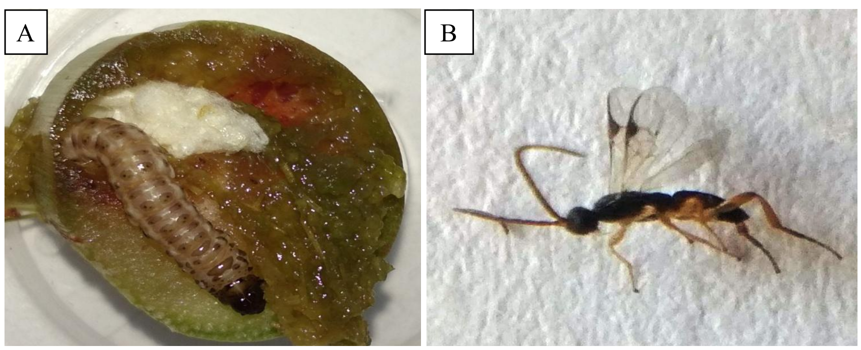

Fig. 3. Parasitisation of *C. partellus* larva by *Cotesia flavipes*. A. Parasitised larva of *C. partellus* and cocoons of parasite B. Adult of *C. flavipes*

August to first week of November. Divya et al. (2009) revealed maximum parasitisation by *C. flavipes* during 45th SMW (35%) during kharif and in 50th SMW (32%) during rabi-summer. Midega et al. (2005) observed that mortality by *Cotesia sesamiae* Cameron and *C. flavipes* was very minimal. Jalali and Singh (2003) reported that larval parasitoid, *Cotesia flavipes* (Cameron) was very important. Jalali et al. (2003) illustrated that larval parasitoids viz., *C. flavipes*, *Myosoma chinensis* (Szepligeti) and *Stenobracon nicevellei* (Bingham) and insect pathogens were insignificant factors in the mortality of *C. partellus*.

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