



Biological studies of *Chilo partellus* (Lepidoptera: Crambidae) on natural diet under laboratory conditions

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Abstract

Chilo partellus is one of the most devastating species of maize. Due to its faster rate of development and extent of damage a study was designed to get useful data about all the life stages of maize stem borer from egg to adult including eggs hatchability percentage, mean developmental period, mean body length and adult emergence under laboratory conditions on natural maize diet at a temperature of 26 ± 2 °C and 65 ± 5 % humidity in Insect Pest Management Program, National Agricultural Research Center (NARC) Islamabad. Eggs hatchability percentage was $87.50 \pm 1.97\%$. Mean development period of egg was 5.2 ± 0.56 days and for 1st, 2nd, 3rd, 4th and 5th instar larvae was 5.25 ± 0.57 , 4.87 ± 0.61 , 3.56 ± 0.62 , 3.87 ± 0.95 and 4.37 ± 1.20 days, respectively. Development was slow in early instars but the rate became faster in the later instars. The mean development duration of pre-pupae and pupae was 2.25 ± 0.77 and 7.5 ± 0.96 days, respectively. The larval stage lasted for 21-23 days, pupal stage took 6-9 days until adult emergence. Mean longevity for females was 2.87 ± 0.99 and for males was 2.75 ± 0.7 days. The study showed that *C. partellus* took 36-41 days with a mean value of 37.75 ± 1.98 to complete its life cycle showing its faster rate of development on natural diet under laboratory conditions.

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Introduction

Maize is an important cereal as well as fodder crop of the world. In Pakistan maize is an economically important cereal crop, ranked third after wheat and rice. During 2016-17, area sown under maize crop increased by 12 % reaching 1334 thousand hectares. Maize crop production also increased significantly by 16.3% with 6.130 million tonnes during 2016 (PBS, 2016-17). Maize production in Pakistan remained as much as 4.763 tons/ha which is around one third of the production in the USA (11.83 tons/ha). Maize is grown on 43% cropped area in Pakistan. It is second most important kharif crop in Pakistan, grown mainly in the Punjab and Khyber Pakhtunkhwa provinces (Khalil and Jan, 2005). In Pakistan several industries are relying on maize including poultry, livestock and also used human consumption. Although, introduction of hybrid seeds increase the maize production many folds but in Pakistan it still remained less as compared to its production in developed world (Ahmad *et al.*, 2007). Amongst the several factors effecting the production of maize, the maize stem borer *Chilo partellus* Swinhoe (Lepidoptera: Crambidae) is one of the factors causing 24-75 % losses in yield (Kumar, 2002). In Peshawar valley *C. partellus* was reported to cause 10-50% damage (Farid *et al.*, 2007). It is a major pest in most of the African and Asian countries (Arabjafari and Jalali, 2007). It is one of the most devastating species of maize (Duale, 1999; Khan *et al.*, 2000; Kfir *et al.*, 2002).

The pest generally attacks the vegetative stage of maize plants or just before harvest thus results in significant economic losses. The *C. partellus* life cycle generally takes 3-4 weeks, depending on factors like temperature and others. Under favourable conditions, pest may persist throughout the year and develop five or even more successive generations (Anne, 2011). The plants can get affected at any stage including flowering, post-harvest, seedling and vegetative stage. It attacks all plant parts except roots. At early stage of plant damage is caused by killing the shoot resulting in "dead heart". In older plants it cause stem damage by feeding inside the shoot. Its damage symptoms

include characteristic holing of funnel leaves, the formation of dead hearts and holes in the tunneled stems (CAB, 2007). There are usually 6 generations per year in areas where climate is suitable, but in the winter or dry season larvae diapauses in stems. Eggs are laid in batches on leaf surfaces, usually close to the midrib.

The eggs hatch after 4-10 days. *Chilo partellus* moths can produce an average of 343 eggs/moth (Ofomata *et al.*, 2000). Understanding different stages of life history of *C. partellus* provides the information about the population fluctuations of pest in field (Jallow and Matsumura, 2011). Studies on life history of insect help in understanding and analyzing factors that affect the survival, growth, reproduction, rate of development and adaptability to field conditions (Odindo and Onyango, 1998). Considering *C. partellus* faster rate of development and extent of damage that it causes, it is an important pest to study for its biology, life cycle and other parameters to get useful data for designing its management strategies.

Materials and methods

The present research experiment was conducted at Insect Pest Management Program of National Agricultural Research Center (NARC), Islamabad to study the biological parameters of *C. partellus* on natural diet in laboratory conditions at temperature 26 ± 2 °C and relative humidity 65 ± 5 %, in *C. partellus* mass rearing laboratory. Seeds of maize were sourced from Maize, Sorghum and Millet & Fodder Program, Crop Science Institute, NARC. Seeds were planted in three plots and also in pots with interval of one week for continuous supply of food as natural diet during entire experiment.

Colony initiation

Laboratory colonies and population of stem borer were set up using the field collected stem borer larvae and pupae. Damaged maize plants showing infestation of maize stem borer were collected and dissected stem borer larvae and pupae present in them were shifted to jars containing maize stems as food.

Larval rearing

Larvae were reared in ventilated plastic jars at room temperature ($26 \pm 2^\circ\text{C}$) and relative humidity $65 \pm 5\%$ until pupation. Pieces of fresh maize stems were supplied as food. Stems were dissected after every two days to check for larval mortality, natural parasitism or pupation. Pupae were collected and transferred to petri plates and then shifted to containers for adults' emergence.

Oviposition and handling of eggs

Upon emergence the adults were shifted to oviposition jars lined with maize leaves inside the jars for egg laying. Leaves were examined each day for eggs. Part of leaves with egg batches were cut and placed in jars for hatching. Early instar larvae were reared in groups in 350 ml jars and supplied with tender leaves and fresh soft stems. After one week stem pieces were provided as larval food.

Study of biological parameters

Biology of *C. partellus* was studied on maize stems and *C. partellus* life stages were observed under binocular stereomicroscope (16SX-Japan) equipped

with a digital Olympus camera system. A DSLR camera was also used for the observations (Fig. 1). The observations were recorded and the mean values were calculated for eggs hatching percentage, eggs developmental period, larval developmental period, larval mean length, pupae developmental period, adult longevity female and adult longevity male.

Results and discussion

All the life stages of *C. partellus* from egg to adult were studied for eggs hatchability percentage, mean developmental period, mean body length and adult longevity. The mean egg duration was 5.2 ± 0.56 days. Egg measurement was recorded as 1.59 ± 0.07 mm. The larval stage lasted for 21-23 days, Development was slow in early instars and the rate became faster in the later instars. Pupal stage took 6-9 days until adult emergence. The emergence ratio of females and males was 1:1.

Table 1. Mean duration and length of life stages of *C. partellus* reared on maize stems under laboratory conditions.

S. No.	Life Stage	Minimum developmental period	Maximum developmental period	Mean developmental period \pm S.E	Mean length (mm) Minimum	Mean length (mm) Maximum
1	Eggs	5	6	5.2 ± 0.56	1.5	1.7
2	Total Larval period	21	23	21.93 ± 0.68		
i	1 st instar	4	6	5.25 ± 0.57	1.0	3.06
ii	2 nd instar	4	6	4.87 ± 0.61	3.27	4.94
iii	3 rd instar	3	5	3.56 ± 0.62	5.87	9.03
iv	4 th instar	3	6	3.87 ± 0.95	10.68	14.56
v	5 th instar	2	7	4.37 ± 1.20	15.95	19.73
3	Pre-pupae	1	4	2.25 ± 0.77		
4	Pupae	6	9	7.5 ± 0.96	10	15
5	Life cycle (egg to adult emergence)	36	41	37.75 ± 1.98		

Minimum developmental period for 1st, 2nd, 3rd, 4th and 5th larval instars was 4, 4, 3, 3 and 2 days and the maximum developmental period for 1st, 2nd, 3rd, 4th and 5th larval instars was observed as 6, 6, 5, 6 and 7 days respectively. The minimum period for the completion of larval stage was 21 days and maximum period was 23 days. The mean developmental period

of 1st, 2nd, 3rd, 4th and 5th instars was 5.25 ± 0.57 , 4.87 ± 0.61 , 3.56 ± 0.62 , 3.87 ± 0.95 , 4.37 ± 1.20 days, respectively. Total mean larval period was 21.93 ± 0.68 days.

The mean body length of each larval instar was also measured on the start and end of each instar.

Table 2. Mean eggs hatchability percentage and adult longevity of *C. partellus* reared on maize stems under laboratory conditions.

S. No.	parameters	Mean \pm S.E
1	Eggs hatchability percentage	87.50 \pm 1.97%
2	Adult longevity female	2.87 \pm 0.99 days
3	Adult longevity male	2.75 \pm 0.7 days

The data showed that the mean body length for 1st instar ranged from 1-3.06 mm, for 2nd instar from 3.27-4.94 mm, for 3rd instar 5.87-9.03 mm, for 4th instar 10.68-14.56mm and for 5th instar from 15.95-19.73 mm (Table 1).

The mean developmental period of pre-pupae was 2.25 \pm 0.77 with minimum period 1 day and maximum period 4 days. Similarly, mean developmental period for pupae was 7.5 \pm 0.96 days. The minimum and maximum developmental periods for pupae were 6 and 9 days, respectively (Table 1).

This is also in accordance with the results of Saranya and Samiayyan (2017) who determined that *C. partellus* completed its development in less time (36.3 \pm 6.01 days) on natural sweet combs diet as compared to artificial diet with mean developmental period of larvae and pupae as 20.5 \pm 1.64 and 5.6 \pm 1.34 days, respectively. While on artificial diet he observed the mean larval and pupal period as 43.5 and 8.2 days, respectively.

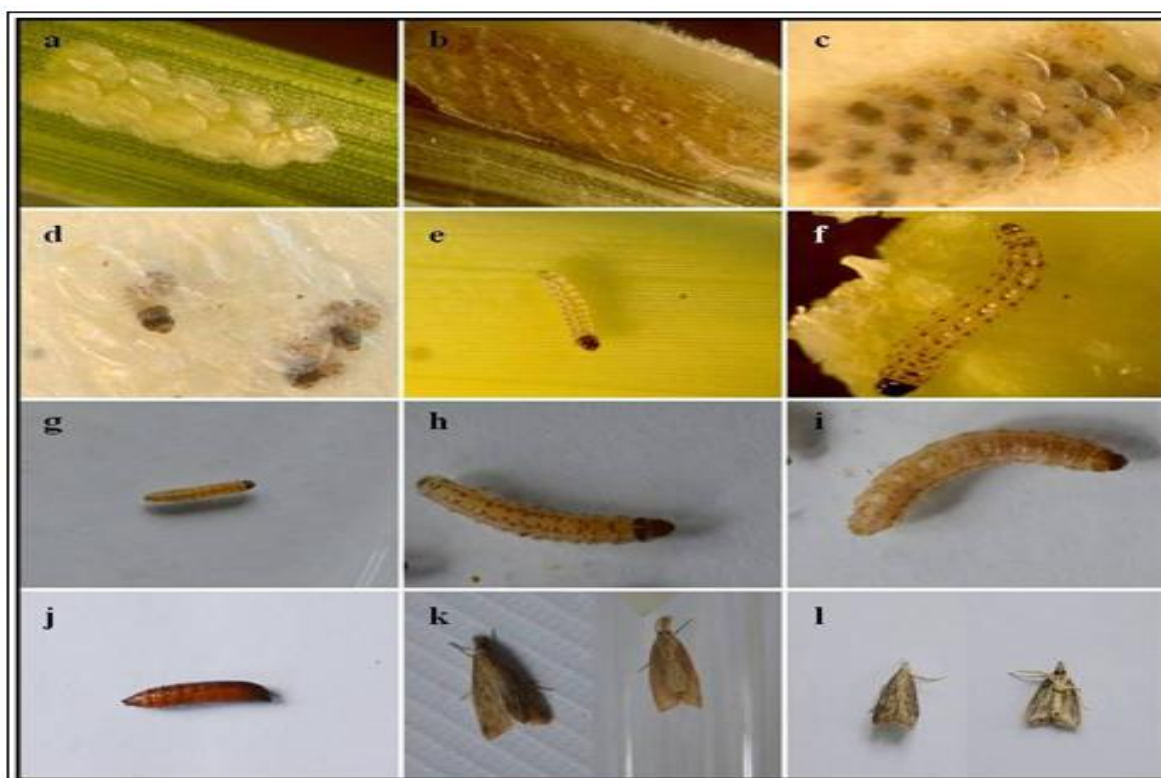


Fig. 1. Life stages of *C. partellus*. (a) Day 1 Eggs; (b) Day 4 eggs (c) Black head stage of eggs; (d) Egg hatching; (e) 1st instar; (f) 2nd instar; (g) 3rd instar; (h) 4th instar; (i) 5th instar; (j) Pupa; (k) *C. partellus* female; (l) *C. partellus* male.

*Pictures (a, b, c, d, e, f) taken with binocular stereomicroscope (16SX-Japan) equipped with a digital Olympus camera system

*Pictures (g, h, I, j, k, l) taken with a DSLR camera.

The life cycle of *C. partellus* on natural maize diet completed in 36-41 days with an average value of 37.75 ± 1.98 (Table 1). Eggs hatchability percentage was $87.50 \pm 1.97\%$ with 25 eggs per replication. Mean value for longevity of females adults was 2.87 ± 0.99 and male adults was 2.75 ± 0.7 (Table 2). Panchal and Kachole (2013) also got the similar results that when *C. partellus* was reared on maize based diet its life cycle completed in 35-42 days with larval period of 28-35 days and pupal period of 7-10 days. In another study Siddalingappa *et al.*, 2010 found that *C. partellus* life cycle got completed in 30 to 69 days having larval period of 20-51 days under laboratory conditions.

Conclusion

The faster development of *C. partellus* on natural diet under laboratory conditions showed that mass rearing of *C. partellus* can be successfully started under laboratory conditions by using maize stems as diet of larvae. During studies, it was also observed that the rearing of *C. partellus* is highly sensitive to environmental conditions. Therefore, well controlled laboratory conditions are very important for the successful rearing of *C. partellus*. Further studies need to be focused on the success of artificial diet for mass multiplication of maize stem borer larvae in short time for further research programs focused on *C. partellus* control and management.

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