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Research Article

Life cycle study of maize stem borer (*Chilo partellus* Swinhoe) under laboratory condition at National Maize Research Program, Rampur, Chitwan, Nepal

[1]Saraswati Neupane * and [1]Subash Subedi,

[1]Nepal Agricultural Research Council, National Maize Research Program Rampur, Chitwan, Nepal
*Correspondence:sarusanu2017@gmail.com; ORCID:https://orcid.org/0000-0003-3033-5840
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ABSTRACT

Maize stem borer *(Chilo partellus* swinhoe) is one of the major threatening global pests of maize and considered as the national top priority entomological research problem in Nepal. The Life cycle of maize stem borer was studied under laboratory condition at National Maize Research Program (NMRP), Rampur, Chitwan, Nepal during 2018. Development of stem borer undergoes following stages like egg, larvae, pupa and adult. Eggs and different instars of maize stem borer larvae were collected from maize fields were put with host materials (maize leaf and stem) to become different instars of larva, pupae and finally turned to adults. Eggs were harvested from adults and kept on blotting paper which was kept inside petriplates and reared for adults. Their life span in each stage (egg, larva and pupa) and the fecundity of adults recorded. Daily room temperature and relative humidity (RH) in laboratory conditions were recorded. The Egg incubation period ranged from 4-7 days and hatched generally in the early morning (6-8 AM). The complete larvae period ranged from 29 to 36 days while pupal period was ranged from 7 to 12 days. The average male pupal length was found 10.6 mm and female was 13.13 mm long. The fecundity of *C. partellus* Swinhoe was recorded 150-160 eggs per female. The Oviposition period was 4-5 days and adult male survived for 4-7 days while female for 5-9 days. The average life cycle of *C. partellus* completed in (44-48) days during summer whereas (60-64) days during winter at average room temperature of (26-27° C) and RH of (70-80%). These results have important implications to know the survival and development of pest including effective pest management strategy.

Keywords: *Chilo partellus* Swinhoe, life cycle, maize

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INTRODUCTION

Insect pests are one of the major biotic constraints that limit the productivity of maize in Nepal. More than 130 insects have been reported to cause damage to maize and about half a dozen insects are economically importance (Atwal, 1976). The major insect pests that attack maize crop include maize aphids, cutworms, stem/shoot fly, root worm and stem borer (Thakur *et al.*, 2018). Among them, maize stem borer, Chilo partellus Swinhoe (Pyralidae: Lepidoptera) has been implicated as a major production constraint throughout the country (Neupane, 1986; Sharma & Gautam, 2010; *Thakur et al.*, 2018). It attacks maize plants from seeds sown in field to maturity and feed on all parts of the plants (Gyawali, 1978; Shivakoti & KC, 1981; Neupane *et al*., 1983). Newly hatched larvae feed on the leaves making pinholes and leaf windowing. They bore down inside the plant whorl and feed. While feeding in the plant whorl, they kill the central shoot, which later on dries up causing dead heart resulting total loss of the crop (Harris, 1990). In general, the borer caused minor damage, pin holes on leaves. In severe cases, dead hearts are formed, the condition in which the plants do not bear any ear at all. At our context, till now, yield loss caused by maize stem borer yet to be estimated in combined with the relationship of stem tunneling as well as leaf damage to monitory value. However, some researchers have reported that borer can culminate yield loss of 20-87% (Mathur, 1994; Chaterji *et al*., 1969). The figure of on-farm of yield loss caused by borer is considerable. It is very difficult to manage stem borer by chemical insecticides alone due to their ability to develop quick resistance against insecticides. The biological study of any pest is always important to explore the survival and development knowhow of the pest and ultimately formulate the effective and sustainable pest management strategy. The time and mode of pesticide application as well as pest behaviour towards host during infection process warrant the information of pest biology otherwise spraying of chemical during egg stage, late larval and pupal stage is ineffective. Scanty information is available on biological aspect of this pest in Nepal. Considering and realizing the significance of these aspects, to know the detail life cycle pattern of maize stem borer, the present studies were under taken at the laboratory of National Maize Reserach Program, rampur, Chitwan, Nepal.

MATERIALS AND METHODS

The Life cycle of maize stem borer was studied under laboratory condition at National Maize Research Program (NMRP), Rampur, Chitwan, Nepal during 2018. Development of stem borer undergoes following stages like egg, larvae, pupa and adult. Daily room temperature and relative humidity (RH) in laboratory conditions were recorded.

Maintenance of insect culture

Eggs and different instars of maize stem borer were collected from maize field at National Maize Research Program, Rampur, Chitwan. The collected larvae were transferred to plastic boxes containing cut stems of maize. The boxes were cleaned daily by removing the excreta and partially eaten stems. The larvae were supplied with sufficient quantity of fresh tender stem pieces as food. The larvae were reared till they attain pupal stage. Pupae obtained were kept in separate plastic jar for adult emergence (Arunkumara *et al*., 2018). The culture then obtained was used for the further studies on biology conducted in growth chamber at 27 ºC temperature and RH of 75 per cent.

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Incubation period
For this five pairs of freshly emerged male and female adults were released into oviposition jar (25 x 10 cm) which was prepared by covering the inner wall of jar with folded paper, fresh maize plants. Ten per cent honey solution was provided as a food to the moths by soaking cotton plug in the solution. The open end of oviposition jar was covered with muslin cloth. Folded paper and leaves served as an ovipositional site and observations were recorded every day for oviposition. Eggs laid on the folded paper by the female moth were transferred with the help of a camel hair brush and needle to a petri-dish with moistened cotton sponge. The petridish was covered and observed for hatching of the egg. Time taken for hatching was recorded by making observation at 24 hours interval.

Larval period
The period from hatching of the eggs till pupation was recorded as larval period. Larvae reared on fresh maize leaf and stem in laboratory condition. These larvae were observed for the morphometric characters (Arunkumara *et al*., 2018).

Pupal period
Pupae obtained after completion of the larval cycle were collected in plastic container and kept for emergence. The time taken from the pupation till emergence of the adult recorded as a pupal period. These pupae were observed for the morphometric characters (Arunkumara *et al*., 2018).

Adult longevity
Adult emerged from pupa was observed for their colour, shape and size. The male and female moth was measured across their expanded wing with the help of standard scale. Male and female were differentiated on the basis of morphological differences. The male and female longevity were calculated separately from date of emergence of adult to the death of adult.

Oviposition period
The period from first egg laid till the last egg laid was recorded as oviposition period.

Fecundity
Individual pairs of freshly emerged moths were kept in cylindrical boxes provided with folded paper and 10% honey solution. Honey and oviposited paper were changed daily till the death of female of the pair. Eggs were counted on oviposited paper and leaves on daily basis and finally total fecundity was calculated.

Total life cycle
The duration of entire life span of insect was considered as total life cycle.

Data analysis
All data were analyzed statistically using Microsoft Excel (2007) computer package program. The average mean, standard deviation and standard error was calculated.

RESULTS AND DISCUSSION

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Incubation period of egg

The eggs were flat oval and creamy white in color. An eggmass consisted of 20-35 eggs, which were overlap and scale like in appearnce (Figure 1). The higher incubation period (6-7 days) was observed during September to February while lower period (4-5 days) during May to August (Table 1). At initial stages egg get appeared from pearly white in color and then finally turns to darker in color. Egg hatched in 4-7 days generally in the early morning (6 am-8 am) (Table 4). This finding is in line with the Krishna *et al* (2018) who reported that eggs of stem borer get hatched within 5-6 days during early morning were flat and creamy white color and finally turns to darker color which represent the head of the larvae.

Larvae

The larvae was found with black or dark brown colored head, purplish pink on dorsal side and white on ventral side (Figure 2). The average mean value of length, breadth and weight of the first and fifth instar larvae observed from 2.05 ± 0.11 to 23.38 ± 0.55 mm; 0.34 ± 0.03 to 3.22 ± 0.17 mm and 1.04 ± 0.06 to 327.5 ± 43.3 mg respectively (Table 3). The higher larval period (35-36 days) was recorded during the month January-February while lower (29-30 days) in May-June (Table 1). The totla larval period was ranged from 29-36 days with the mean value of 32.28 ± 0.17 (Table 4). In the larval period mean value of instars I, II, III, IV and V observed from 4.90 ± 0.28, 6.50 ± 0.17, 8.40 ± 0.16, 9.30 ± 0.15 and 10.40 ± 0.16 respectively (Table 4). The present findings with respect to larval duration are in agreement with that of Deshpande (1978) and Marulasiddesha (1999). The morphometric measurements of the pest are also in line with the findings of Krishna *et al* (2018).

Pupae

The pupae were pale brown with cylindrical shape (Figure 3). The higher pupal period (11-12 days) was recorded during the month November-February while lower period (7-8 days) in May-June (Table 2). The male pupae was slightly smaller than that of female pupae. The average mean length, breadth and weight of the male pupae observed from 10.66 ± 0.23 mm, 2.23 ± 0.07 mm and 29.15 ± 1.28 mg respectively (Table 3). In case of female pupae, the average mean length, breadth and weight were 13.13 ± 0.15mm, 2.66 ± 0.02mm and 49.15 ± 0.74 mg respectively (Table 3). The male pupal period ranged from 7-9 days with the mean value of 7.70 ± 0.26 days while 10-12 days with average mean value of 10.90 ± 0.23 days for female pupae (Table 4). The present findings are in close agreement with Deshpande (1978), Krishna et al (2018) and Arunkumara *et al* (2018) who reported that pupal period lasted for 6 to 11 days.

Adult

The adults were medium sized with yellowish brown forewings having rows of black spots all along anterior margin. Male moth was dark brown in colour with pale brown forewings and pale yellow hindwing while female hind wing was much lighter than that of male (Figure 4). The higher adult period (8-9 days) was recorded during the month January-February while lower (4-5 days) in May-June (Table 2). The average mean length, breadth and weight of the male adult observed from 13.53 ± 0.22 mm, 23.55± 0.22 mm and 49.12 ± 0.29 mg respectively (Table 3). In case of female pupae, the average mean length, breadth and weight were 18.55 ± 0.23 mm, 29.84 ± 0.32 mm and 57.62 ± 0.51 mg respectively (Table 3). The male adult period ranged from 4-7 days with the mean value of 5.40 ± 0.34 days while 5-9 days with average mean value of 7.0 ± 0.39 days for female adult (Table 4). The finding from

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this study is well supported by Berger (1992) , Bleszynzki (1970) and Harris (1990) who reported that adults were relatively small moths with wing lengths ranging from 7 to 17 mm. Females are generally larger than males and both sexes rest with the wings folded over the abdomen. The forewings are generally light yellow-brown with some darker scale patterns forming longitudinal striations which are usually darker at the wing margins (Arunkumara *et al.*, 2018).

Oviposition period

The oviposition period is the period from first egg laid till the last egg laid and it ranged from 4-5 days with average mean value of 4.2 ± 0.13 days (Table 4). These results are in the conformity with earlier records of Chavan (2006) who reported that oviposition period of 3 to 5 with an average of (4.18 ± 0.64) days. Similar, another report also reported the oviposition period to ranges from 3.00 to 5.00 days with an average of 4.2 ± 0.63 days. Thus, the present finding of oviposition period was more or less in conformity with past report reported by Siddalingapa *et al.* (2010).

Fecundity

The fecundity of *C. partellus* Swinhoe was recorded 150-160 eggs per female with the mean value of 157± 0.52 eggs per female (Table 4). The findings of this study were in support with the findings of Songa *et al* (2000) and Berner *et al* (1993) who reported that the fecundity of *C. partellus* was approximately 150 eggs per female.

Total life cycle

The average life cycle of *C. partellus* from egg to adult (Figure 5) completed in (44-48) days during peak summer period (May-June) whereas (60-64) days during peak winter season i.e. in January- February (Table 2). The total life cycle period ranged from 44-64 days with the mean value of 53.82 ± 0.49 days (Table 4). These findings are in agreement with previous records of Marulasiddesha (1999) reported that life cycle of stem borer as 30 to 65 days and also reported the life cycle as 30 to 69 days with an average of 49.50 ± 13.50 days by Siddalingapa *et al.* (2010) .

Table 1: Egg incubation and larval period of *Chilo partellus (*Swinhoe) at laboratory of NMRP, Rampur under natural feeding condition in 2018-2019

S. N.	Month (2018-2019)	Incubation period of egg (days)		Larval period (days)	
		Range	Mean ± SE	Range	Mean ± SE
1	July-August	4-5	†4.5 ± 0.16	30-31	†30.2 ± 0.13
2	September-October	6-7	6.7 ± 0.15	33-34	33.5 ± 0.17
3	November-December	6-7	6.5 ± 0.17	34-36	34.7 ± 0.26
4	January-February	6-7	6.4 ± 0.16	35-36	35.4 ± 0.16
5	March- April	5-6	5.8 ± 0.13	30-31	30.6 ± 0.16
6	May-June	4-5	4.7 ± 0.15	29-30	29.3 ± 0.15

Note: *† mean of 10 observations, SE- Standard error*

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Figure 1: Egg mass of stem borer

Figure 2: Larvae of stem borer

Figure 3: Pupae stage

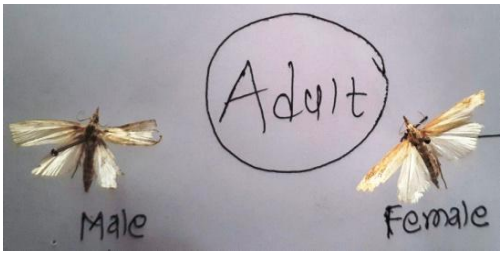

Figure 4: Adult stage of stem borer

Table 2: Pupal, adult and total life cycle period of *Chilo partellus (*Swinhoe) at laboratory of NMRP, Rampur under natural feeding condition in 2018-2019

S. N.	Month (2018-2019)	Pupal period (days)		Adult period (days)		Total life cycle (days)	
		Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE
1	July-August	8-9	†8.4 ± 0.16	5-6	†5.3 ± 0.15	47-51	†48.7 ± 0.54
2	September-October	9-10	9.8 ± 0.13	5-7	6.0 ± 0.30	54-58	55.9 ± 0.48
3	November-December	11-12	11.3 ± 0.15	7-8	7.2 ± 0.13	59-63	60.7 ± 0.50
4	January-February	11-12	11.6 ± 0.16	8-9	8.4 ± 0.16	60-64	62.10 ± 0.50
5	March- April	8-9	8.8 ± 0.13	5-6	5.6 ± 0.16	48-52	49.70 ± 0.45
6	May-June	7-8	7.5 ± 0.17	4-5	4.7 ± 0.15	44-48	45.80 ± 0.47

Note: *† mean of 10 observations, SE- Standard error*

Table 3: Morhological measurements of *Chilo partellus (*Swinhoe) at laboratory of NMRP, Rampur under natural feeding condition in 2018-2019

S. N.	Growth stages	Length (mm)		Breadth (mm)		Weight (mg)	
		Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE
1	First instar larvae	1.5-2.5	†2.05 ± 0.11	0.21-0.44	†0.34 ± 0.03	0.8-1.4	†1.04 ± 0.06
2	Second instar larvae	4.2-6.0	5.08 ± 0.21	0.73-0.85	0.8 ± 0.01	2.50-4.85	3.70 ± 0.32
3	Third instar larvae	8.2-15.5	12.48 ± 0.86	0.93-1.46	1.19 ± 0.06	10.6-30.45	22.49 ± 2.14
4	Fourth instar larvae	16.2-20.4	17.97 ± 0.44	1.75-2.54	2.18 ± 0.09	1.25-101.5	74.18 ± 5.30
5	Fifth instar larvae	20.6-25.2	23.38 ± 0.55	2.95-3.45	3.22 ± 0.17	110.5-490.6	327.5 ± 43.3
6	Male pupae	9.5-11.5	10.66 ± 0.23	1.95-2.52	2.23 ± 0.07	23.5-35.6	29.15 ± 1.28
7	Female pupae	12.5-13.8	13.13 ± 0.15	2.55-2.75	2.66 ± 0.02	45.5-52.5	49.15 ± 0.74
8	Male adult	12.5-14.5	13.53 ± 0.22	22.5-24.5	23.55± 0.22	47.5-50.4	49.12 ± 0.29
9	Female adult	17.5-18.5	18.55 ± 0.23	28.5-31.5	29.84 ± 0.32	55.5-60.5	57.62 ± 0.51

Note: *† mean of 10 observations, SE- Standard error, mm- millimeter, mg-milligram*

Table 4: Duration of different stages and fecundity of *Chilo partellus (*Swinhoe) at laboratory condition of NMRP, Rampur under natural feeding condition in 2018-2019

S.N.	**Characteristics**	**Range**	**Mean ± SE**
1.	Egg incubation period (days)	4-7	†5.75 ± 0.16
2.	Larval period (days)		
	2.1 First instar	4-6	4.90 ± 0.28
	2.2 Second instar	6-7	6.50 ± 0.17
	2.3 Third instar	8-9	8.40 ± 0.16
	2.4 Fourth instar	9-10	9.30 ± 0.15
	2.5 Fifth Instar	10-11	10.40 ± 0.16

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3.	Total larval period (days)	29-36	32.28 ± 0.17
4.	Male pupal period (days)	7-9	7.70 ± 0.26
5.	Female pupal period (days)	10-12	10.90 ± 0.23
6.	Male adult (days)	4-7	5.4 ± 0.34
7.	Female adult (days)	5-9	7.0 ± 0.39
8.	Oviposition period (days)	4-5	4.2 ± 0.13
9.	Total life cycle period (days)	44-64	53.82 ± 0.49
10.	Fecundity (number)	155-160	157± 0.52

Note: *† mean of 10 observations, SE- Standard error*

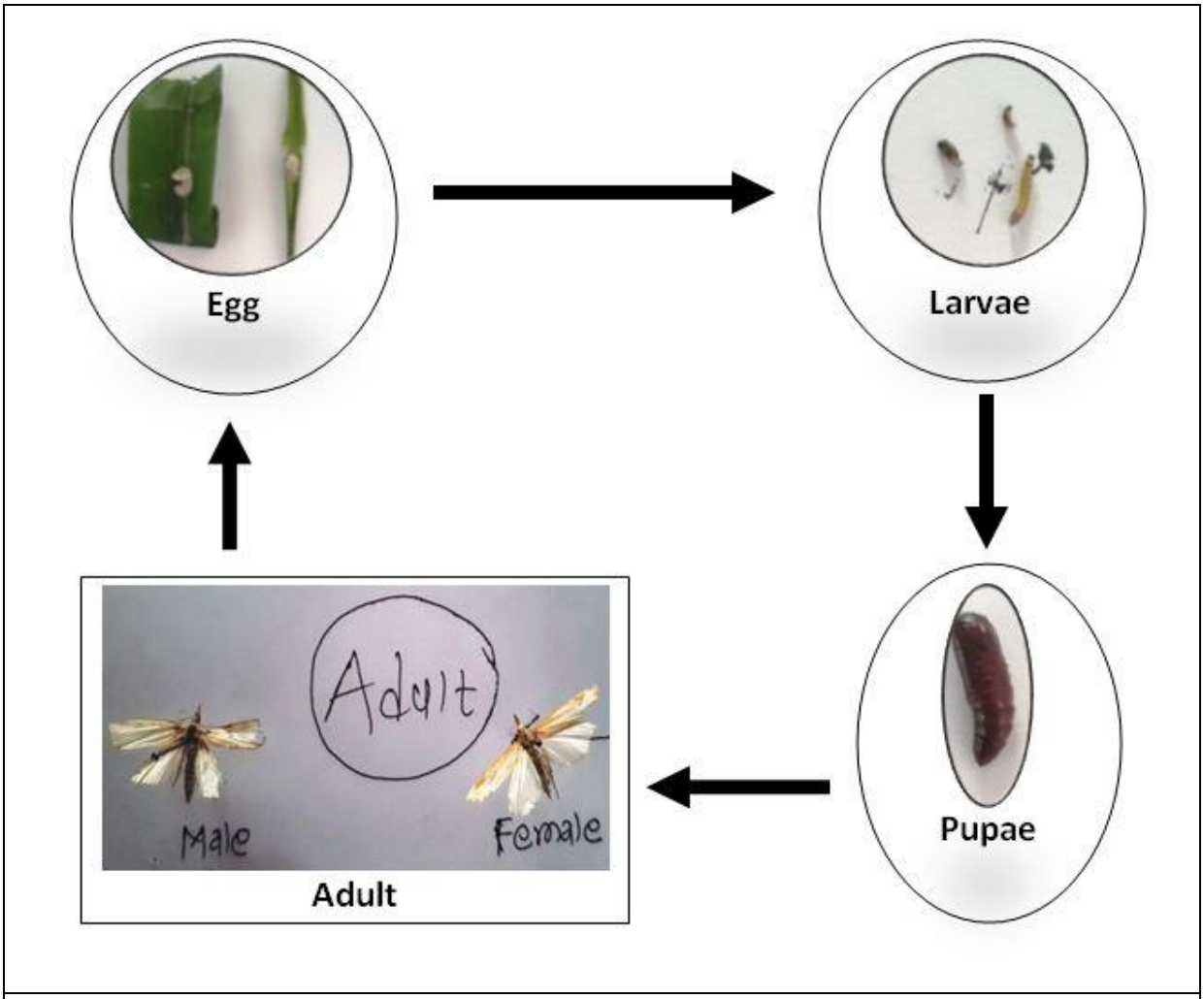

Figure 5: Life cycle of maize stem borer (*Chilo partellus* Swinhoe)

CONCLUSION

The present findings from the study are important to understand the pest strategies during host infection process inorder to formulate and design the sustainable pest management plan in the future This study supplies ample informations regarding the biology, survival, development and morphometric parameters of different stages of pest for developing pest resistant program.

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Author Contributions

S.N. designed and organized the experiment, analysed data and wrote the paper; S.S. helped during manuscript preparation.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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