Studies on the biology and reproductive behaviour of yellow stem borer, *Scirpophaga incertulas* Wlk.

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ABSTRACT

The biology of Scirpophaga incertulas Wlk studied at CRRI, Cuttack, Orissa revealed that average incubation, larval, pre-pupal, pupal, pre-oviposition, oviposition, post oviposition, male and female longevity, total life cycle of male and female were completed in 6.71, 34.74, 1.19, 7.52, 1.13, 1.32, 0.27, 2.64, 2.96, 52.6 and 55.4 days and 7.2, 39.38, 1.22, 8.06, 1.21, 1.41, 0.41, 2.75, 3.12, 58.69 and 62.14 days during Sept.-Oct. and Oct.-Nov., respectively. The fecundity, egg masses/adult, no. of eggs/eggmass, number of larvae emerged/eggmass, % adult emergence and sex ratio (male:female) is 142, 2, 112.8, 82.6, 52.38 and 1:1.88 in the moth of Sept.-Oct. and 160.7, 2.2, 126.3, 108, 57.26 and 1:2 during Oct.-Nov., respectively. Neonate larvae failed to make entry into fully matured 150 days old mother tillers. The larvae could survive beyond 20 days on cut stem pieces and spikelets inside the unopened boot leaf. They could survive up to 8th day on the mid rib of the leaf.

Key words: *Biology, behaviour, Scirpophaga incertulas, rice*

Insect pests are major constraints for increasing the productivity in all the ecosystems of rice in the tropics. In India, approximately 100 insect species feed on rice and 20 of these are considered to be major pests, causing 30% yield loss. (Cramer, 1967; Pathak and Dhaliwal, 1981). Among these, yellow stem borer *Scirpophaga incertulas* Wlk is the dominant and the most destructive insect pest occurring throughout the country (Walker, 1975, Panda *et al.*, 1976 and Pasalu *et al.,* 2005) causing an yield loss of about 10-60 per cent. The unique character of this insect species is that it is highly monophagous (Rao, 1974). Successful methods for its rearing is not available so far. It is pertinent to know the biology and reproductive behaviour of this insect to devise a suitable rearing method for its mass multiplication. Efforts have been made by different scientists to study its biology on the host in some states of India. (Karat and Patel, 1988; Bora *et al.*, 1994; Harinkheren and Agarwal 1994, Malhi and Brar 1998). However, information on the biology and reproductive behaviour of the pest is not available in the Orissa condition where yellow stem borer is endemic. Keeping this in view studies on the biology and reproductive behaviour of this pest was undertaken under green house condition.

MATERIALS AND METHODS

Biology and reproductive behaviour of yellow stem borer was studied under green house condition at CRRI, Cuttack, Orissa on the susceptible variety TN-1 with 10 replications diring September-October and October-November. Earthen pots measuring 8cm. diameter were filled with well pulverized soil, FYM, basal fertilizer as per requirement and puddled properly. 10 days old seedlings were transplanted @ 5 seedling/pot and kept in water trays and grown up to 40 days. Moths were collected from the field and were released in pots covered with mylar cage to study the behavior of adult moth, time of oviposition, size and colour of egg mass. Field collected moths were also released in pots covered with mylar cage @ 1moth/pot and 5moths/pot separately to study the no. of egg masses laid by each female and ovipositional behaviour (site of oviposition,) respectively. Ten eggs masses were boiled in 10% KOH solution and dissected to count the eggs inside each egg mass under a binocular stereo zoom microscope.

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Ten egg masses of different sizes were kept individually in glass tubes with cotton plug to study the time of hatching, time taken for hatching, the incubation period and the number of larvae emerging out from each egg mass. The behaviour of freshly emerged larvae was observed for the duration of survival without food, with moisture only and with cut rice stem pieces. Ten freshly emerged larvae were kept in a specimen tube with the above treatments and replicated 10 times. The survival of the larvae under submerged condition was observed by placing the larvae with covered petridishes under water in trays.

The behaviour of freshly emerged larvae with relation to mode of entry into the young rice plant, the site of entry and time taken by the larvae to enter into the plant tissue were noted. Survival of freshly emerged larvae was studied on different parts viz. leaf blade, leaf sheath, cut stem and in spikelets from unopened boot. Ten freshly emerged larvae were released in each of the plant parts and replicated 10 times. Larval duration was studied on the whole plant by releasing them on 40 days old potted rice plants @ 2 larvae/tiller. Ten such plants were used for recording the number and duration of each larval instar by teasing of the stems and by examining the caste-off larval head capsules. The pupal duration was observed as the period from the start of pupation to the date of adult emergence by putting the pupae in specimen tubes in the laboratory. The male and female moths were paired and released in individual potted plants covered with mylar cage. Similarly, the pre-oviposition, oviposition and post-oviposition period; fecundity, percent adult emergence, adult longevity and behaviour of both the sexes, eggmasses/adult and sex ratios were determined.

RESULTS AND DISCUSSION

Yellow stem borer moths sat quietly on the rice leaves with its head towards the leaf tip. The female moth moved its abdomen tip to either side slowly and simultaneously laid the eggs. The female moth oviposited both on dorsal and ventral surface of the leaf but the dorsal side was preferred most to ventral side and sometimes eggs were laid on leafsheath under green house condition. Although any portion of rice leaf (basal, middle, apical) was suitable for oviposition, the middle portion was the most preferred site recording highest no. of egg masses (40.7%) followed by basal (34.3%) and the apical (25%). The observations made in the present study in relation to the site of oviposition were in conformity with the findings of Shahjahan (2002). Brar *et al.,* (2001) also observed similar type of ovipositional behaviour.

Eggs of the YSB were laid in compact egg masses varied in shape from oval, flattened and some what rectangular and were covered with brownish velvety hair obtained from the hair on the abdominal of the female moth. Completely naked egg masses without any hair were laid by the females whose abdominal hairs were removed experimentally with the help of an adhesive tape. In all the instances oviposition took place during night mostly from 9.00 P.M. to 1.00 A.M. Hatching from egg masses took place in the early hours of the day up to 7 A.M. It took 10-45 minutes for complete hatching of the eggs in each egg mass depending on the size of the egg mass and larvae emerged through several holes made on the sides of the egg mass.

The average incubation period was found to be 7.2 days in the month of Oct.-Nov. as compared with 6.71 days during Sept.-Oct. (Table 1) Korat and Patel (1988) have reported that the average incubation period was 6.43 days at 27ºC and 6.20 days at 30ºC. Bora *et al.* (1994), Malhi and Brar (1998) have also reported that the incubation period ranged from 6-8 days and 6.70 days during July and 6.83 days during August respectively. The neonate larvae are grey, head and pro-thoracic shield dark. The average duration of 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, 5^{th} and 6^{th} instar larvae were 3.35 days, 4.28 days 5.38 days, 7.29 days, 8.53 days, 10.45 days in the month of Oct.-Nov. while it was 2.95 days, 3.75 days 4.84, 6.69 days 7.95 days, 8.60 days in the month of Sept.-Oct., respectively (Table 1). It was observed that larvae of the succeeding instar took relatively more time for their development than the preceding instar in the above two periods of study. The instars could be distinguished from their size, prothoracic hood mark and colour intensity of head. Total larval duration as well as the duration of each instar increased as the temperature decreased. The average total larval period was 39.38 days and 34.74 days in the month of Oct.-Nov. and Sept.-Oct., respectively. The same pattern of observations on larve period have been made by various workers as 25.38 days at 27ºC and 22.38 days at 30ºC (Korat and Patel, 1988) and 28.85 days during

Table 1. Biometrical observations on Yellow stem borer, *Scirpophaga incertulas* under green house conditions on rice in the month of Sept.-Oct. and Oct.-Nov.

Stages	Duration (days) Mean ± S.Em. (Sept-Oct)	Duration (days) Mean ± S.Em. (Oct.-Nov.)
Egg	6.71 ± 0.22	7.2 ± 0.25
Larva :		
1st instar	2.95 ± 0.15	3.35 ± 0.15
2nd instar	3.75 ± 0.19	4.28 ± 0.18
3rd instar	4.84 ± 0.21	5.38 ± 0.14
4th instar	6.69 ± 0.19	7.29 ± 0.15
5th instar	7.95 ± 0.22	8.53 ± 0.22
6th instar	8.60 ± 0.18	10.45 ± 0.21
Total larval period	34.74 ± 0.45	39.38 ± 0.44
Pre-pupa	1.19 ± 0.02	1.22 ± 0.03
Pupa	7.52 ± 0.19	8.06 ± 0.19
Pre-oviposition	1.13 ± 0.02	1.21 ± 0.04
Oviposition	1.32 ± 0.03	1.41 ± 0.03
Post-oviposition	0.27 ± 0.02	0.41 ± 0.02
Adult male	2.64 ± 0.11	2.75 ± 0.13
Female	2.96 ± 0.14	3.12 ± 0.15
Total life		
male	52.6 ± 0.79	58.69 ± 0.56
Female	55.64 ± 0.69	62.14 ± 0.61

July-August and 32.96 days during August-September, respectively (Malhi and Brar, 1998). The colour of 2nd, 3rd and 4th instar larvae was creamy white, the 5th instar dirty white while that of the 6th instar was greenish yellow to yellowish white. The prolegs of abdomen were reduced and the croachets, stout and short. Head capsule was orange coloured and relatively smaller than the width of the body. The colour characters of the larvae recorded during the present study was in conformity with the description given by earlier workers like Kok and Varghese (1966) and Nishida and Tori (1970). The present study revealed pre-pupal duration as 1.22 days in the month of October-November while it was 1.19 days in the month of September-October, (Table 1) which are more or less in agreement with the report of Malhi and Brar (1998) who reported a pre-pupal range of 1.15-1.25 days. The pupal stage lasted for 8.06 days and 7.52 days (Table 1) in the month of Oct.-Nov. and Sept.-Oct., respectively where as Malhi and Brar (1998) reported 6.90 to 6.96 days pupal period while Korat and Patel (1988) had observed pupal period of 7.74 days at 27°C and 7.22 days at 30°C, respectively. The pupa were pale in the beginning gradually turn darkish brown. The tips of pupal appendages were free and partly exarate type.

The adults exhibited remarkable sexual dimorphism, male moths were smaller than the greyish brown female with 8-9 small dark spots near the tip of the forewing and five along the sub-terminal area, abdomen slender, anal end has a thin hairy structure covering dorsally. The female is straw coloured with a conspicuous single black spot at center towards lower angle of each of the fore wings and hind wings are pale straw coloured. The tip of the abdomen of female is covered with tufts of yellowish silken hairs forming a circle around a ventral opening.

The pre-oviposition, ovi-position and post-oviposition periods were on an average 1.21, 1.41, 0.41 days in the month of October-November where as it was 1.13, 1.32, 0.27 days, respectively in the month of September-October. These findings are more or less in conformity with the report of Korat and Patel (1988). The average male and female longevity moth was (2.64±0.11) 2.96 days and 2.75 and 3.12 days, in the month of September-October and October-November, respectively (Table 1). The above findings during the present study are more or less in conformity with the observation given by earlier workers like Korat and Patel (1988) and Malhi and Brar (1998). The total lifespan of yellow stem borer was recorded to be 45.08days (Korat and Patel, 1988) where as Malhi and Brar (1998) reported it as 46.35 days and 50.79 days during July-August and August-September respectively depending on the feed and weather conditions. It was observed in this study that yellow stem borer (male) completed its life cycle on an average in 52.6 days for males and 55.64 days for females in September-October and average 58.69 days for males and 62.14 days for females in October-November which is conformity with the findings of Harinkhere and Agarwal (1994) and more or less in conformity with the observation of Malhi and Brar (1998).

The average fecundity of female was recorded to be 142 and 160.7 (Table 2) in the month of Sept.-Oct. and Oct.-Nov., respectively which is more or less in conformity with the findings of Harinkhere and Agarwal (1994), Bora *et al.* (1994) and Malhi and Brar (1998) who recorded the fecundity as 120-155, 133.4 and 127-308, respectively depending on the field and

weather conditions. The number of egg masses laid by an adult, no. of eggs/eggmass, no. of larvae emerged/ eggmas, percent adult emergence were 2.2, 126.3, 108, 57.26 in the month of October-November while it was 2, 112.8, 82.6, 52.38 in the month Sept.-Oct. (Table 2) which is in conformity with the observations of Panigrahi and Rajamani (2007). The sex ratio (male:female) was found to be 1:2 and 1:1:88 (Table 2) in the month of October-November and September-October respectively which is in conformity with the findings of Bore *et al.* (1994) and Korat and Patel (1998).

showed dead heart symptoms. On 10, 20 and 30 days old seedlings larvae entered successfully and produced typical dead heart symptoms within 24 to 36 hours. However, larval growth was supported on an average for 12, 24 and 36 hours by 10, 20 and 30 days old seedlings respectively after the larval entry.

Neonate larvae failed to make entry into fully matured 150 days old mother tillers. Tillers that were at milk stage at panicle emergence stage were successfully infested and white ear heads were produced within 10 to 12 days following release of 5 larvae tiller^{-1}. Mother tillers at primodium initiation stage,

Table 2. Reproductive behaviour of yellow stem borer, *Scirpophaga incertulas* reared in the month of Sept.-Oct. and Oct.-Nov.

Reproductive behaviour	Sept-Oct.		Oct.-Nov.	
	Mean + S.Em	Range	Mean + S.Em	Range
Fecundity	142+ 36.88	88-192	160.7+ 36.47	95-202
Egg masses/Adult	2.20+ 0.774	1.0-3.0	2.2+ 0.748	1-3
No. of eggs/eggmass	112.8+8.66	97-124	126.3+5.45	119-137
No. of larvae emerged/ eggmass	82.6 + 6.54	77-94	108+5.58	101-116
% adult emergence	52.38+0.78	50.7-53.4	57.26+2.52	53.7-61.2
Sex ratio	1:1.88		1:2	

The freshly emerged larvae were highly phototropic. They first moved towards the tip of the plant and after some wandering they reached the base. They entered inside the plant tissue by making small pinholes in the lowest leaf sheath just above the water level. They took a minimum time of 18 minutes and a maximum of 70 minutes with an average of 35 minutes to reach the site and enter inside the plant tissue. Most of the larvae made individual entry holes while a few larvae to the extent of 2-3 entered through the hole made by the first larva. When the water level was increased the site of entry also raised and always remained just above the water level.

Freshly emerged larvae survived for 6 hours without any food or water. They survived for 36 hours without any plant tissue but with moisture. Under submerged condition they survived for 4 hours. Freshly emerged larvae also could float on the water surface by wriggling of abdomen.

On 5 days old seedlings neonate larvae bored into the center of the plumule but 90% of the larvae were found dead within 24 hours. Many seedlings

late vegetative stage, vegetative stage and tillering stage (45 days) resulted in typical dead heart production within 10,9,8 and 5 days after infestation respectively. Smallest secondary tillers within the hill were more infested than the relatively older primary tillers. The primary tillers in turn were more affected than the mother tiller within the hill. Average percent dead heart (DH) formed on plants at 35DAT was 19.2 for mother tillers, 28.4 for primary tillers and 34.5 for secondary tillers.

Neonate larvae could survive beyond 20 days on cut stem pieces and spike lets inside the unopened boot leaf. At 20th day of rearing survival of the larvae on spikelets was more (32.0%) than on cut stem pieces (25.0%). The larvae survived up to 8th day on the mid rib of the leaf. Soon after release the larvae entered the mid rib started feeding. Starting from 7th day onward the larvae were observed to come out of the mid rib and wander on the leaf blade frequently. When the neonate larvae were released on the cut stem with the leaf sheath removed, they could not enter the central stem piece successfully and eventually died within 5 to 8 hours. However,

larvae could survive up to 4 days on leaf sheath alone (Fig. 1).

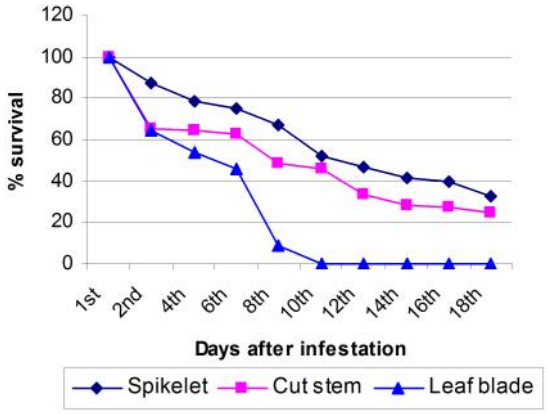

Fig. 1. Survival of neonate larvae of S. *incertulas* Wlk. on different parts of rice plant

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