

## Comparative biology of yellow stem borer, *Scirpophaga incertulas* walker, (Lepidoptera: Pyraustidae) in aerobic and transplanted rice

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### ABSTRACT

The biology of yellow stem borer, *Scirpophaga incertulas* (Wlk.) showed that eggs were oval, flattened and creamy white in both aerobic and transplanted rice. However, average length and breadth varied slightly. It was  $0.7 \pm 0.03$  mm and  $0.43 \pm 0.02$  mm in transplanted paddy and  $0.6 \pm 0.03$  mm and  $0.38 \pm 0.02$  mm in aerobic paddy, respectively. The eggs were laid in masses having an average length and breadth of  $5.9 \pm 1.41$  mm and  $3.41 \pm 0.36$  mm, respectively on transplanted paddy and  $5.6 \pm 1.36$  mm and  $3.37 \pm 0.0$  mm, respectively on aerobic paddy. The newly hatched larva was yellowish green with dark head. It passed through five instars. The full grown larva was dirty white with the length of  $20.3 \pm 1.21$  mm on transplanted paddy and  $19.9 \pm 0.30$  mm on aerobic paddy. The average length of prepupa was  $12.61 \pm 1.30$  mm on transplanted paddy and  $11.5 \pm 0.93$  mm on aerobic paddy. The pupa was pale to dark brown and was longer and broader on transplanted paddy than on aerobic paddy. Fore-wings of the adult female were yellow in colour with a distinct black spot in the centre at each fore-wing. The fore-wings of the adult male were brown with numerous small light brown spots on them. Average length and breadth of the female and male moth and their longevity were higher on transplanted paddy than on aerobic paddy. Fecundity of the female was  $159.3 \pm 39.8$  eggs on transplanted paddy and  $152.2 \pm 33.29$  on aerobic paddy. Total life cycle of the pest was  $42.8 \pm 1.73$  and  $43.8 \pm 0.67$  days, respectively on transplanted paddy and aerobic paddy.

**Key words :** Biology, Aerobic, Transplanted, Instars, Prepupa, Fecundity and life cycle

### INTRODUCTION

Rice, *Oryza sativa* L. is the most important and staple food crop for more than two thirds of the population of India and more than 65 per cent of the world population (Mathur *et al.*, 1999). Rice consumes almost 50 per cent of irrigation water and the water crisis is the greater threat to rice cultivation. Inadequate rainfall, lack of water harvesting measures, depleting of ground water, inadequate water reservoirs and misuse of water for irrigation have brought down the per capita availability of water by 40-60 per cent in Asian countries. Therefore, the future of rice cultivation mostly depends on developing and adopting technologies that would ensure efficient water use. Hence, aerobic rice cultivation is one option to enhance water use efficiency.

The yellow stem borer (YSB), *Scirpophaga incertulas* Walker (Pyralidae: Lepidoptera) of rice is one of the major pest in all rice growing regions of Asia (Listinger, 1979) and in the south east Asian region (Banerjee and Pramanik, 1967) and India in particular (Chelliah *et al.*, 1989). Unlike other rice stem borers, *S. incertulas* is well adapted to the aquatic deep-water rice environment. However, no attempts have been made so far on the comparative study between the transplanted and aerobic paddy for this pest. Studies on biology are needed to detect occurrence, early warning of the pest, identifying the peak occurrence to predetermine the time of infestation and estimating actual population density to decide insecticide applications.

### MATERIALS AND METHODS

Biological studies were undertaken in the laboratory at the Department of Entomology, University of Agricultural Sciences Bangalore, College of Agriculture, Navile Shimoga during the month of July-September, 2005-06.

Primary culture was established by collecting the pupae of *Scirpophaga incertulas* from the paddy fields and were kept in a mating cage of 17 cm diameter and 2 cm height. After the emergence, the male and female adults were allowed for mating and the mated females were released into the cage of size 50 cm x 50 cm x 70 cm containing plants of transplanted and aerobic paddy separately. After oviposition, the rice leaves containing the egg masses were clipped off and their bases were wrapped in moist cotton to keep them fresh until hatching. These were then placed on a moist filter paper in the Petriplates of diameter 10.5 cm, and were exposed for embryonic development. The dates at which eggs hatched were recorded. On hatching, first instar larvae were detected from the egg mass with the help of hand lens and collected with the help of camel hairbrush and the immature stages of the borer were reared on transplanted and aerobic paddy tillers separately following the method of Saxena *et al.* (1990). By destructive sampling method external characters of larvae at different instars, number of moults and total larval period using ocular stage micrometer and millimeter scale under stereoscopic binocular microscope were recorded.

At 25 to 30 days after infestation (DI) earthen pots containing paddy hills with white ears harbouring late larvae or pupa (pale yellow in colour, near root zone) were kept in the insect cages (50 cm x 50 cm x 70 cm) in the green house. After formation of pupa, the stems were split open to facilitate adult emergence. Pupal period was recorded as the time between formation of pupa and adult emergence. The pupa thus obtained were kept in a plastic cage (17 cm diameter and 7.5 cm length) for adult emergence.

Emerged adults, were separated as males and females and pairs of male and female were caged separately in cage containing 30 day old potted seedlings, separately for transplanted and aerobic paddy. Adults were provided with five per cent sugar solution in a cotton swabs. Observations on pre-oviposition, oviposition and post oviposition periods were recorded. The egg masses laid by the female were then collected and reared to study the incubation period, fecundity and hatching percentage. Once hatching was completed, the egg mass were dipped in 70 per cent alcohol and the hairs removed. The eggs were then separated out with the help of a fine camel hairbrush and the number of hatched and unhatched eggs were counted under a stereoscopic binocular and the hatching percentage and fecundity was calculated out. Incubation period was recorded as the time between egg laying and hatching.

## RESULTS AND DISCUSSION

The results obtained from the present investigation are summarized under following heads:

### *Egg mass:*

Egg mass is covered with brownish hairs from the anal tufts of the female. The length and width of egg masses were  $5.9 \pm 1.41$  mm and  $3.41 \pm 0.36$  mm in transplanted paddy, whereas it was  $5.6 \pm 1.36$  mm and  $3.37 \pm 0.30$  mm in aerobic rice, respectively. Similar results were obtained by Korat and Patel (1988) and Bora *et al.* (1994).

### *Egg :*

Eggs were laid with in the masses and were white, oval and flat in shape. The mean length, width and incubation periods were  $0.7 \pm 0.03$  mm,  $0.43 \pm 0.02$  mm and 6.5 days, respectively, with hatching percentage of 90.69 in transplanted paddy. Whereas, in aerobic rice these were comparatively low with  $0.6 \pm 0.03$  mm,  $0.38 \pm 0.02$  mm and 6.5 days, respectively, with hatching per cent of 88.17. However, Korat and Patel (1988) reported that the incubation period as 6.43, while it was  $6.3 \pm 0.48$  during September-October as per the reports of Bora *et al.* (1994). The slight variation in the present study may be due to change in variety and other ecological conditions.

**Table 1 : Mean morphological measurements of egg mass, egg, pupa and adult of *Scirpophaga Incertulas* reared on transplanted and aerobic rice during *Kharif* Season**

Stage	Mean morphological measurements $\pm$ S.D.	
	Transplanted paddy	Aerobic paddy
Egg Hatchability (%)	$90.69 \pm 5.74$	$88.17 \pm 6.54$
No. of eggs hatched on		
	6 <sup>th</sup> day	$73.8 \pm 19.23$
	7 <sup>th</sup> day	$71 \pm 26.6$
Egg mass length (mm)	$5.9 \pm 1.41$	$5.6 \pm 1.36$
Egg mass width (mm)	$3.41 \pm 0.36$	$3.37 \pm 0.30$
Total no. of egg masses laid	$2.3 \pm 0.48$	$2.4 \pm 0.52$
Fecundity (No. of eggs/female)	$159.3 \pm 39.82$	$152.2 \pm 33.29$
Egg length (mm)	$0.7 \pm 0.03$	$0.6 \pm 0.03$
Egg width (mm)	$0.43 \pm 0.02$	$0.38 \pm 0.02$
Pupal length (mm)		
	Male	$12.1 \pm 0.19$
	Female	$12.9 \pm 0.23$
Pupal width (mm)		
	Male	$2.19 \pm 0.02$
	Female	$2.40 \pm 0.40$
Wing expansion (mm)		
	Male	$19.1 \pm 1.02$
	Female	$27.0 \pm 1.46$
Body length (mm)		
	Male	$9.1 \pm 0.63$
	Female	$11.4 \pm 1.62$
Body width (mm)		
	Male	$2.36 \pm 0.32$
	Female	$3.1 \pm 0.08$

Data based on 10 observations

**Table 2: Larval length and head capsule width of *Scirpophaga incertulas*, in different instars reared on transplanted and aerobic rice during kharif season**

Stage		Mean larval length (mm) $\pm$ S.D		Mean larval head width (mm) $\pm$ S.D	
		Transplanted paddy	Aerobic paddy	Transplanted paddy	Aerobic paddy
Larval instars	I	2.0 $\pm$ 0.09	1.8 $\pm$ 0.07	0.25 $\pm$ 0.01	0.21 $\pm$ 0.04
	II	5.7 $\pm$ 0.62	5.4 $\pm$ 0.21	0.48 $\pm$ 0.04	0.40 $\pm$ 0.06
	III	10.1 $\pm$ 0.26	10.0 $\pm$ 0.14	0.76 $\pm$ 0.02	0.71 $\pm$ 0.05
	IV	14.5 $\pm$ 0.61	14.2 $\pm$ 0.25	0.94 $\pm$ 0.03	0.89 $\pm$ 0.01
	V	20.3 $\pm$ 1.21	19.9 $\pm$ 0.30	1.25 $\pm$ 0.02	1.12 $\pm$ 0.07
Prepupa		12.61 $\pm$ 1.30	11.5 $\pm$ 0.93	--	--

Data based on 10 observations

### Larva :

The larval period lasted for  $28.7 \pm 1.10$  days and  $28.4 \pm 1.47$  days on transplanted and aerobic rice, respectively. The first instar larva was yellowish green with dark head and was non-gregarious in feeding habit. Second, third and fourth instar larva were creamy white with black head. Whereas, last instar (fifth instar) was dirty white in colour with length of  $20.3 \pm 1.21$  mm and  $19.9 \pm 0.30$  mm on transplanted and aerobic paddy, respectively. The mean total larval period was  $28.7 \pm 1.70$  and  $28.4 \pm 1.47$  days on transplanted and aerobic paddy, respectively.

The observations on different instar duration, their size are reported here for the first time on aerobic rice. There were five larval instars and which lasted for 27.30 days as per the reports of Bora *et al.* (1994), but larval duration and body size differed, which may be attributed to change in microclimate and crop husbandry practices during the study. In contrast there were six larval instars as per Malhi and Brar (1998) on basmati.

### Pupa :

The average pupal period was  $8.6 \pm 0.49$  days and  $7.6 \pm 0.49$  days on transplanted rice and aerobic rice, respectively. However, Malhi and Brar (1998) differed with the present study, according to them the period was 6.90 to 6.96 days during July-August and August-September, respectively. This may be attributed to the change in climatic conditions, crop variety used for the study and methods of crop establishment. Similar results were reported by Korat and Patel (1988) as 7.74 days at  $21^{\circ}\text{C}$  and 7.22 days at  $30^{\circ}\text{C}$ .

### Adult :

Similar to pupa several observations on adults were made in the present study as that of the other workers, except on the aerobic rice, which was reported here for the first time. The mean duration of the adult was  $68.9 \pm 3.07$  hours for female and  $59.0 \pm 0.71$  hours for male

**Table 3: Duration of different stages of *Scirpophaga incertulas* reared on transplanted and aerobic rice during kharif season 2005-06**

Stage	Mean duration of different stages (in days) $\pm$ S.D of stem borer	
	Transplanted rice	Aerobic rice
Egg	6.5 $\pm$ 0.50	6.8 $\pm$ 0.20
Larval instars	I	5.6 $\pm$ 0.72
	II	4.5 $\pm$ 0.68
	III	5.3 $\pm$ 1.03
	IV	5.1 $\pm$ 1.12
	V	7.0 $\pm$ 0.83
Prepupal	1.2 $\pm$ 0.31	1.4 $\pm$ 0.46
Total larval period	28.7 $\pm$ 1.10	28.4 $\pm$ 1.47
Pupa	8.6 $\pm$ 0.49	7.6 $\pm$ 0.49
Total life cycle	42.8 $\pm$ 1.73	43.8 $\pm$ 0.67
Adult male duration (hr.)	59.0 $\pm$ 0.71	53.2 $\pm$ 0.81
Adult female duration (hr.)	68.9 $\pm$ 3.07	67.4 $\pm$ 2.06
Pre oviposition period (hr.)	25.6 $\pm$ 1.2	25.2 $\pm$ 0.83
Oviposition period (hr.)	23.0 $\pm$ 1.0	22.0 $\pm$ 0.71
Post oviposition period (hr.)	20.3 $\pm$ 0.87	20.2 $\pm$ 0.52

Data based on 10 observations

with fecundity of  $159.3 \pm 39.82$  eggs on paddy. While in aerobic paddy the longevity of female and males were  $67.4 \pm 2.06$  hours and  $53.2 \pm 0.81$  hours, respectively with fecundity of  $152.2 \pm 33.29$  eggs which agreed with Malhi and Brar (1998). The results of the present study slightly varies with the results of Korat and Patel (1988).

Pre-oviposition, oviposition and post oviposition period were  $25.6 \pm 1.2$ ,  $23.0 \pm 1.0$  and  $20.3 \pm 0.87$  on transplanted paddy and  $25.2 \pm 0.83$ ,  $22.0 \pm 0.71$  and  $20.2 \pm 0.52$  on aerobic paddy, respectively, which was in agreement with Korat and Patel (1988).

### Total life cycle (egg to adult emergence) :

The average total life cycle of *S. incertulas* was  $42.8 \pm 1.73$  days and  $43.8 \pm 0.67$  days, on transplanted

and aerobic paddy, respectively, which is in agreement with the Malhi and Brar (1998) who reported as  $46.35 \pm 1.60$  days during September which differed from the present study due to change in climate and rice variety used. This indicated that YSB prefers aerobic conditions than transplanted rice but the larval period, larval length and width were lower in aerobic rice may be due to difference in microclimate of the rice plant tissue under aerobic and transplanted condition.

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Received : July, 2009; Accepted : September, 2009