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Natural parasitism of eggs of yellow stem borer, *Scirpophaga incertulas* Walker (Lepidoptera: Crambidae) in rice ecosystem at Tiruchirappalli, Tamil Nadu

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ABSTRACT: Three species of parasitoids viz., *Telenomus dignus* Gahan, *Trichogramma japonicum,* Ishii and *Tetrastichus schoenobii* Ferriere were recorded from the egg masses of rice yellow stem borer, *Scirpophaga* incertulas (Walker) in a field study. The extent of parasitism was high during *Rabi* (43.33 – 93.33 %) and low during *Kharif* (0 - 40.00 %). Parasitism by *T. dignus* was maximum in October (50.00 %), *T. japonicum,* in November (23.08 %) and *T. schoenobii* in February (55.55 %). *T. dignus* and *T. schoenobii* in combination parasitized maximum number of egg masses (41.82 %). Multiple parasitism by the three species was high in December (8.33 %) and January (7.14%). Parasitic potential was maximum, when *T. schoenobii* alone parasitised the egg masses followed by *T. dignus* and *T. schoenobii* in combination. Host density in the field influenced the extent of parasitism.

KEYWORDS: Rice yellow stem borer, *Scirpophaga incertulas,* egg parasitoids, seasonal incidence

INTRODUCTION

Rice (*Oryza sativa* L.) belonging to family Poaceae is an important grain crop in the world feeding more than 50 per cent of the human population (Agrawal *et al*., 2005). Globally, it is the second most cultivated cereal crop next to wheat. India ranks first in area (43.79 m. ha) and second in production (101.96 MT) Anonymous (2018). Tamil Nadu is one among the major rice producing states in India. The productivity of rice crop is influenced by several biotic and abiotic factors. The rice crop is subjected to considerable damage by nearly 300 species of insect pests, among which only 23 species are serious (Pasalu and Gururaj, 2006). Yield loss due to insect pests of rice has been estimated to be about 25 per cent (Dhaliwal *et al.,* 2010). In India, out of the total loss incurred by different insect pests of paddy, 25 to 30 per cent damage is done by stem borer alone (Dhivahar and Dhandapani,2003). The yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) (Lepidoptera: Crambidae) is the most predominant species of stem borer in rice ecosystem in Tamil Nadu (Reuolin and

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Soundararajan, 2019). Each unit increase in white ear damage has a greater impact on rice yield (Jiang *et al.,* 2005).

Globally, rice stem borer accounts for 50 per cent of the insecticides used in rice fields (Huesing and English, 2004). Over reliance on synthetic pesticides causes ecological adversity and health related problems (Carvalho, 2017). It has also led to an exponential increase in the number of insect species developing resistance to insecticides (Sparks and Nauen, 2015) and destruction of population of beneficial insects (Jafar *et al.,* 2013). To combat this, the use of biocontrol agents has to be promoted as the best alternative to insecticides for pest management. A maximum of 95.00 per cent natural parasitism of yellow stem borer eggs by the parasitoids *Trichogramma sp., Telenomus sp.* and *Tetrastichus sp*. have been reported in rice ecosystem (Lakshmi *et al.,* 2010; Rahaman and Stout, 2019). Prasanthi *et al.* (2020) have reported the natural parasitism of YSB eggs by the parasitoid species such as *Telenomus dignus* Gahan, *Tetrastichus schoenobii* Ferriere and *Trichogramma japonicum* Ashmead. Management of yellow stem borer is easy and effective at the egg stage, as the larva is concealed inside the stem. Hence, the present study was conducted to examine the egg parasitoids of yellow stem borer and the extent of natural parasitism of eggs in the rice ecosystem at Tiruchirappalli, Tamil Nadu.

MATERIALS AND METHODS

Field study was conducted at the experimental farm of Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli District, in a Randomised Block Design during (*Kharif*) 2018 and (*Rabi*) 2019 with cv. TRY 3 and replicated thrice with a plot area of 30m^2 for each replication. The standard agronomic practices recommended by Tamil Nadu Agricultural University were adopted except the plant protection measures. Based on weather parameters obtained from the Agrometeorological Station at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, an average maximum temperature of 34.79°C and 32.11°C, average minimum temperature of 25.20°C and 22.55°C and average relative humidity of 65.14 per cent and 71.17 per cent were observed during the study in *Kharif,* 2018 and *Rabi,* 2019 respectively.

1. Parasitism of *S. incertulas* in rice ecosystem

1.1. Natural parasitism of egg mass

The egg masses of yellow stem borer were collected thrice per month with 10 days interval (30 egg masses/replication) during *Kharif,* 2018 and *Rabi,* 2019 from the field plots and kept in petri plates with moist filter paper to avoid drying of leaves. Then the egg masses were observed for the emergence of the adult parasitoids. Once emergence was completed, the egg masses were dipped in 70 per cent alcohol to remove the hairs. The eggs were then separated with a fine camel hair brush and the number of unemerged adults, hatched and unhatched eggs, were counted under a stereo zoom microscope. The emerged adult parasitoids were also observed under the stereo-zoom microscope to identify the respective species and number. The extent of parasitism of egg masses of yellow stem borer was worked out (Vennila *et al.,* 2018).

$$\text{Parasitism (\%)} = \frac{\text{No. of parasitised egg mass}}{\text{No. of sampled egg mass}} \times 100$$

The data obtained from the experiment was statistically analysed by RBD one factor analysis using a computer based AGRES software after arcsine transformation.

1.2. Relative parasitism of egg masses by parasitoids in combination or alone

The parasitism by each species (egg parasitoids recorded based on emergence) of *Trichogramma japonicum* (Ashmead), *Telenomus dignus* (Gahan) and *Tetrastichus schoenobii* (Ferriere) was assessed by the formula given below,

$$\text{Adult emergence (\%)} = \frac{a}{b} \times 100$$

Where, a- no. of egg mass with adult emerged (each species of parasitoid), b- no. of parasitized egg mass.

1.3. Parasitic potential of parasitoids in combination or alone

The parasitic potential of different species of egg parasitoids was assessed based on the hatching of yellow stem borer larvae using the formula,

$$\text{Parasitic potential (\%)} = \frac{A}{E} \times 100$$

Where, A-Number of larva emerged and E- Total number of eggs in an egg mass, which is obtained by, E= A+B+C+D, where, B-Unemerged larva, C-Emerged parasitoids and D - Unemerged parasitoids.

The parasitisation of eggs in an egg mass by each species of parasitioid was assessed (Kim and Heinrichs, 1985)

$$T.\ schoenobii\ (\%) = \frac{3C + 3D}{(A + D) + (3C) + (3D)} \times 100$$

$$T.\ dignus\ (\%) = \frac{C + D}{A + B + C + D} \times 100$$

$$T.\ japonicum = \frac{\frac{C}{2} + D}{A + B + \frac{C}{2} + D} \times 100$$

Where, A- no. of hatched stem borer larvae, B- no. of unhatched stem borer larvae, C- no. of emerged parasitoid and D- no. of unemerged parasitoid

Three host eggs are needed to complete the larval period by *T. schoenobii* whereas *T. japonicum* is tiny, so that, one to four (average of two) parasitoids developed from one host egg. Thus, in calculating the parasitic potential of *T. schoenobii*, the number of emerged parasitoids was multiplied by three. For *T. japonicum,* the number of emerged parasitoids was divided by two.

2. Seasonal incidence of yellow stem borer by light trap catches

The seasonal incidence of stem borer species was monitored using light trap to arrive at the moth population during *Kharif,* 2018 and *Rabi,* 2019. The light trap unit made of galvanised iron sheet with a trapping device and collecting chamber was installed in the field and operated from 7.00 PM to 11.00 PM. The mercury vapour lamp of 160W was used as the light source. The collecting jar with insecticide was changed every day and insects collected were counted each day and the species was assessed and sexed to arrive at the monthly mean population.

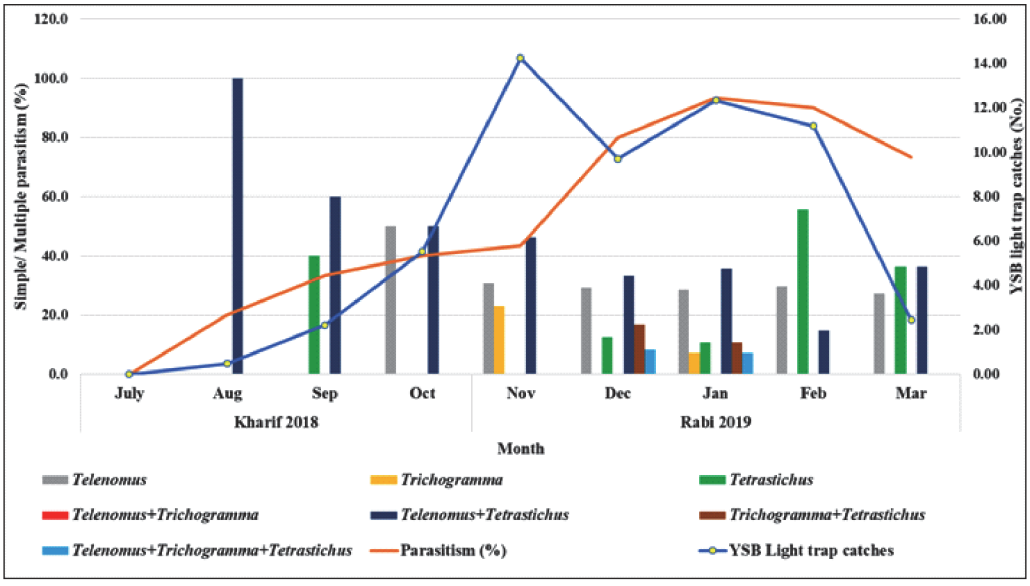

Fig. 1. Seasonal influence on yellow stem borer population and natural parasitism of egg mass

RESULTS AND DISCUSSION

Natural parasitism of egg mass of yellow stem borer

It was clearly evident from the present observations that, the parasitism of egg mass of was yellow stem borer minimum in August 2018 (16.67 %) which subsequently increased in September 2018 (33.33 %), October 2018 (40.00 %) in *Kharif,* and maximum parasitism was observed in January 2019 (93.33 %), which was on par with the parasitism in February 2019 (90.00 %) and in December 2018 (80.00 %) during *Rabi,* (Fig. 1), which varies from the early report that, peak parasitisation was observed during *Kharif,* 2018, particularly in October ranging from 75.29 to 97.56% (Varma *et al.,* 2013). Lakshmi *et al.* (2010) reported a maximum of 95.0 per cent parasitism of egg mass of yellow stem borer as against 93.33 per cent in the present study, which would be due to variations in weather parameters or repeated application of insecticides in rice ecosystem at Tiruchirappalli.

Relative parasitism of yellow stem borer egg mass by egg parasitoids, either alone or in combination

The activity of *T. dignus* was maximum in October 2018 (50.00 %) during *Kharif,* 2018 which is in agreement with the maximum parasitisation by *Telenomus* during October in *Kharif* (Varma *et al.,* 2013). The activity of *T. japonicum* was observed only during *Rabi,* 2019, in November with parasitism of 23.08 per cent of egg masses (Fig. 1). The relative parasitism of yellow stem borer egg mass by different species of egg parasitoids revealed 8.33 per cent and 7.14 per cent multiple parasitism by the three species (*T. dignus, T. schoenobii* and *T. japonicum*) during December and January of rabi respectively (Table 1). The species *T. japonicum* and *T. schoenobii* in combination parasitised egg masses (16.67 %) and *T. dignus* and *T. schoenobii* together parasitised egg masses (33.33 %) in December 2018. The maximum parasitism of egg masses was done by *T. dignus* and *T. schoenobii* in combination (41.82 %) and minimum (1.72 %) was done, when mulitiple parasitism occurred by the three species of egg parasitoids. The species *T. dignus* and *T. japonicum* did not parasitise any egg mass in combination.

The activity of *T. dignus* was maximum in October 2018 (50.00 %) followed by January 2019 (28.57 %). The parasitism by *T. japonicum* was maximum in November 2018 (23.08 %), followed by January 2019 (7.14 %). The activity of *T. schoenobii* was maximum in February 2019 (55.55 %) and March 2019 (36.36 %).

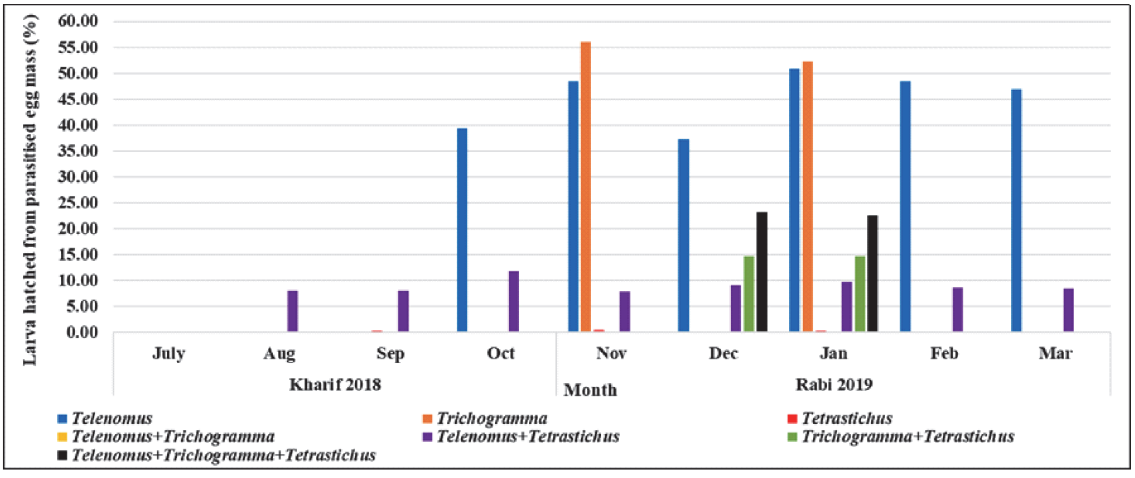

Fig. 2. Parasitic potential of different species of egg parasitoids

Table 1. Relative parasitism of yellow stem borer egg mass by egg parasitoids

Season	Month	Egg mass parasitised by species (%)*						
		Telenomus	*Tricho-gramma*	*Tetrastichus*	*Telenomus* + *Tricho-gramma*	*Telenomus*+ *Tetrastichus*	*Trichor-gramma*+ *Tetrastichus*	*Telenomus*+ *Tricho gramma*+ *Tetrastichus*
Kharif, 2018	July	0.00 (0.91)c	0.00 (0.91)c	0.00 (0.91)d	0.00 (0.91)	0.00 (0.91)e	0.00 (0.91)c	0.00 (0.91)b
	August	0.00 (0.91)c	0.00 (0.91)c	0.00 (0.91)d	0.00 (0.91)	100.00 (89.10)a	0.00 (0.91)c	0.00 (0.91)b
	September	0.00 (0.91)c	0.00 (0.91)c	40.00 (39.23)bc	0.00 (0.91)	60.00 (50.77)b	0.00 (0.91)c	0.00 (0.91)b
	October	50.00 (45.00)a	0.00 (0.91)c	0.00 (0.91)d	0.00 (0.91)	50.00 (45.00)bc	0.00 (0.91)c	0.00 (0.91)b
Rabi, 2019	November	30.77 (33.69)c	23.08 (28.71)a	0.00 (0.91)d	0.00 (0.91)	46.15 (42.79)bc	0.00 (0.91)c	0.00 (0.91)b
	December	29.17 (32.69)c	0.00 (0.91)c	12.50 (20.71)c	0.00 (0.91)	33.33 (35.26)cd	16.67 (24.09)a	8.33 (16.78)a
	January	28.57 (32.31)b	7.14 (15.50)b	10.71 (19.10)c	0.00 (0.91)	35.71 (36.70)cd	10.71 (19.10)b	7.14 (15.50)a
	February	29.63 (32.98)c	0.00 (0.91)c	55.55 (48.19)a	0.00 (0.91)	14.81 (22.63)d	0.00 (0.91)c	0.00 (0.91)b
	March	27.27 (31.48)c	0.00 (0.91)c	36.36 (37.08)ab	0.00 (0.91)	36.36 (37.08)cd	0.00 (0.91)c	0.00 (0.91)b
Mean	-	21.71	3.36	17.24	0.00	41.82	3.04	1.72
SEd	-	4.85	2.93	7.07	-	7.94	1.49	4.35
CD (p=0.05)	-	10.29	6.2	14.98	-	16.84	3.16	9.23

*Mean of three replications; Figures in parentheses are arcsine transformed values
In a column, means followed by similar letter(s) are not statistically different (p=0.05) by LSD

Parasitic potential of different species of egg parasitoids of yellow stem borer

The egg masses parasitised by *T. schoenobii* alone, had a minimum of 0.24 per cent YSB larval emergence, thus revealed that, maximum eggs in an egg mass were parasitised by *T. schoenobii* alone, followed by *T. dignus* and *T. schoenobii* in combination parasitising eggs/egg mass (8.95 % hatching) (Fig. 2). The species *T. dignus* and *T. schoenobii* together parasitised maximum number of egg masses (41.82 %), which is in contrast to the earlier report that, highest parasitisation (35.00 %) was by the combination of *T. rowani* and *T. japonicum* (Kim and Heinrichs, 1985). Maximum number of eggs in an egg mass was parasitised by *T. schoenobii,* since two to four (average of three) host eggs were needed to complete the larval period by *T.* schoenobii, which is in accordance to earlier finding that, *T. schoenobii* was the most abundant parasitoid, parasitising 95 per cent of the eggs.

Maximum number of larvae hatched from the egg mass parasitised by *T. japonicum,* since an average of two parasitoids developed from one host egg (Kim and Heinrichs, 1985). Further, maximum larval hatching was observed in the egg mass parasitised by *T. dignus* (45.21 %) and *T. japonicum* (54.16 %), since both the parasitoids parasitised only those eggs laid on the upper surface of the egg mass, allowing the remaining eggs to hatch. Such partial parasitism reduced their efficacy in controlling the stem borer. *T. schoenobii* destroyed all the eggs in an egg mass and appeared to be effective in controlling stem borer which henceforth is clear from the present study, that only 0.24 per cent larva hatched from the egg mass parasitised by *T. schoenobii* alone (Manjunath, 1990). The parasitism of eggs in an egg mass declined on the occurrence of multiple parasitism, as 22.88 per cent larvae hatched in an egg mass parasitised by the three species.

Seasonal incidence of yellow stem borer by light trap catches

The observations on the seasonal incidence of yellow stem borer adults based on light trap catches indicated that, the mean moth population of YSB reached its peak during November 2018, followed by December 2018 and January 2019 in *Rabi* (Fig. 1), which was in direct proportion with the maximum parasitism by the egg parasitoids in January 2019 (93.33 %), followed by February 2019 (90.00 %) and December 2018 (80.00 %) during *Rabi.* Justin and Preetha (2013) reported that, the infestation of *S. incertulas* was found during August to September and December to January. The relative parasitism by all the three species of egg parasitoids either alone or in combination was also observed during *Rabi,* 2019, when the pest population was more than *Kharif*, 2018. Thus, the present study indicated that, the extent of parasitism and the activity of parasitoids were influenced by the host density.

A maximum of 93.33 % of natural parasitism of the egg mass of yellow stem borer was observed, which managed the pest in the egg stage itself. Hence, in rice ecosystem, with the natural occurrence of egg parasitoids, measures must be taken to avoid insecticide spray or to spray with the insecticides safer to the parasitoids to conserve them. The parasitic potential was maximum in an egg mass parasitised by *T. schoenobii* alone, followed by *T. dignus* and *T. schoenobii* in combination. Hence augmentative measures must be taken to enhance it, for successful management of yellow stem borer with the biocontrol agents.

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