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Different hatching combinations of egg masses of yellow stem borer [*Scirpophaga incertulas* (Walker)] in rice ecosystem with special reference to emergence of egg parasitoids

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Abstract

Rice is staple food for an estimated 3.5 billion people worldwide and is regarded as “Global grain” (Gadal *et al.*, 2019) ^[1]. The yellow stem borer *Scirpophaga incertulas* (Walker) is one of the most important and widely distributed pests of rice in India. Under integrated pest management system, egg parasitoids have been employed extensively as bio control agents to check stem borer population. Recognizing the region specific naturally occurring biocontrol agents and assessing their performance under natural condition are important areas to be studied to make biocontrol strategies more sustainable. Field experiment (2024-25) conducted at UBKV revealed *Telenomus dignus* and *Tetrastichus schoenobii* were actively parasitizing yellow stem borer egg masses reaching an overall percent parasitization rate of 62.36%. Considering both the seasons, average relative abundance of *Tetrastichus schoenobii* was 56.90% and *Telenomus dignus* was 43.09%. Parasitized egg masses were found to hatch in different combinations of larva and parasitoids indicating single species parasitization as well as multiple species parasitization occurring naturally under field condition.

Keywords: Parasitoids, *Telenomus*, *Tetrastichus*, egg mass, yellow stem borer

Introduction

Rice is the third most produced agricultural product in the world. About 90% of the world's rice is produced and consumed in Asia (Khush *et al.*, 2002) ^[2]. Stem borers are among the primary pests that cause significant damage to rice crops worldwide (Shu *et al.*, 2000) ^[3]. Rice stem borers can cause economic losses of up to 60% (Rahman and Stout, 2019) ^[4]. Each unit increase in white ear damage has a greater negative impact on rice yield (Jiang *et al.*, 2005) ^[5]. *Scirpophaga incertulas* (Walker) can reduce rice yield by 38% to 50% (Prasad *et al.*, 2007) ^[6]. Controlling this pest from the early stages is crucial, as it is a monophagous pest that attacks the crop from seedling to maturity. Rice ecosystems also host a variety of beneficial insects in addition to pests. Egg parasitoids (*Trichogramma* sp., *Telenomus* sp., and *Tetrastichus* sp.) and predators (beetles, mirid bugs, earwigs, and spiders) are widely used as biological control agents against stem borers (Chakraborty, 2012) ^[7]. Reports indicate that parasitoids such as *Trichogramma* sp., *Telenomus* sp., and *Tetrastichus* sp. can naturally parasitize up to 95% of yellow stem borer eggs (Lakshmi *et al.*, 2010 ^[8]; Rahman and Stout, 2019 ^[4]). In the Terai region of West Bengal, *Tetrastichus* sp. and *Telenomus* sp. were found to be naturally occurring egg parasitoids of rice yellow stem borer (Sankeerthana, 2023) ^[9]. These were later confirmed up to species level as *Tetrastichus schoenobii* and *Telenomus dignus* (Sankeerthana *et al.*, 2025) ^[10].

Materials and Methods

Egg masses of the rice yellow stem borer, *Scirpophaga incertulas*, were collected from different paddy fields (kharif rice 2024 and boro rice 2025) within the campus of Uttar Banga Krishi Viswavidyalaya. Egg masses were collected based on as many egg masses available at the time of sampling from randomly selected fields (Manjunath, 1990) ^[11]. While collecting, a portion of the leaf containing the egg mass was also taken and stored separately in plastic pouches.

These pouches were carried to the laboratory of the department of Agril Entomology for further examination. Each egg mass was observed under a stereozoom microscope (Olympus SZX7) and transferred into a plastic container covered with a white cloth secured by a rubber band. To maintain humidity, a moist cotton swab was placed inside each container. The samples were kept undisturbed until the emergence of parasitoids or pest larvae or both. Emerged larvae or parasitoids were killed and preserved in 70% alcohol after 24 hours of emergence. The containers were properly labeled and stored for further identification and counting. Observations were recorded on the hatching pattern of each egg mass. All emerging individuals were counted and recorded separately.

Count data on the following parameters were recorded under laboratory condition from fortnightly collected YSB egg masses

- Total number of collected egg masses
- Number of hatched egg masses
- Number of egg masses hatched into YSB larvae only per fortnight
- Number of egg masses hatched into only parasitoids (single species)
- Number of egg masses hatched into only parasitoids (multiple species)

- Number of egg masses hatched into both larvae and parasitoids (single species)
- Number of egg masses hatched into both larvae and parasitoids (multiple species)
- Number of larvae or parasitoids or both hatched from each egg mass

Calculating percent parasitism of YSB egg masses

The data was used to generate the percentage parasitism of egg masses. To determine the percent parasitism, the total number of egg masses collected and the number of parasitized egg masses were noted. The degree of parasitism in yellow stem borer egg masses was determined (Vennila *et al.*, 2018)^[12].

Parasitism (%) = (Number of parasitized egg masses / Number of sampled egg masses) × 100

Results and Discussion

Percent hatching and percent parasitism

During the entire study period, a total of 282 egg masses were collected from kharif rice (2024) and 59 egg masses were collected from the boro rice (2025).

Table 1: Number of collected YSB egg masses, hatched egg masses, percent hatching and percent parasitization recorded from kharif rice 2024 and boro rice 2025

Crop	No. of Egg Masses Collected	No. of Egg Masses Hatched	% Hatching	No. of Parasitized Egg Masses	% Parasitization
Kharif Rice 2024	282	167	59.21%	151	53.54%
Boro Rice 2025	59	42	71.18%	42	71.18%
Total / Avg	341	209	65.18%	193	62.36%

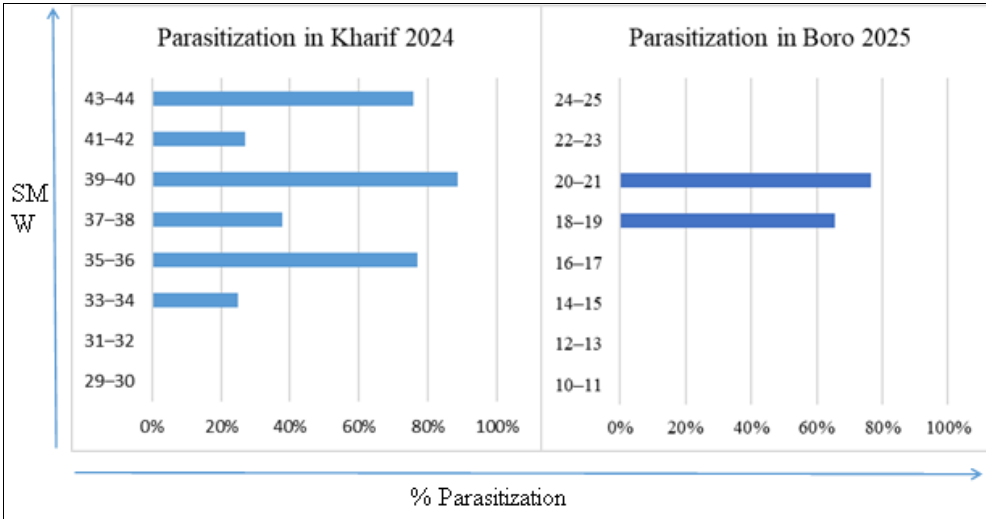


Fig 1: Percent parasitization of egg masses in kharif rice 2024 and boro rice 2025

In the present study the percent parasitism of egg masses ranged from 0% - 88.64% in kharif 2024 with highest parasitization occurring during 39th to 40th SMW. In case of boro paddy, the parasitoids were found to become active for a very short span and percent parasitization ranged from 0% to 76.67% with peak parasitization occurring during 20th to 21st SMW. The overall parasitization of egg masses was quite high for both the seasons. Considering both the seasons together, the average hatching percentage was 65.18% and percent parasitism was recorded as 62.36%. The reason behind this seasonal variation may be due to difference in the availability of host eggs during both the seasons. During Kharif, as there were abundant paddy crops

growing inside the campus, availability of YSB egg masses were also abundant. For this, the parasitoids got many host egg masses and the value of percent parasitization was moderate (53.54%). In contrary, boro rice was grown in limited amount of land restricting the availability of both rice crop as well as YSB egg masses for parasitization. The parasitoids targeted the limited amount of available egg masses pushing the percent parasitization rate at higher level in boro rice (71.18%). This study suggests that level of parasitization depends on availability or density of host insect's egg masses present in the field. Rauf (2000)^[13] from Indonesia has also documented similar observation reporting a high level of parasitism of egg mass

reaching as high as 85% in case of white stem borer on rice. Manjunath (2023)^[11] also observed that the parasitoids typically record a high rate of patriotization of egg masses and may often reach 100% but the parasitoids are unable to parasitize all eggs laid in the egg masses leading to partial patriotization of egg

masses. This observation also supports the finding of Sharmitha *et al.* 2020^[14] who documented that host density in the field influenced the extent of parasitism.

Relative abundance

Table 2: Numbers of sampled YSB egg masses, parasitized egg masses, larvae hatched and total number of parasitoids hatched from egg masses collected from kharif rice (2024) and boro rice (2025)

Crop	Egg masses		YSB larvae hatched	Telenomus hatched	Tetrastichus hatched	Total parasitoids hatched
	Sampled	Parasitized				
Kharif rice	282	151	1191	2018	1902	3920
Boro rice	59	42	57	830	1561	2391

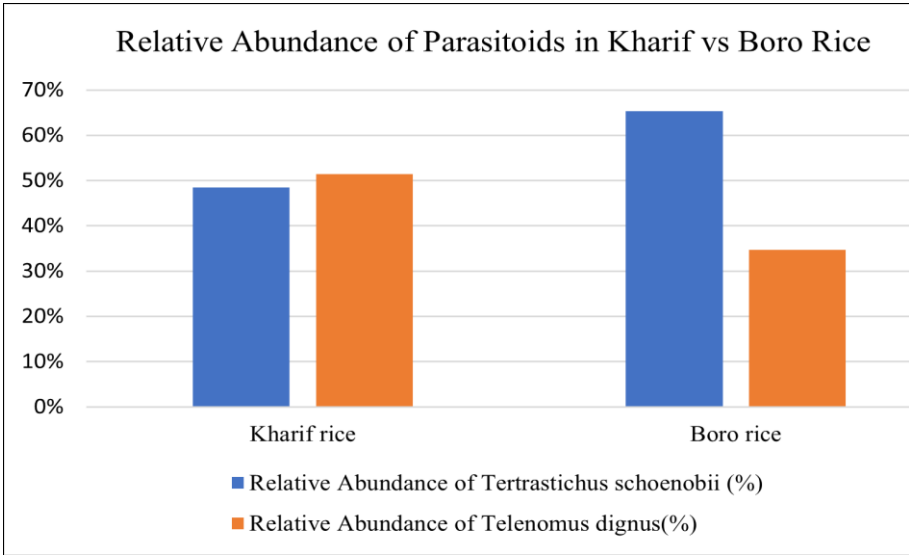


Fig 2: Relative abundance of *Telenomus dignus* and *Tetrastichus schoenobii* in kharif rice 2024 and boro rice 2025

Different hatching combinations

The percentage of egg masses hatching into only larvae was 8.38% which signifies that the percentage of unparasitized egg mass was quite low. 15.57% egg masses hatched into larvae + *Telenomus dignus* and 0.59% egg masses hatched into larvae + *Tetrastichus schoenobii* indicating occurrence of partial parasitization of eggs in egg masses. 1.79% of the egg masses hatched into larvae + *Telenomus dignus* + *Tetrastichus schoenobii* indicating partial but multiple parasitization. Percentage of egg masses hatching into only *Telenomus dignus* and only *Tetrastichus schoenobii* was 32.34% and 30.53% respectively which indicate single species parasitization. Only

10.77% egg masses hatched into join parasitization by *Telenomus dignus* and *Tetrastichus schoenobii* where there was no larval emergence indicating full destruction of YSB larvae. In case of boro rice (2025) also there were different combinations of egg mass hatching. Egg masses hatching into larvae + *Telenomus dignus* combination was 14.29% and larvae + *Tetrastichus schoenobii*, was 7.14% which indicate partial parasitization allowing larval emergence. No egg mass hatched into larvae + *Telenomus dignus* + *Tetrastichus schoenobii* combination. Under single species parasitization, egg masses hatching into *Telenomus dignus* alone was 19.05% and *Tetrastichus schoenobii* alone was 59.52%.

Table 4: Percentages of egg masses hatching into different combinations collected from kharif rice 2024

Different hatching combinations	Numbers of egg masses hatched into Different combinations (Total=167)	Percentages	Emergence of...	Mean±SD
Larvae only (Unparasitized)	14	8.38%	Larvae	57.50±41.64
Larvae+Tele	26	15.57%	Larvae	14.04±13.22
			Tele*	16.77±12.42
Larvae+Tetra	1	0.59%	Larvae	1.0
			Tetra**	21.00
Larvae+Tele+ Tetra	3	1.79%	Larvae	6.67±5.03
			Tele*	11±7.94
			Tetra**	9±8.58
Tele only	54	32.34%	Tele*	24.15±15.67
Tetra only	51	30.53%	Tetra**	28.67±16.29
Tele+Tetra	18	10.77%	Tele*	9.78±7.90
			Tetra**	20.89±16.26

Tele* - *Telenomus dignus* Tetra** - *Tetrastichus schoenobii*

Table 5: Percentages of egg masses hatching into different combinations collected from boro rice 2025

Different hatching combinations	Numbers of egg masses hatched into combinations (Total=42)	Percentages	Emergence of.	Mean±SD
Larvaeonly (Unparasitized)	0	0	Larvae	-
Larvae+Tele	6	14.29%	Larvae	8.67±4.32
			Tele*	69.33±18.35
Larvae+Tetra	3	7.14%	Larvae	1.33±0.58
			Tetra**	82.67±12.66
Larvae+Tele+ Tetra	0	0	Larvae	-
			Tele*	-
			Tetra**	-
Tele only	8	19.05%	Tele*	51.75±15.49
Tetra only	25	59.52%	Tetra**	52.52±15.88
Tele+Tetra	0	0	Tele*	-
			Tetra**	-

Tele*-*Telenomus dignus* Tetra**-*Tetrastichus schoenobii*

Conclusion

The egg masses of rice yellow stem borers were found to be naturally parasitized by two different species of parasitoids under field condition and the overall rate of parasitization was quite high. But a close observation on different hatching patterns revealed partial parasitization of egg masses either by a single species of parasitoid or by multiple species of parasitoids.

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