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Prospective of *Telenomous remus* (Nixon) (Hymenoptera: Scelionidae) as natural egg parasitoid and its developmental biology on *Scirpophaga incertulas* (Walker)

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ABSTRACT

Collection of egg masses of yellow stem borer, *Scirpophaga incertulas* (Walker) from three different rice growing areas of Dehradun was carried out during *kharif* 2021 and 2022 on weekly interval. The study was conducted to determine the percent natural parasitization of *S.incertulas* eggs by various egg parasitoids. Results revealed that during both years of study and at all the three study locations, only one egg parasitoid, *Telonomus remus* was recorded, causing parasitization of *S. incertulas* eggs. Activities of other egg parasitoids like *Tetrastichus* spp. and *Trichogramma* spp. were not detected in both seasons of year 2021 and 2022, under natural conditions and in the absence of augmentative release. Comparative analysis of our results shown that maximum parasitization of *S. incertulas* egg was found from Vikasnagar (50.23%), as compared to Doiwala (44.24%) and Mehuwala (42.54%) areas from fourth week of August to first week of September 2022. When we compare results from both the year of study, then it is concluded that during *kharif* 2022 percent parasitization was higher than 2021. The mean incubation period of *T. remus* eggs was 2.12 days, while larval and pupal stages were completed in 4.53 and 3.29 days, respectively. Longevity of adult female is higher (2.87) than adult male (1.76).

Key words: *Rice, Egg Parasitoids, Biology, Telonomus remus, Scirpophaga incertulas*

Introduction

Rice is one of the most vital food commodities in the world. In recent years, rice production has faced some unforeseen challenges in term of yield and quality of produce. The overall output in rice cultivation have been declining for many years, despite the fact that the demand from world's populations is always rising (Yadev and Kumar, 2018; Bin Rahman and Zhang, 2023). According to the most recent fore-

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casts from the UN Population Division, the present century will be marked by a similar rising trend of problems in rice cultivation (United Nations Department of Economic and Social Affairs, 2019).

Insect pests like yellow stem borer, *Scirpophaga incertulas* (Walker) have a significant negative influence on rice productivity and accounting for about 11.2 to 71.7% of yield losses due to dead heart and white ear formation (Krishnaiah and Varma, 2012; Heinrichs and Muniappan, 2017; Babendreier *et al.,* 2020).

During recent years, the incidence of insect pests in rice have increased as a result of the rapid expansion of the area planted under high-yielding cultivars and the rising use of chemical fertilizers and broad spectrum insecticides. Insecticides used carelessly during paddy cultivation can destroy natural enemies and disrupt the natural ecosystem's delicate equilibrium and contaminate the harvested food (Sreeramulu *et al*., 2015; Chintalapati *et al.,* 2023).

To tackle this, the greatest alternative to synthetic chemical insecticides must be conservation and release of insect biocontrol agents. Various studies reported that *Trichogramma* spp., *Telenomus* spp., *and Tetrastichus* spp. have been shown to naturally parasitize yellow stem borer eggs to a maximum of 95 percent in the rice ecosystem (Chadramohan and Chelliah, 1990; Lakshmi *et al.,* 2010; Rahaman and Stout, 2019; Manju *et al.,* 2002; Ghosh, 2003). According to Satpathi *et al.,* (2005); Parra and Coelho (2019), the most significant single cause of death for the immature stages of the rice yellow stem borer is egg parasitism caused by *Telenomus remus*. In contrast *Trichogramma* spp. was not found in rice ecosystem during *kharif* season in Uttarakhand rice growing areas under natural conditions (Puspakumari and Tiwari, 2005; Pathak and Tiwari, 2006).

Oktaviani *et al.* (2021) stated that the immature stage of *T. remus* reached 8.13 days, the longevity of the male was 10.07 days, while a female lived for 10.29 days with a fecundity of 75 eggs, and a sex ratio of male and female was 1:2.16.

The present study was planned and conducted in order to create conservation strategies for natural enemies in rice agro-ecosystem and to promote non chemical methods of insect pest management.

Materials and Methods

The study was carried out at three different rice growing areas of Dehradun districts in Uttarakhand, India. Dehradun experiences a humid subtropical climate. Summer time temperatures can reach up to 44 °C for a few days. An average of 2,073.3 mm of rain falls on this region is experienced each year. The rainiest months are July and August, which receive the majority of the annual precipitation.

Natural parasitism of *S. incertulas* Eggs

Three different rice belts of Dehradun viz. Doiwala, Mehuwala, and Vikasnagar were selected for study on weekly interval to determine the extent of natural parasitization of yellow stem borer, *S. incertulas* (Walker) eggs by various egg parasitoids inhabiting rice ecosystem. During *kharif* of year 2021 and 2022, definite number of egg masses of *S. incertulas* were collected from each location mentioned above. Collection of egg masses was started about three to four weeks after the transplanting of rice. As per the description given by Kim *et al.* (1986), collected egg masses were placed singly in petri plates with filter paper and covered with an 11 x 10 cm plastic funnel inserted into a 6.5 x 7.0 cm vial to keep the parasites alive. To facilitate hatching and subsequent studies, the egg masses were incubated in Entomology laboratory, School of Agricultural Sciences, SGRR University, Dehradun.

A stereo zoom microscope was used to study each egg mass after hatching. The identification of parasitoids was done as per the identification key given by Goulet H. and Huber, (1993). To determine the percentage of parasitized eggs of *S. incertulas* from various locations and throughout various times of the *kharif* season, the hatched larvae of *S. incertulus* and emerged adult egg parasitoids of *Telenomus* spp etc. were counted separately from each egg mass. The following formula was used to compute the percent of parasitized eggs:

Per cent egg parasitization =

$$\frac{\text{Total number of egg parasitoids emerged}}{\text{Total larvae emerged} + \text{Total egg parasitoids emerged}} \times 100$$

Biology of *T. remus*

Egg masses of *S. incertulas* along with rice leaf tips were collected from various rice fields in the study area. These egg masses were taken to Entomology laboratory, School of Agricultural Sciences, SGRR University, Dehradun, where they were housed in plastic containers with wire mesh for optimal aeration until emergence of adult *T. remus* started. The laboratory has an average humidity and tempera-

ture of 70% and 25°C, respectively. Cotton swab soaked in a 50% honey water solution was placed in each plastic container as food for adults of egg parasitoid.

To study the biology, adults of *T.remus* were released into vials having freshly laid un –parasitized egg mass of *S. incertulas* for parasitization process. The *S. incertulas* egg mass was slightly dissected twice daily with a sharp pin one day after the introduction of the *T.remus* adults so that different developmental stages of the parasitoid could be seen under a stereo-zoom microscope.

Results and Discussion

The results of study regarding natural parasitization (%) of *S. incertulas* egg masses by different egg parasitoids during *kharif* 2021 and 2022 at different localities of Dehradun are presented in Table 1 & 2.

Table 1. Per cent natural parasitization of *S. incertulas* eggs by *T.remus* at different rice growing areas of Dehradun during *Kharif*-2021

Date	Per cent natural parasitization of *S. incertulas* eggs		
	Doiwala	Mehuwala	Vikasnagar
13-8-2021	28.58	30.19	8.47
20-8-2021	12.72	43.93	0.00
27-8-2021	27.41	31.05	32.70
03-9-2021	14.51	29.57	30.77
10-9-2021	21.12	56.09	40.45
17-9-2021	4.00	0.00	9.89
24-9-2021	0.00	0.00	62.56
1-10-2021	13.28	21.87	4.35
8-10-2021	7.78	32.50	30.37
15-10-2021	19.48	30.63	45.90
Mean	14.89	27.58	26.55
S.Em.±	4.34	7.93	13.73
CD at 5%	12.16	22.20	38.46

During *kharif* 2021 mean level of *S. incertulas* egg parasitization was significantly low at Doiwala area (14.89%) as compared to Mehuwala (27.58%) but was *at par* with Vikasnagar (26.55%). During *kharif* 2022, mean level of parasitization was low at Mehuwala (26.43%) as compared to Doiwala (33.99%) and Vikasnagar (31.85%), from where almost same level of parasitization was recorded.

At Doiwala, maximum egg parasitization (28.58%) was reported during second week of August in *kharif* 2021, but it became nil when fourth week of September (0.0 %) approaches. At

Table 2. Per cent natural parasitization of *S. incertulas* eggs by *T. remus* at different rice growing areas of Dehradun during *Kharif*-2022

Date	Per cent natural parasitization of *S. incertulas* eggs		
	Doiwala	Mehuwala	Vikasnagar
20-8-2022	32.14	29.00	28.09
27-8-2022	44.24	42.54	30.93
03-9-2022	39.76	42.01	50.23
10-9-2022	41.83	21.94	44.44
17-9-2022	17.70	10.07	26.67
24-9-2022	37.44	31.44	31.92
1-10-2022	33.04	19.86	13.99
8-10-2022	27.75	20.92	15.43
15-10-2022	32.01	20.05	44.96
Mean	33.99	26.43	31.85
S.Em.±	5.66	9.80	16.98
CD at 5%	15.88	27.50	47.64

Mehuwala and Vikasnagar maximum activity of *T.remus* was observed during second (56.09%) and fourth week (62.56%) of September 2021 ,respectively. At the end of season the Vikasnagar study area presented maximum activity of egg parasitoid in rice crop (45.90%) as compared to Doiwala (19.48%) and Mehuwala (30.63%). It is important to note down that during fourth week of September 2021 percent egg parasitization at Doiwala and Mehuwala study areas was nil. It may be due to indiscriminate use of insecticides or may be attributed to some other unknown crop cultivation operation.

Table 2 indicates that during *kharif* 2022 at all the study locations *S.incertulas* egg parasitization was noticed during entire study period from third week of August till October 2022. Comparative analysis of all the locations revealed that maximum parasitization of *S.incertulas* egg was obtained from Vikasnagar (50.23%) as compared to Doiwala

Table 3. Life stage duration of *T. remus* under laboratory conditions at Entomology Laboratory, School of Agricultural Sciences, SGRR University, Dehradun.

S.N.	Life stage	Mean duration (days)
1.	Egg	2.12
2.	Larva	4.53
3.	Pupa	3.29
4.	Adult Male	1.76
5.	Adult Female	2.87
6.	Total Duration Male	11.70
7.	Total Duration Female	12.81

(44.24%) and Mehuwala (42.54%) areas from fourth week of August to first week of September 2022. When we compare both year of study, then it is concluded that during *kharif* 2022 percent parasitization was higher than 2021.

During both the years of study maximum activities of *T. remus* was found in second week of September, while minimum activities was observed in third week of September. Present findings are supported by the observations of Pushpakumari and Tiwari (2005), Pathak and Tiwari (2006), who also found that egg masses of YSB were parasitized by *T. remus* only while *Tetrastichus* spp. and *Trichogramma* spp. were not found in any rice agro-eco system of study area. Some other reports also indicate that *Telenomus* spp. are dominant parasitoid in most of the rice agro-ecosystem of India (Manju *et al.*, 2002; Satpathi *et al.,* 2005; Kiruthika *et al.,* 2022).

In our findings only *T.remus* egg parasitoid was observed in all the egg samples collected from Doiwala, Mehuwala, and Vikasnagar during both years of study. No other egg parasitoid like *Tetrastichus* spp. and *Trichogramma* spp. was detected in any of the parasitized egg mass collected. Our study is in contrast to the results published by different workers, who reported that *Trichogramma* spp., and *Tetrastichus* spp. were naturally parasitizing yellow stem borer eggs to a maximum of 95 percent in the rice ecosystem (Chadramohan and Chelliah, 1990; Manju *et al.,* 2002; Ghosh, 2003; Lakshmi *et al.,* 2010; Rahaman and Stout, 2019).

It is also clearly shown in our findings that percent parasitization of *S.incertulas* eggs caused by *T. remus* was not uniform in rice fields of all the three rice growing areas located at Dehradun. It may be due to difference in prevailing abiotic environmental stressors, host–parasite interaction, specific agronomic practices and other biotic factors also including human intervention.

Results regarding the developmental biology of *T. remus* are preseted in table 3. It is shown in our findings that *T. remus* consists of four life stages viz. egg, larva, pupa, and adult. The mean incubation period of egg stage is 2.12 days while larval and pupal stages were completed in 4.53 and 3.29 days, respectively. Longevity of adult female is higher (2.87) than adult male (1.76) . The average longevity of insect from egg to male adult was 11.7 days while it was 12.81 days in case of female parasitoid. Study conducted by Oktaviani *et al.* (2021) on biology of *T. remus* are in line of our findings.

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Conflict of interest

We have no conflict of interest with any person regarding the title of paper or concept behind the study or methodology adopted in completion of this research paper.

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