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Egg Mass Density Dependent Parasitoids of Rice Yellow Stem Borer, *Scirpophaga incertulas* (Walker) (Lepidoptera: Pyralidae)

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A B S T R A C T

Rice, (*Oryza sativa* L.), is liable to infestation with several insect pests, from which the rice stem borer, *Scirpophaga incertulas* (Walker) (Lepidoptera: Pyralidae) is one of the most destructive and widely distributed throughout the india. To determine the extent of parasitization of yellow stemborer egg masses, the egg masses were randomly collected at weekly intervals depending on the availability from rice fields, and brought to the laboratory for collection of emerging parasites. The per cent egg parasitism was calculated based on the emergence of stem borer larvae or adult parasitoids. We found three species of hymenopterous parasitoids-*Tetrasticus schoenobii, Telenomus* spp., and *Trichogramma japonicum* from the observations of three consecutive experimental years. Among three, *T. Shoenobii* was predominant and remained active for the longer period as compared to *Telenomus* sp. and *T. Japonicum. In the present study peak activity of T. Shoenobii (73 % in 2015-16; 72.67 in 2016-17 & 77.33 % in 2017-18) was found during first week of September, when the stem borer egg mass density was high (1.6 – 5.3 /sq.mt).* The yellow stem borer egg parasitoid population followed a linear trend in relation to the availability of the YSB egg masses. Peak activity of *Tetrastichus* was noted when the egg mass density was high during first week of september, and the *Tetrastichus* activity was declined with the decrease in stem borer egg mass density.

Introduction

Rice is one of the important cereal crops of the world and forms staple food for more than 50 per cent of the world population and 85 % Indian population. In India rice is grown over an area of 43.86 million hectares, with a production of 1018.8 million tonnes (Agricultural Statistics at a glance- 2015). In Andhra Pradesh rice is cultivated in about 2.21million hectares with a production of 12.69 million tonnes and productivity of 5.72 t/ ha (Agricultural Statistics at a glance-2018). India's rice productivity demeans due to both abiotic and biotic constraints. Among the different insects associated with rice, the yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) (Lepidoptera: Pyralidae) is one of the most destructive and widely distributed throughout the india (Banerjee,

1967, Torii, 1967 and Panda, 1976). Its life cycle and nature of damage create complexicities for the control. As an alternative to chemical control or as part of Integrated Pest Management (IPM) programs, there is a resurgence of interest in the use of parasitoids to suppress the *S. Incertulas*. Early destruction of yellow stem borer egg masses by encouraging the field parasitoid population is essential to maximize yield with least toxic chemical input usage (Gupta *et al.*, 1985). Though, both natural and applied biological control measures are equally important in successful management of pest populations, there has been a shift in emphasis from the introduction of exotic parasites and predators to the recognition of the importance of naturally occurring biological control agents and this approach is gradually becoming one of the major topics in applied entomology (Weber and Lundgren, 2009).

About 60 per cent of the insect-pest control by nature and achieved by the natural enemies. Many workers reported the population regulation of YSB at high density level by the action of egg parasitoids (Pathak, 1968, Nishida and Wongsiri, 1974 and Subba Rao *et al.*, 1983).

Earlier investigations shown that, among the natural enemy complex, egg parasitoids were most predominant than those attacking other developmental stages of yellow stem borer, *S. Incertulas* (Rao, 1972, Israel and Padmanabhan, 1978 and Chandramohan and Chelliah, 1990). Hence, present investigation was carried out to assess the extent of egg parasitism by indigenous egg parasitoids of yellow stem borer, which can become a tool as natural sustaining parasitoids and provident by virtue of their significance in integrated pest management. The natural enemies of YSB and the influence of host density on the abundance of egg parasitoids are discussed in the paper.

Materials and Methods

Field study was carried out in three consecutive crop years (2015, 2016 and 2017) during Kharif season at Agricultural Research Station, Nellore (14º 27' N, 79 º 59' E, 20 m above sea level), Andhra Pradesh, India. Soil type in the study area is Red soils/Alluvial soils (PH: 7.9 to 8.1). The mean annual maximum and minimum temperatures are 33.6 and 25.6 ºC, respectively with annual precipitation of 1040.7 mm.

The stem borer, *S. Incertulas* egg masses were collected from pesticide free plots at weekly intervals in a crop season depending upon the availability of egg masses. At each time egg masses were collected at random covering all directions to obtain 100 egg masses. During the egg mass collection process, each egg mass containing leaves were cut of 2 cm length, the collected egg masses were brought to the laboratory and placed individually in separate plastic vials (15 cm long and 2.5 cm wide) plugged with cotton wool at room temperature 80$\pm$5 % relative humidity and observed periodically for emergence of adult parasitoids.

The parasitoids were emerged from parasitized eggs and the first instar larvae of *S. Incertulas* hatched from un-parasitized eggs, were counted for determination of extent of egg parasitism. Per cent parasitism was computed based on No. of egg masses collected and no.of egg masses from which parasitoids emerged. Parasitoids emerged were identified with the help of key published in the form of booklet (Shepard *et al.*, 1987). The egg parasitism was calculated based on the emergence of larvae or adult parasitoids.

Results and Discussion

Extent of parasitization of rice yellow stem borer, *Scirpophaga incertulas* egg masses was

assessed for three consecutive years (2015-16, 2016-17 and 2017-18) in insecticide untreated rice fields at Agricultural Research Station, Nellore, Andhra Pradesh, India. Our observations confirmed the presence of three species of hymenopteran parasitoids of *S. Incertulas*, namely *Tetrastichus shoenobii* Ferriere, *Telenomus sp. and Trichogramma japonicum* Ashmead (Catling 1983, Nickel, 1964). The comparative parasitization by different parasitoids in 2015-16, 2016-17 and 2017-18 is shown in Table 1. The highest level of parasitization was by *Tetrastichus* wihch ranged from 42.17 % in 2017-18 to 39.54 % in 2016-17. In Bangladesh, Catling (1979) found an average of 75.5% of egg masses and 49.7% of eggs were parasitized. *T. schoenobii* was the most important parasitoid. Catling *et al.,* (1983) reported a similar situation for deepwater rice in Bangladesh, where 61-89% of yellow stem borer egg masses were parasitized. *Tetrastichus schoenobii* emerged in a single spell starts from first week of September (24 %) and reached peak during 4th week of September (83 %), parasitisation continued till 4th week of October (Fig. 1). Among naturally occurring egg parasitoids, *T. Schoenobii* was the predominant (Chakraborty, 2012; Chandramohan and Chelliah, 1990) and parasitization by the remaining two parasitoids was less than 10 per cent.

The level of parasitization by *Telenomus* spp. ranged from 2.79 during 2015-16 and 1.83 during 2017-18 (Table 1). It emerged in one spell starting from 1st week of September (0.67 %) till October 3rd week (2 %) peaking in 4th week of September (6 %) (Fig. 2) (Kumar and Singh, 2016). The level of parasitisation by *T. japonicum* ranged from 3.96 % in 2015-16 and 3.54 % in 2016-17. Parasitization occurred in a single spell starts form 1st week of September (0.67 %) and continues till 4th week of October (2 %) and reached peak in 4th week of September (9 %) (Varma *et al.,* 2013). On the IRRI farm in the Philippines, egg parasitism by *T. schoenobii, T. rowani*, and *T. japonicum* averaged 84, 42 and 24 per cent, respectively (Kim *et al.,* 1986).

This might be attributed to the high level of infestation of yellow stem borer on rice during September month (Manju *et al.,* 2002, Hikim 1979) as well as the crop was maintained without any agricultural inputs and free from any pesticidal applications (Mathur, 1999) when the egg masses were kept in vials, large number of parasitoids were emerged rather than the stem borer larvae. These natural enemies particularly egg parasitoids may exert important evolutionary pressure on yellow stem borer and keep the infestation of *S. Incertulas* under control.

In the present study the periods of parasitoids emergence was form September till October with no emergence in November, December and January, the winter months. This confirms the fact that parasitoids become less active during winter months. Gupta *et al.,* 1985 reported that stem borer egg parasitization by *T. Schoenobii* was high during kharif than Rabi. It was further confirmed by Lakshmi *et al.,* (2010), that *T. Schoenobii* was prevalent from September to November where as *Trichogramma* and *Telenomus* from September to October, but the activity of egg parasitoids decreased during November.

High level (47.63% in 2015-16; 45.95% in 2016-17 and 48.67 in 2017-18) of cumulative egg parasitization of *S. Incertulas* (Lakshmi *et al.,* 2010; Senapati *et al.,* 1999) emphasized the need to have more truely integrated pest management approached against YSB on rice. This will create opportunities for increased inclusion of biologically base pest management strategies using the three parasitoids (Fig. 3).

Table.1 Comparative parasitisation by three parasitoid during the periods 2015-16, 2016-17 and 2017-18

Parasitoid	family	Parasitisation (%) Mean±SD		
		2015-16	2016-17	2017-18
Tetrastichus shoenobii	Eulophidae	40.88±9.98	39.54±7.32	42.17±6.59
Telenomus spp.	Scelionidae	2.79±2.13	2.83±2.16	1.83±1.11
Trichogramma japonicum	Trichogrammatidae	3.96±3.07	3.54±2.66	4.67±2.66
CD (P=0.05%)		7.745	7.634	9.148

Fig.1 Parasitisation by *Tetrastichus shoenobii* during the periods 2015-16, 2016-17 and 2017-18

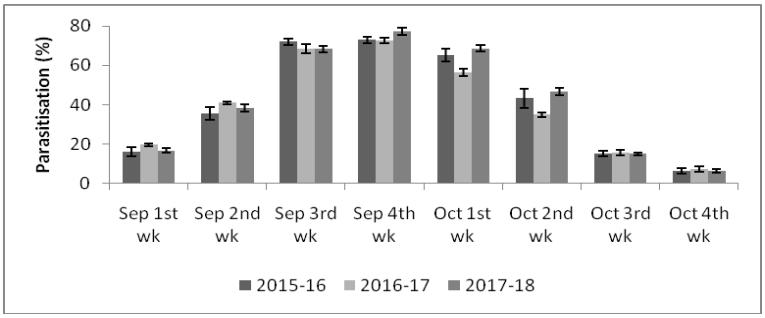


Fig.2 Parasitisation by *Telenomus* spp. during the periods 2015-16, 2016-17 and 2017-18

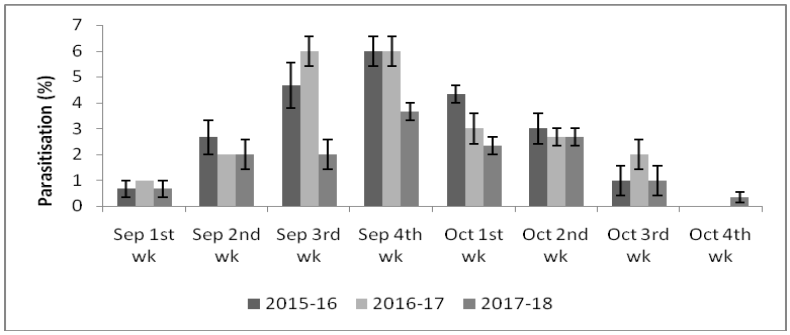
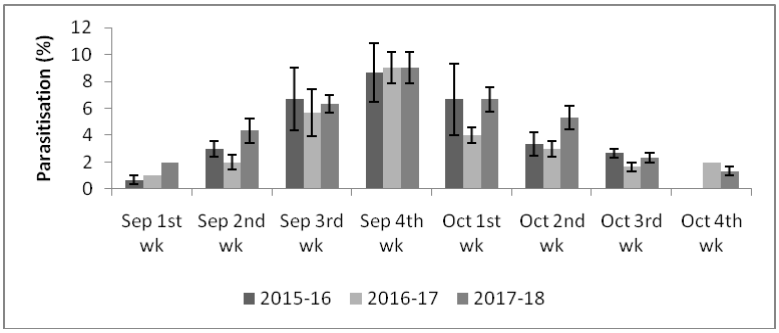


Fig.3 Parasitisation by *Trichogramma japonicum* during the periods 2015-16, 2016-17 and 2017-18



In the present study, peak activity of *Tetrastichus* was seen during September and October months. The stem borer egg mass density in the above months ranged from 1.6 to 5.3 per square meter with a slow increase in egg mass density from first week of September to 4th week of September followed by decline in the subsequent periods. In the other periods, the egg mass density was from 0.1 to 0.15 per square meter.

The highest (73 % in 2015-16; 72.67 % in 2016-17 and 77.33 % in 2017-18) egg parasitism of *Tetrastichus* was recorded following the higher egg population in the fourth week of September (Kumar and Singh, 2016). Increased level of *Tetrastichus* parasitism with corresponding increase in host density was earlier reported by many workers (Rao, 1929; Nickle, 1964; Catling *et al.*, 1983; Kim *et al.*, 1986; Pandya *et al.*, 1995 and Ramanamurthy 2001). Manju *et al.*, 2002 also noted that abundance of egg population was positively correlated with the extent of parasitism.

As reported in many studies, activity of YSB egg parasitoids is seasonally allied, egg mass size dependant, and paddy growth stage specific (Chakraborty, 2012, Shepard and Arida, 1986) and in the present study it was proved, parasitoids acted in a density dependent manner.

Further, it was observed that there was larval survival in egg masses parasitized by *T. Japonicum* but very rarely live larvae were recorded form egg masses parasitized by *Telenomus* and *Tetrastichus*. Mostly the egg masses were parasitized either by single or two parasitoid species. Occationally all the three parasitoid species were observed in a single mass. Chakraborty (2012) also reported parasitization of yellow stem borer egg mass by more than one species.

Based on the observations of consecutive experimental years, it is clear that the three parasitoids were prevalent in nature and parasitizing egg masses of *S. Incertulas*. Among three parasitoids, *T. Schenobii* was found to be predominant as this parasitoid emerged in large number and remained active for the longer period as compared to *Telenomus* sp. and *T. japonicum*.

The yellow stem borer egg parasitoid population followed a linear trend in relation to the availability of the YSB egg masses. Peak activity of Tetrastichus was noted when the egg mass density was high during first week of september, and the Tetrastichus activity was declined with the decrease in stem borer egg mass density.

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