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Abundance of yellow stem borer, *Scirpophaga incertulas,* Walker egg parasitoids in relation to cultural practices in West Bengal, India.

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ABSTRACT

Field study by randomized block design on the incidence of both yellow stem borer (YSB) and its important parasitoids were carried out in the field of rice cultivar *Swarna mashuri* (MTU 7029) during four consecutive crop years (2005-2008) at Raiganj, Uttar Dinajpur, West Bengal, India. Observations include all the life stages of YSB (egg, larvae and pupa) and its important hymenopteran parasitoids species. *T. rowani*, Gahan (Scelionidae), *T. schoenobii*, Ferriere (Eulophidae) and *T. chilonis,* Ishii (Trichogrammatidae) were identified as the three important egg parasitoids in this region. High average parasitization at early vegetative stages (63.85%) decreased steadily and remained constant during mid-tillering stage (34.65%), and further declined during the ripening stage (14.67%). The overall egg mass parasitization (%) by *T. chilonis*, *T. rowani* and *T. schoenobii* was 18.23-71.67%, 15.56-67.34% and 10.23-52.56% respectively. Abundance of *T. chilonis* was maximum in 37 standard meteorological weeks (SMW) and minimum in 30 SMW. Maximum number of *T. rowani* was recorded in 37 SMW and lowest in 30 SMW. Number of *T. schoenobii* was maximum in 37 SMW and minimum in 30 SMW.

Keywords: *Scirpophaga incertulas*, *Trichogramma chilonis*, *Telenomus rowani*, *Temelucha schoenobii,* population dynamics.

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INTRODUCTION

Stem borers (SBs) are key group of insect pests of rice in tropics [1]. Out of all borer species, yellow stem borer (YSB), *Scirpophaga incertulas*, Walker is distributed throughout India and is considered as the most dominating and destructive insect pest species [2]. Extent of yield loss, in South-east Asia, due to the infestation of *S. incertulas* and *S. innotata* was estimated to about 17 % [3]. 5-10% average rice crop damage in every year with occasional local catastrophic stem borer outbreaks which results in up to 60% loss is a reported phenomenon [4]. Alteration of physical environments of rice landscape, unscientific modification of suggested cultural practices, injudicious adoption of multiple cropping patterns, improper cultivation of high yielding rice varieties, in appropriate application of high levels of inorganic N fertilizer and insecticides are primarily responsible for YSB menace [5 - 6]. Contrary to this, bio-agents are safe to environment with no reported toxicity to human health and can thus be utilized effectively for pest regulation and suppression [7]. Bio-agents broadly encompass both predators and parasitoids. Utility of parasitoids as bio-agents has gained momentum, in recent years, in this consideration. Activity of YSB egg parasitoid is seasonally allied; egg mass size dependent and paddy growth stage specific. Early destruction of yellow stem borer egg masses by encouraging the field parasitoid population is essential to maximize yield with least toxic chemical input.

MATERIALS AND METHODS

Experimental layout

Field experiment was conducted with transplanted 35-day old seedlings of widely cultivated variety *Swarna mashuri* (MTU 7029) during four consecutive kharif seasons (2005-2008) at Raiganj [26°35´15´´(N) – 87°48´37´´(W)], Uttar Dinajpur, West Bengal. The soil of the experimental field was sandy loam with pH value 6.6. Available N, P_2O_5 and K_2O was 357, 59 and 358 kg/ha respectively. Experiment was conducted in random block design with the transplanted seedlings at 15x15 cm hill to hill spacing in both the seasons. Each plot was 10 m x 10 m by size and separated from the nearer plot by 2.5 ft. distance. Fertilizer inputs and necessary field management was done in due time following the suggestive direction given in the National protocol with befitting modifications. There were three replications for each of the four experiment years.

Assessment of YSB egg mass parasitization

Mated YSB female moths captured from light traps were individually confined to the rice plant cages and allowed to deposit eggs until their death. The plant parts with YSB egg masses were then kept in the rice fields of different growth stages in relation to standard meteorological weeks (SMW) for egg mass parasitization in natural conditions. After 2-3 days, the plant parts with eggs were transferred to glass tubes (20 cm long and 2.5 cm wide) in laboratory with 2.5 cm standing water to moist the cut portion of the rice plant. The mouth of the tubes were plugged with cotton and allowed necessary time for parasitoids to come out. Egg parasitoids emerged and got trapped in cotton and accordingly counted. Each tube contained 2 egg masses and for each date there were three tubes. Observation was made for 11 consecutive weeks extending from 30 to 40 SMW.

Statistical analysis

Data were analyzed and subjected to ANOVA or factorial analysis of variance (FANOVA) and statistical significance was judged at the level ($P < 0.05$).

RESULTS AND DISCUSSION

Collected egg masses broadly represent two categories, active and inactive. Eggs were inactivated either by parasitization or by season induced sterilization. The active egg masses hence influence the subsequent pest intensity. Available egg masses and the quantum of their viability also differ in different seasons.

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Table 1: Species abundance of YSB egg parasitoids in relation to SMW

Seedling Spacing	category	Species abundance in relation to SMW										
		30	31	32	33	34	35	36	37	38	39	40
10x10	A	3.12 (1.90)	6.23 (2.59)	7.80 (2.88)	8.12 (2.94)	9.78 (3.21)	12.50 (3.61)	18.11 (4.31)	23.70 (4.92)	18.50 (4.36)	12.91 (3.66)	9.27 (3.13)
	B	4.26 (2.18)	6.06 (2.56)	7.02 (2.74)	7.63 (2.85)	16.24 (4.09)	17.79 (4.28)	21.70 (4.71)	31.74 (5.68)	22.58 (4.80)	11.46 (3.46)	7.34 (2.80)
	C	6.12 (2.57)	10.91 (3.38)	11.81 (3.51)	17.85 (4.28)	20.08 (4.54)	29.47 (5.47)	36.57 (6.09)	49.22 (7.05)	36.10 (6.05)	15.74 (4.03)	8.11 (2.93)
15x15	A	3.77 (2.07)	8.14 (2.94)	9.87 (3.22)	10.13 (3.26)	12.23 (3.57)	15.62 (4.01)	22.64 (4.81)	29.62 (5.49)	23.12 (4.86)	16.14 (4.08)	10.12 (3.26)
	B	5.32 (2.41)	7.57 (2.84)	8.78 (3.05)	9.79 (3.21)	20.67 (4.60)	22.24 (4.77)	27.13 (5.26)	39.68 (6.34)	28.23 (5.36)	14.32 (3.85)	12.23 (3.57)
	C	7.65 (2.85)	13.64 (3.76)	14.76 (3.91)	22.31 (4.78)	26.35 (5.18)	37.21 (6.14)	48.21 (6.98)	61.52 (7.88)	45.12 (6.75)	22.17 (4.76)	13.47 (3.74)

A: *Tetrastichus sp*, B: *Telenomus sp.*, C: *Trichogramma* sp.
Figure in the parenthesis is the square root transformed values

Table 2: Extent of parasitization in relation to SMW

Seedling Spacing	Category	Species composition			Extent of parasitization in relation to SMW										
		A	B	C	30	31	32	33	34	35	36	37	38	39	40
10x10	A1	+	-	-	5.90 (2.53)	11.77 (3.50)	14.74 (3.90)	15.35 (3.98)	18.48 (4.36)	23.63 (4.91)	34.23 (5.89)	44.79 (6.73)	34.97 (5.96)	24.40 (4.99)	17.52 (4.24)
	A2	-	+	-	8.05 (2.92)	11.45 (3.46)	13.27 (3.71)	14.42 (3.86)	30.69 (5.58)	33.62 (5.84)	41.01 (6.44)	59.99 (7.78)	42.68 (6.57)	21.66 (4.71)	13.87 (3.79)
	A3	-	-	+	11.57 (3.47)	20.62 (4.60)	22.32 (4.78)	33.74 (5.85)	37.95 (6.20)	55.70 (7.50)	69.12 (8.34)	93.03 (9.67)	68.23 (8.29)	29.75 (5.50)	15.33 (3.98)
	A4	+	+	-	7.13 (2.76)	15.38 (3.98)	18.65 (4.38)	19.15 (4.43)	23.11 (4.86)	29.52 (5.48)	42.79 (6.58)	55.98 (7.52)	43.70 (6.65)	30.50 (5.57)	19.13 (4.43)
	A5	-	+	+	10.05 (3.25)	14.31 (3.85)	16.59 (4.13)	18.50 (4.36)	39.07 (6.29)	42.03 (6.52)	51.28 (7.20)	75.00 (8.69)	53.35 (7.34)	27.06 (5.25)	23.11 (4.86)
	A6	+	+	-	14.46 (3.87)	25.78 (5.13)	27.90 (5.33)	42.17 (6.53)	49.80 (7.09)	70.33 (8.42)	81.12 (9.57)	81.82 (9.57)	85.28 (9.26)	41.90 (6.25)	25.46 (5.10)
	A7	+	-	+	5.90 (2.53)	11.77 (3.50)	14.74 (3.90)	15.35 (3.98)	18.48 (4.36)	23.63 (4.91)	34.23 (5.89)	44.79 (6.73)	34.97 (5.96)	24.40 (4.99)	17.52 (4.24)
	A8	+	+	+	8.05 (2.92)	11.45 (3.46)	13.27 (3.71)	14.42 (3.86)	30.69 (5.58)	33.62 (5.84)	41.01 (6.44)	59.99 (7.78)	42.68 (6.57)	21.66 (4.71)	13.87 (3.79)
15x15	B1	+	-	-	6.79 (2.70)	13.54 (3.75)	16.95 (4.18)	17.65 (4.26)	21.25 (4.66)	27.17 (5.26)	39.36 (6.31)	51.51 (7.21)	40.22 (6.38)	28.06 (5.34)	20.15 (4.54)
	B2	-	+	-	9.26 (3.12)	13.17 (3.70)	15.26 (3.97)	16.58 (4.13)	35.29 (5.98)	38.66 (6.26)	39.36 (6.90)	68.99 (8.34)	49.08 (7.04)	24.91 (5.04)	15.95 (4.06)
	B3	-	-	+	13.31 (3.72)	23.71 (4.92)	25.67 (5.12)	38.80 (6.27)	43.64 (6.64)	64.06 (8.03)	79.49 (8.94)	106.98 (10.37)	78.46 (8.89)	34.21 (5.89)	17.63 (4.26)
	B4	+	+	-	8.20 (2.95)	17.69 (4.26)	21.45 (4.68)	22.02 (4.75)	26.58 (5.20)	33.95 (5.87)	49.21 (7.05)	64.38 (8.05)	50.26 (7.12)	35.08 (5.96)	22.00 (4.74)
	B5	-	+	+	11.56 (3.47)	16.46 (4.12)	19.08 (4.42)	21.28 (4.67)	44.93 (6.74)	48.33 (6.99)	58.97 (7.71)	86.25 (9.31)	61.35 (7.86)	31.12 (5.62)	26.58 (5.20)
	B6	+	+	-	16.63 (4.14)	29.65 (5.49)	32.09 (5.71)	48.50 (7.00)	57.27 (7.60)	80.88 (9.02)	104.79 (10.26)	133.71 (11.58)	98.07 (9.93)	48.19 (6.98)	29.28 (5.46)
	B7	+	-	+	6.79 (2.70)	13.54 (3.75)	16.95 (4.18)	17.65 (4.26)	21.25 (4.66)	27.17 (5.29)	39.36 (6.31)	51.51 (7.21)	40.22 (6.38)	28.06 (5.34)	20.15 (4.54)
	B8	+	+	+	9.26 (3.12)	13.17 (3.70)	15.26 (3.97)	16.58 (4.13)	35.29 (5.98)	38.66 (6.26)	47.16 (6.90)	68.99 (8.34)	49.08 (7.04)	24.91 (5.04)	15.95 (4.06)

+ denotes combination, - denotes non-combination, A: *Tetrastichus* sp, B: *Telenomus* sp.,
C: Trichogramma sp. Figure in the parenthesis is the square root transformed values

In relation to the season

The highest number of egg masses was obtained in the month of November followed in descending order by February, October, April and March. The number of egg masses was nearly the same in August and December. The frequency of inactive eggs was season specific.

In relation to paddy growth stages

Species of the parasitoids was identified from both the infected eggs and larval stages of the adult YSB. But their relative abundance and effectively depended on the prevailing agro-climatic situation and stages of the life cycle of the host occurring in the field.

T. rowani, Gahan (Scelionidae), *T. schoenobii*, Ferriere (Eulophidae) and *T. chilonis,* Ishii (Trichogrammatidae) were the three important YSB egg parasitoids recorded from the paddy field at Raiganj, Uttar Dinajpur, and West Bengal. In all cases percentage of parasitization was found to be egg mass size dependent (r = 0.796) and was also be fitting with the standing paddy growth stages, high in the early growth stages but low in late growth stages (Table 1). High average parasitization at early vegetative stages (63.85%) decreased steadily and remained constant during mid-tillering stage (34.65%), and further declined during the ripening stage (14.67%). The overall egg mass parasitization (%) by *T. chilonis*, *T. rowani* and *T. schoenobii* was 18.23-71.67%, 15.56-67.34% and 10.23-52.56% respectively. Abundance of *T. chilonis* was maximum in 37 standard meteorological weeks (SMW) and minimum in 30 SMW. Maximum number of *T. rowani* was recorded in 37 SMW and lowest in 30 SMW. At all the growth stages abundance of *T. chilonis* was maximum and *T. schoenobii* was minimum (Table 2).

Due to wide spread chemical control in Japan , solitary parasitoids with relatively narrow host range like *Temelucha biguttula, Chelonus munakatae* were replaced almost completely by a more generalist gregarious and polyphagous *species, Apanteles chilonis* [8]. Study on the rate of parasitism of overwintering *Chilo* sp. larvae for 23 years in Aomori, Japan have shown that before 1964 the rate was negatively correlated with moth density but after 1965 a new regulatory mechanism or natural control by a larval parasitoid came into operation [9]. Activity of *T. schoenobii* was reduced as temperature and wind velocity increased where as environmental factors had little effect on the activity of *T. rowani* [10]. In Andaman, India education of yield was 1.6 % in plots where parasitoids were released @ 50,000/ha as compared with 10.3% in plots where no release was done [11]. During wet season egg mass wise parasitism ranged from 84.6-100% and egg parasitism from 28.0-74.7% where as in dry season egg mass parasitism ranged from 26.0 to 56.0% .In general YSB eggs laid towards the late tillering or early reproductive stage of the crop are parasitized to lesser extent as the rice plant are older and the borer eggs are laid towards the lower part of the leaf or leaf among the dense foliage, thus movement and searching ability of the parasitoids are affected adversely.

Release of egg parasitoids is the only possible method of checking the stem borer occurring in the low land and deep water situations where other control strategies are least possible [12]. Egg parasitism of YSB by *Temelucha. dignoides* or *T. schoenobii* may be same per cent [13]. *T. schoenobii* was second best in importance in regulating the late broods of YSB population during winter [14]. It has noted that egg parasitoid activities might not be dependent on the density of the egg masses [15]. Egg population was correlated with the parasitism but not significant [16]. At Navasari, Gujrat, *Telenomus. diginus* and *T. schoenobii* were the most abundant parasitoids of YSB [17]. Egg parasitism was recorded 86.7% at 40 days after transplantation (DAT) where larval parasitism reached 58.3% at 60 DAT [18]. *T. rowani* (Gahan) was considered the most abundant of the three parasitoids in Karnataka. Field parasitism due to *T. schoenobii* in Andhra Pradesh was 30.6% in kharif and 23.7 in rabi season where in laboratory, parasitism reached 48 % [19]. In Warangal lead to the conclusion that *T. schoenobii* was the main egg parasitoid in kharif season [18]. *T. rowani* afforded up to 26.84% parasitism in October and November was less active and considered of interest for biological control [20]. In Kapurthala, Punjab indicated that towards the end of September *T. dignoides* was found in abundance [21]. Investigation on the parasitoid complex at Kaul, Haryana resulted in identification of three species of egg parasitoids viz. *Telenomus diginus* (Gahan), *Trichogramma japonicum* (Ashmed) and *Trichogramma chilonis* (Ishii). Parasitism due to *Telenomus diginus* was always more compared to *Trichogramma japonicum* in Ludhiana. At Cuttack, *Temelucha dignoides* being the dominant one during rabi and kharif seasons followed by *T.emelucha schoenobii*. Parasitism due to *T. japonicum* was very low. The egg mass and egg parasitism were more during rabi but the number of eggs per egg mass and percentage of egg hatchability were more during kharif. Maximum number of egg masses (32.4-63.3%) was parasitized by *T. dignoides* alone in all the seasons. Very few egg masses (3.0-13.6%) were parasitized by *T. japonicum* in kharif season. Maximum egg-wise parasitism was by *T. dignoides* followed by *T. schoenobii*, *T. japonicum* parasitized the least number of eggs in both the seasons. Due to the internal nature of feeding and higher prevalence in unfavorable lowland ecology, unsuitable for chemical pest control and apparent appearance of resistance varieties, maximum information on its natural biological control is available. The extent of all parasitism in different parts of India ranges from

4.0 to 97.2 % [22]. Central Rice Research Institution (CRRI), Cuttack indicated that parasitism of egg masses increased only when host enrichment was under taken by placement of egg masses of stem borer in the rice field, especially during the scarcity of moth population [23]. The stem borer parasitism at Coimbatore was due to *T. schoenobii* (32%), *T. rowani* (24%) and *T. japonicum* (2%). Total parasitism due to these parasitoids ranged for 15-45% at Chinchura and 3-20% at Nawagram [24]. Field parasitism of YSB egg masses in the Eastern Ghat zone of Orrisa was 73.6-96.9% on egg mass basis and 16.8-31.6% on egg basis. The parasitoid population followed a linear trend with the number of eggs in the host egg mass [25]. Sukhija *et al*., (1991) have reported that parasitism ranged from 41.0 to 71.7% in plots treated with foliar application of insecticides and 32.8 to 81.6% in plots treated with granular insecticides. It have noted that granular formulation were less toxic to *Temelucha dignoidis* [26]. Among the spray, monocrotophos showed moderate toxicity to *T. dignoides* [27]. Granular insecticides viz. quinalphos, phorate and carbofuran applied at 30 days after transplanting resulted in 40.06, 35.0 and 34.78% egg parasitism of YSB respectively by *T. dignoides* when observed at 40 DAT. Whereas similar observations in plots sprayed with monocrotophos, quinalphos, clorpyriphos and acephate resulted in 24.7, 14.6,6.9 and 4.6% egg parasitism respectively compared with 41.0% in untreated plots. Some neem products like nimbecidine (0.25-4.0%), neemgold (2.0-4.05) and rakshak (1.0%) also had adverse effect on parasitism [28].

CONCLUSION

This field study was carried out in the field of rice cultivar *Swarna mashuri* (MTU 7029) during four consecutive years (2005-2008) at Raiganj, Uttar Dinajpur, West Bengal, India, by randomized block design on the incidence of both yellow stem borer (YSB) and its important hymenopteran parasitoids like *Trichogramma chilonis*, *Telenomus rowani* and *Temelucha schoenobii*. Observation includes all the life stages of YSB (egg, larvae and pupa) and *T. chilonis*, *T. rowani* and *T. schoenobii* were identified as the three important egg parasitoids in this region. High average parasitization at early vegetative stages (63.85%) decreased steadily and remained constant during mid-tillering stage (34.65%), and further declined during the ripening stage (14.67%). The overall egg mass parasitization (%) by *T. chilonis*, *T. rowani* and *T. schoenobii* was 18.23-71.67%, 15.56-67.34% and 10.23-52.56% respectively. Abundance of *T. chilonis* was maximum in 37 standard meteorological weeks (SMW) and minimum in 30 SMW. Maximum number of *T. rowani* was recorded in 37 SMW and lowest in 30 SMW. Number of *T. schoenobii* was maximum in 37 SMW and minimum in 30 SMW. At all the growth stages abundance of *T. chilonis* was maximum and *T. schoenobii* was minimum.

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