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Evaluation of *Trichogramma* spp. against yellow stem borer (*Scirpophaga incertulas* Walker) on paddy

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Abstract

Field trials were conducted in 2017-18, 2018-19 and 2019-20 to know the efficacy of two species of *Trichogramma* viz., *T. chilonis* and *T. japonicum* for their effectiveness against yellow stem borer of paddy as compared to farmer's practice of insecticidal treatments. The trial was conducted on farmer's fields in Chandrapur district in Maharashtra State. Results of the pooled studies revealed that the per cent infestation of white ear heads due to yellow stem borer (*Scirpophaga incertulas* Walker) on paddy was found lowest in *Trichogramma japonicum* released fields with highest yields. There was reduction in the cost of management of stem borer in *Trichogramma* released plots which was reflected through increased ICBR when compared with insecticidal management plot. *Trichogramma japonicum* would provide answer for effective and eco-friendly management of yellow stem borer of paddy.

Keywords: biological control; egg parasitoid; natural enemy; rice stem borer; *Trichogramma* sp.

Introduction

Paddy (*Oryza sativa* L.) is the most important crop in the world and plays a central part in Asian food security. This crop is widely distributed especially in Southern parts of China where rice accounts for 88.7% of the total agricultural acreage. It occupies 7.31 lakh ha area (<http://www.rkmp.co.in> Rice Knowledge Management Portal (RKMP). in Vdarbha region and is considered to be the most important crop for sustainable livelihood of eastern Vidarbha farmers. However, rice production in this area is suffering from serious pest and disease damage causing substantial yield losses every year. Key pests of rice include yellow stem borer (YSB) (*Scirpophaga incertulas* Walker, Crambidae) rice leaf folder (*Cnaphalocrocis medinalis* Guenée, Crambidae), rice plant hopper (*Nilaparvata lugens* Stål, Delphacidae) and rice green semilooper (*Naranga aenescens* Moore, Noctuidae). Among those, the yellow stem borer is considered to be the most important pest of rain-fed low land and flood-prone rice ecosystems. Populations of this pest substantially increased within one decade recently in paddy fields due to continuous promotion of double cropped paddy area. Conventional control methods for Lepidoptera pests in paddy fields usually involve the application of agrochemicals. However, these methods may cause damage to the environment and lead to food safety issues, particularly because broad-spectrum insecticides of considerable toxicity are generally used. Optimized methods with less environmental impact and high sustainability are in demand, such as releasing biological control agents. So far, many studies have demonstrated that *Trichogramma* wasps can successfully control Lepidopteran pests by parasitizing their eggs. Major success stories have been reported from maize crops and *Trichogramma* has been introduced in many maize growing areas worldwide. A true IPM system should conserve beneficial insect and utilize them as a basic component in the management of key pests. Therefore, safer and eco-friendly methods with less environmental impacts and high sustainability are warranted in paddy ecosystem. So far, many studies have demonstrated that *Trichogramma* wasps can successfully control Lepidopteran pests by parasitizing their eggs (Lou *et al.*, 2014; Innundative Releases of *Trichogramma chilonis* (Ishii) for Management of Pink Bollworm *Pectinophora gossypiella* (Saunders) on Cotton also support the effectiveness of egg parasitoids as a effective eco friendly tool for the pest management. *Trichogramma japonicum* is the most commonly used species of *Trichogramma* for control of the paddy stem borer worldwide (Zeigler *et al.*, 2008) [1].

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Materials and Methods

The present investigations were conducted on farmer's fields in *Palasgaon Jat* village of *Chandrapur* district in Maharashtra State in *kharif* seasons of 2017-18, 2018-19 and 2019-20 to know the efficacy of two species of *Trichogramma* viz., *T. chilonis* and *T. japonicum* for their effectiveness against yellow stem borer of paddy as compared to farmer's practice of insecticidal treatment. The egg parasitoid *Trichogramma japonicum* and *Trichogramma chilonis* cards were prepared in the Bio control laboratory of the Department of Entomology, College of Agriculture, Nagpur, under the jurisdiction of Dr. PDKV, Akola (MS) using laboratory developed egg culture of Rice moth *Corcyra cephalonica* which were maintained at 25±2°C and 60±70% relative humidity. The parasitoids were released in the field by attaching the small strips of the cards with parasitized eggs

to paddy leaves at an interval of 8 days @ 3 cards (aprox. about 60,000 parasitized eggs) per acre per release starting at 30 days after transplanting (DAT). Such six releases were made during the entire crop season. There were three treatments (spread over 0.4 ha area) each being replicated for 22 times (22 farmers). Farmer's practice (control) comprised of application of conventional insecticide sprays (3 sprays) at usual intervals as followed by the farmers. The details of treatments and along with their cost particulars are given in Table 1. Field infestations of yellow stem borer *Scirpophaga incertulas* Walker was recorded as % white ear heads due to stem borer before harvesting. The observations were recorded on 10 hills per plot randomly and per cent white earhead due to stem borer was calculated. The data were analyzed statistically under Randomized Block Design (RBD) after appropriate transformation for significance of the treatment.

Table 1: Details and cost particulars of treatments

Treatment	Application dose	Cost details	Total cost of treatment (Rs. ha)
T-1: Innundative release of <i>Trichogramma japonicum</i>	Six releases (@ 8 cards per ha) at an interval of 8 days starting from 30 days after transplanting	Cost of Tricocards @ Rs. 47.33/ card, Cost of labour for tricho card release @ Rs. 25/hr, Cost of labour charges for field operations @ Rs. 250/day,	2422.00
T-2: Innundative release of <i>Trichogramma chilonis</i>	Six releases (@ 8 cards per ha) at an interval of 8 days starting from 30 days after transplanting	Cost of Tricocards @ Rs. 47.33/ card, Cost of labour for tricho card release @ Rs. 25/hr, Cost of labour charges for field operations @ Rs. 250/day,	2422.00
T-3: Farmer Practice (Check): Application of insecticides only	Soil application of Fipronil 0.6% @ 10 kg/ha	Rs. 2,125/- ha + Rs. 1250/- labour cost = Rs. 3,375/-	7,542.00
	Chlopyriphos 50% + Cypermethrin 5% @ 250 ml/ha	Rs. 668/- ha + Rs. 1250/- labour cost = Rs.1,918/-	
	Cartap Hydrochloride 50% SP @ 1kg/ha	Rs. 1000/- ha + Rs. 1250/- labour cost = 2,250/-	

Result and Discussion

Effect of innundative releases of *Trichogramma* on infestation of yellow stem borer

The results in Table 1 on infestation of yellow stem borer revealed that all the treatments were significantly superior over control (Farmer's practice) in all the years of experiment.

In 2017-18 the per cent white ear heads due to yellow stem borer were found lowest (4.07%) in *Trichogramma japonicum* released fields statistically at par with *Trichogramma chilonis* (4.58) and both these treatments were statistically significantly superior over farmer's practice where highest (15.24%) white ear head infestation was recorded.

In 2018-19 the per cent white ear heads due to yellow stem borer were found lowest (3.90%) in *Trichogramma chilonis* released fields statistically at par with *Trichogramma japonicum* (4.89%) and both these treatments were significantly superior over farmer's practice where highest (16.13%) white ear head infestation was recorded.

In 2019-20 the per cent white ear heads due to yellow stem borer were found lowest (3.91%) in *Trichogramma japonicum* released fields statistically at par with *Trichogramma chilonis* (4.82) and both these treatments were statistically significantly superior over farmer's practice where highest (14.32%) white ear head infestation was recorded.

Results of the pooled studies revealed that the per cent white ear heads due to yellow stem borer were found lowest (4.29%) in *Trichogramma japonicum* released fields statistically at par with *Trichogramma chilonis* (4.43%) and both these treatments were significantly superior over farmer's practice where highest (15.33%) white ear head infestation was recorded. The two *Trichogramma* species viz., *T. japonicum* and *T. chilonis* have given suppression of yellow stem borer *Scirpophaga incertulas* Walker to the extent of 72.01% and 71.10%, respectively over farmer's practice and proved effective.

Table 2: Effect of innundative releases of *Trichogramma* species on infestation of yellow stem borer of paddy

Treatment	Per cent white ear heads due to yellow stem borer				Per cent reduction in infestation over Farmer Practice
	2017-18	2018-19	2019-20	Pooled (2017-20)	
T-1: Innundative release of <i>Trichogramma japonicum</i>	4.07 (2.12)	4.89 (2.31)	3.91 (2.09)	4.29 (2.18)	72.01
T-2: Innundative release of <i>Trichogramma chilonis</i>	4.58 (2.23)	3.90 (2.08)	4.82 (2.29)	4.43 (2.20)	71.10
T3: Farmer Practice (Check) i.e. Application of insecticides only	15.24 (3.95)	16.43 (4.10)	14.32 (3.84)	15.33 (3.97)	--
F - test	Sig.	Sig.	Sig.	Sig.	
SE (m)	0.06	0.05	0.05	0.05	
CD @ 5%	0.17	0.15	0.15	0.14	
CV	10.34	8.87	9.14	8.20	

*Figures in parenthesis are square root transformed values

Effect of inundative releases of *Trichogramma* on yield of paddy

The results in Table 3 on yield of paddy revealed that all the treatments were significantly superior over control (Farmer's practice) in all the years of experiment.

In 2017-18 the highest yield was recorded in (22.73 q/ha) in *Trichogramma japonicum* released fields and it was significantly superior over *Trichogramma chilonis* (21.50 q/ha) and both these treatments were statistically significantly superior over farmer's practice where lowest (i.e. 20.68 q/ha) paddy yield was recorded.

In 2018-19 the highest yield was recorded in (29.32 q/ha) in *Trichogramma japonicum* released fields and it was significantly superior over *Trichogramma chilonis* (28.41 q/ha) and both these treatments were statistically significantly superior over farmer's practice where lowest (i.e. 26.90 q/ha)

paddy yield was recorded.

In 2019-20 the highest yield was recorded in (30.55 q/ha) in treatment T1 i.e. *Trichogramma japonicum* released fields statistically at par T2 i.e. *Trichogramma chilonis* (29.84 q/ha). However, both these treatments were significantly superior over farmer's practice which recorded the lowest (i.e. 27.54 q/ha) paddy yield.

Results of the pooled studies revealed that the highest yield (27.53 q/ha) was obtained from *Trichogramma japonicum* released fields statistically at par with *Trichogramma chilonis* (26.59 q/ha) and both these treatments were significantly superior over farmer's practice where lowest yield of paddy (25.04 q/ha) was recorded. The two *Trichogramma* species viz., *T. japonicum* and *T. chilonis* have given more yield to the extent of 9.94% and 6.19%, respectively over farmer's practice and proved effective.

Table 3: Effect of inundative releases of *Trichogramma* species on yield of paddy

Treatment	Yield (q/ha)				Per cent increase in yield over Farmer Practice
	2017-18	2018-19	2019-20	Pooled (2017-20)	
T-1: Inundative release of <i>Trichogramma japonicum</i>	22.73	29.32	30.55	27.53	9.94
T-2: Inundative release of <i>Trichogramma chilonis</i>	21.50	28.41	29.84	26.59	6.19
T3: Farmer Practice (Check) i.e. Application of insecticides only	20.68	26.90	27.54	25.04	--
F - test	Sig.	Sig.	Sig.	Sig.	
SE (m)	0.27	0.31	0.42	0.20	
CD @ 5%	0.78	0.88	1.21	0.56	
CV	5.89	5.13	6.80	3.50	

Effect of inundative releases of *Trichogramma* species on economics and ICBR: In terms of economics the treatment T-1 i.e. inundative release of *Trichogramma japonicum* with highest ICBR of 1: 1.27 ranked first and proved more effective (Table 4). On the basis of lowest per cent white

earhead infestation of yellow stem borer, highest yield, value of increased yield, and ICBR value, six inundative releases of *T. japonicum* @ 1,60,000 eggs (8 cards) per ha after 30 days after transplanting at an interval of 8 days was found effective and economical against paddy stem borer.

Table 4: Cost Economics and ICBR of the treatments

Treatment	*Cost of Treatment (Rs./ha)	Yield (Q/ha)	Yield increase over farmer's practice (Q./ha)	Value of increased yield (Rs.)	Incremental benefit (Rs.) (5-2)	ICBR (5-2)/2	Rank
1	2	3	4	5	6	7	8
T-1: Inundative release of <i>Trichogramma japonicum</i>	2,422.00	27.53	2.49	5,508.00	3,086.00	1: 1.27	I
T-2: Inundative release of <i>Trichogramma chilonis</i>	2,422.00	26.59	1.55	3,429.00	1,007.00	1: 0.41	II
T3: Farmer Practice (Check) i.e. Application of insecticides only	7,542.00	25.04	--	--	--	--	--

* Cost particulars of treatments as per Table 1;
Price of Paddy @Rs.2212/-per quintal

Paddy stem borer *Scirpophaga incertulas* since last two years has become a serious threat to Paddy cultivation in Vidarbha and also in many other paddy growing states of India. Under these circumstances inundative releases of *Trichogramma japonicum* would provide answer for effective and eco-friendly management of this stem borer.

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