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Impact of *Trichogramma chilonis*, egg parasitoid in management of rice leaf folder, *Cnaphalocrocis medinalis* and validation at farmer field

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Abstract

Trihogamma chilonis is a potent egg parasitoid of rice leaf folder. To prove the efficacy of against lepidopteran pests, leaf folder, *Cnaphalocrocis medinalis* (Guenée) in basmati rice (var. Pusa 1121) was conducted at research fields and later at farmer field for validation of its efficacy. Six augmentative releases of *T. chilonis* viz., 30000, 40000, 50000 per acre were made at ten days' intervals starting from 20 days after transplanting (DAT) and was compared with untreated control. In management of *C. medinalis* best results were achieved when 50000 parasitized eggs per acre in both the years (56.39% and 52.40%) when release start from 20 days after transplant and remain at par with T₅ (53.86 & 49.16%) and T₆ (54.98 and 50.62%). For management of rice leaf folder (*C. medinalis*) release of parasitized eggs of *T. chilonis* @ 50000 per acre starting from 30 DAT were recommended to be tested at farmer field. At farmer fields *T. chilonis* @ 50000 eggs per acre gave better management over untreated. Grain yield in treatments T₂, T₃, T₅ and T₆ remains at par with chemical spray treatment (T₇), during both the years. Which indicates no yield penalties on using egg parasitoid on proper time. There is increase in yield was observed over control at farmers' fields also. There was no significant effect on natural enemies was observed during both the years.

Keywords: Rice leaf folder, *Cnaphalocrocis medinalis*, *Trichogramma chilonis*, egg parasitoids, basmati rice, yield and natural enemies.

Introduction

Rice (*Oryza sativa*) is the most important cereal crop in the developing world and is the staple food of over half of the world's population including all of East and Southern Asia (Yu *et al.*, 2020) [28]. In India, area under rice cultivation is 51.27 million hectares, production of 150.18 million tonnes with productivity of 2929 kg/ha in year 2024-25 (Anonymous, 2025 A) [1]. India exported a total of 20.19 MT rice, earning a massive foreign exchange of Rs. 1,05,722 crores till February 2024. In Haryana, rice is cultivated on 1.83 million hectares with production of 7.13 million tonnes and productivity of 3.88 tonnes/ha (Anonymous, 2025 B) [2].

The adoption of high-yielding varieties, the inclusion of modern agronomic practices, and monoculture in extensive areas, combined with humid conditions, promote the rapid growth of insect pests (Kraker *et al.*, 2000, Reddy, 2013) [11, 19]. As the rice crop is grown worldwide in a wide variety of ecosystems and soil conditions, it becomes a favorable host for a diverse assortment of insects and pathogens from the nursery to harvest. However, only a small number of them are regarded as significant pests that result in losses by reducing yield. Among these Insect-pests, the rice leaf folder, *C. medinalis* Guenée, is of significant importance due to its capacity to deplete chlorophyll from the leaves, resulting in a substantial decline in crop yield. The rice leaf folder poses a considerable threat as a primary foliage consumer. This pest is highly detrimental across all rice-growing environments in Asia, causing yield reductions ranging from 30 to 80% during severe outbreaks (Gangwar, 2015) [6]. Its prevalence has extended to nearly all rice cultivation regions throughout the country (Krishnaiah and Varma, 2011) [12].

The management of rice leaf folder using synthetic chemicals has not proven to be an effective venture due to insecticide resistance, pest resurgence, and its contribution to environmental

pollution (Mahal *et al.*, 2006)^[16]. Due to concerns about the long-term ecological impact of synthetic pesticides and their potential harm to human health (Linka *et al.*, 2005)^[15], as well as to beneficial insects (Youn *et al.*, 2003)^[27], and domestic animals, natural approaches to pest control have been the subject of renewed research. This resurgence of interest includes the use of safe, effective and environmentally acceptable bio-intensive methods. The awareness for the consumption of ecologically safe food has provided impetus to organic farming in India and intensive efforts have been made to find out alternate methods of pest control (Nathan *et al.*, 2004)^[18]. An ecologically sound strategy, i.e. use of biocontrol agents was felt necessary for developing pest management practice through successive releases of biocontrol agents in the genus *Trichogramma* (Hymenoptera: Trichogrammatidae) have been widely used for biological control of lepidopteran insect pests (Ko *et al.*, 2014)^[10]. Augmentative releases of *T. chilonis* (Ishii) and *T. japonicum* (Ashmead) @ 1,00,000 each have been found effective for the biological suppression of yellow stem borer, *S. incertulas* and leaf folder, *C. medinalis* in organic rice (Sangha, K. S. *et al.*, 2018)^[21]. Therefore, evaluation of bio-efficacy *T. chilonis* against leaf folder in rice was carried out at CCS HAU Rice Research Station, Kaul to promote and increase acceptance at farmers' level.

Materials and Methods

Management of leaf folder in rice using egg parasitoid *T. chilonis* in basmati rice (var. PB 1121) was conducted at Rice Research Station, Kaul, Geographically, located at 29° 51' 29.5' N latitude and 76° 39' 24.3' E longitude at an elevation of 241 meters above mean sea level in the North- Western part of the Haryana. PB1121 was transplanted during second week of July in plots size of 50 sq.m. (10x5 m²) with three replications in spacing of 20x15cm during both the years (2022 and 2023). Each plot was separated by 3 m² of non-experimental area to avoid inter-plot movement of released parasitoid. Experimental field was maintained with recommended package of practices except plant protection measures. Six different augmentative releases of *T. chilonis* were made starting from 20 days after transplanting (DAT) and was compared with untreated control. *Tricho*-cards were procured from Bio-control lab at Regional Research station, (Uchani)Karnal. Each *Tricho*-card was cut into small strips so as to obtain 10 parasitized eggs per strip and stapled uniformly to the underside of the leaves in all treatments. Following treatments were used to check relative efficacy of egg parasitoid, *T. chilonis* for control of rice leaf folder:

Treatment details

Treatments	Treatment details	Time of release of egg parasitoid or spray of insecticide
T ₁	Release of <i>T. chilonis</i> eggs @30000/acre	20,30, 40, 50 & 60 DAT
T ₂	Release of <i>T. chilonis</i> eggs @40000/acre	20,30, 40, 50 & 60 DAT
T ₃	Release of <i>T. chilonis</i> eggs @50000/acre	20,30, 40, 50 & 60 DAT
T ₄	Release of <i>T. chilonis</i> eggs @30000/acre	30, 40, 50 & 60 DAT
T ₅	Release of <i>T. chilonis</i> eggs @40000/acre	30, 40, 50 & 60 DAT
T ₆	Release of <i>T. chilonis</i> eggs @50000/acre	30, 40, 50 & 60 DAT
T ₇	Spray of Flubendiamide 20 WG @ 50 g/acre at ETL of pest	30 & 50 DAT or at ETL
T ₈	Control	-

Observations recorded

Leaf folder infestation was recorded at 10 days' interval starting from 20 days after transplanting (DAT). Total leaves and damaged leaves were recorded to compute per cent damaged leaves with the following formulae:

$$\text{Per cent damaged leaves} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

Effects on natural enemy's population was also recorded from 10 randomly selected hills/plot after each application and pooled later.

Grain yield of the crop was recorded at harvest from all plots/replication and converted into q/ha.

Farmers' field trial: Adaptive trials were carried out at 5 multi-locations in districts Kaithal, Jind and Karnal during *Kharif*, 2024. Plot size for treated and untreated control was one acre each. Egg parasitoids, *T. chilonis* were released @ 50,000/acre at 30, 40, 50 and 60 Days after transplant rice crop. Observations were recorded on per cent leaf infestation by leaf folder from 5x5 m plot at three locations per trial. Total leaves and infected leaves per 10 plants were counted for leaf folder. Grain yield q/acre was recorded at harvest.

Statistical analysis: The data was statistically analysed with analysis of variance using OPSTAT Software (Sheoran *et al.*, 1998)^[24].

Results and Discussion

Sequential release of *T. chilonis* at fixed days after transplant for management of rice leaf folder, *C. medinalis* shows a significant decrease in pest population at 40 days in treatment T₂ (8.14 and

10.33), T₃ (7.73 and 9.96), T₅ (8.58 and 10.56) and T₆ (8.52 and 10.41) as compare to T₁ (10.51 and 12.40), T₄ (10.28 and 12.06) and control (17.88 and 22.26), respectively during 2022 and 2023 (Table 1). Lowest mean damage of 6.41% was observed in T₃ among *T. chilonis* followed by T₆ (6.62%) similarly while lowest 5.20% was observed in chemical treatment (T₇) during 2022. Similar trend was observed in second year, mean lowest damage was in T₃ (8.59%) and T₆ (8.91%) as compared to control with mean damage of 18.05%. Highest reduction over control 64.26% was observed in chemical treatment while among *Tricho*-cards T₃ (52.40%) followed by 50.62% in T₆ (Table 1). Similar trend was observed by Kaur *et al.*, 2008^[8] when *T. chilonis* and *T. japonicum* @ 100,000 was augmentatively released for the biological suppression of yellow stem borer and leaf folder in organic rice. Different doses of *T. chilonis*, viz., 50,000, 75,000, 100,000, 125,000 and 150,000 parasitized eggs per hectare were tried by Chhavi *et al.*, 2019^[5] and reported maximum control when 150,000 parasitized eggs per hectare were released. Egg releases of *Trichogramma* sp. @ 100000 and 1250000 per hectare significantly reduced leaf folder infestation (Sagheer *et al.*, 2008)^[20]. Highest egg parasitization of leaf folder eggs due to release of *T. chilonis* @ 1 lakh parasitoids/ha for six times was also reported by (Mose *et al.*, 2018)^[17].

Results similar to rice research farms were obtained at farmers' field. Where in all treated fields mean damage ranged from 6.42-6.57% while in untreated damage ranged from 12.37-12.77%. Reduction in treated was 47-48% over the untreated plots (Table 2). The efficiency of *T. japonicum* and *T. chilonis* reported by Kumar and Khan (2005)^[13] on tiller damage and folded leaves varied from 78.1% to 81.6% from 72.6 to 81.8%, respectively, where egg parasitoids were released @ 1,00,000/ha in rice ecosystem. Earlier works Lakshmi *et al.*, 2010^[14]; Chakraborty,

2012^[4]; Varma *et al.*, 2013^[25]; Vennila *et al.*, 2018^[26]; Sharmistha *et al.* 2020^[23]; Sankeerthana *et al.*, 2025^[22]) report frequent multi-species parasitization of single egg masses and highlight *T. schoenobii*, *T. dignus*, *T. japonicum*, *T. chilonis* and *T. rowani* as key contributors.

Significantly higher yield was observed in all the treatments as compared to control. In treatment T₆ increase in yield as compared to control was 23.82% during Kharif 2023 (Table 3). However, increase in yield was highest 28.08% in chemical spray treatment as compared to other treatments (Table 3). Under farmer filed conditions highest increase in yield observed was

15.50% as compared to untreated (Table 2). Khan *et al.* (2005)^[9] reported that the increase in paddy yield after inundative releases of *T. chilonis*, over control, ranged from 33.0 to 89.5 kg per acre. Six releases of *T. chilonis* and *T. japonicum* each @ 1,00,000/ha starting from 30 days after transplanting (DAT) resulted in lower incidence of rice leaf folder and stem borer and higher grain yield in organic basmati rice during 2014 and 2015, respectively over untreated control (Sangha *et al.*, 2018)^[21]. Karthikeyan *et al.* (2007)^[7] also reported that parasitoid releases in paddy resulted higher grains yield by 25.79–45.13% over insecticide treated plots.

Table 1: Efficacy of egg parasitoid, *T. chilonis* at ten days' intervals for management of leaf folder (*C. medinalis*) in basmati rice during 2022 & 2023

Treatment	Release of <i>T. chilonis</i> @	Release of <i>T. chilonis</i> at Days After Transplanting (DAT)										2022		2023	
		20 DAT		30 DAT		40 DAT		50 DAT		60 DAT		Mean	% Reduction over control	Mean	% Reduction over control
		2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	7.69	47.66	9.69	46.33
T ₁	30000/acre	4.12	5.98	13.6	15.51	10.51	12.40	6.02	8.33	4.19	6.21	6.56	55.34	9.03	49.96
T ₂	40000/acre	4.03	5.90	13.8	15.55	8.14	10.33	3.68	7.52	3.20	5.85	6.41	56.39	8.59	52.40
T ₃	50000/acre	4.00	5.85	13.8	15.15	7.73	9.96	3.43	6.53	3.05	5.46	7.88	46.36	9.90	45.12
T ₄	30000/acre	4.33	6.03	14.1	16.20	10.28	12.06	6.41	8.95	4.27	6.28	6.78	53.86	9.17	49.16
T ₅	40000/acre	3.82	5.71	14.5	16.19	8.58	10.56	3.62	7.45	3.39	5.96	6.62	54.98	8.91	50.62
T ₆	50000/acre	4.09	5.91	13.9	15.91	8.52	10.41	3.48	6.82	3.14	5.51	5.20	64.62	6.45	64.26
T ₇	Flubendiamide 20 WG @ 30 & 50 DAT	3.87	5.73	14.6	16.35	1.71	2.33	4.58	5.78	1.26	2.06	14.70		18.05	
T ₈	Control	4.13	6.16	14.8	17.00	17.88	22.66	18.02	23.56	18.65	20.85				
CD (<0.05)		NS	N/S	NS	NS	1.45	2.10	1.17	1.07	0.55	1.03				
C.V.		8.76	2.86	8.7	4.01	8.92	10.51	10.74	6.47	6.03	8.04				

DAT-Days after transplanting

Among natural enemies, highest population of spiders followed by dragonfly/damselfly and coccinellids was observed during both the years. No mirid bug was recorded in any treatment in both years. During, both the year, no effect on natural enemies

was seen in any treatment (Table 4.). Higher natural enemies' population (lady bird beetles and spider) was reported in ecological engineering, IPM and farmer's practices (Baliyan, U. *et al.*, 2025)^[3].

Table 2: Efficacy of egg parasitoid, *Trichogramma chilonis* on incidence of leaf folder in rice under farmers' field trials during Kharif, 2024

Release of <i>T. chilonis</i> @ 50000 at different Days After Transplanting (DAT)														
	Leaf folder Damage (%) per 10 hill								Mean population (Treat.)	Mean population (Untreat.)	% decrease over control	Average yield per acre (in q) on farmers' field		
	30 DAT		40 DAT		50 DAT		60 DAT					Treat.	Control	Increase in yield over control (%)
Village & District	Treat.	Untreat.	Treat.	Untreated.	Treat.	Untreat.	Treat.	Untreat.						
Pindara (Jind)	11.2	10.8	8.15	11.98	6.23	13.01	4.88	13.68	6.42	12.37	48.09	15.91	13.77	13.47
Pindara (Jind)	10.92	11.01	8.33	12.56	6.84	13.64	4.55	13.87	6.57	12.77	48.53	16.06	13.58	15.49
Rasina (Kaithal)	9.6	10.21	8.21	12.34	6.81	13.01	4.53	14.47	6.52	12.51	47.90	15.93	13.74	13.74
Pundrak (Karnal)	11.5	10.05	7.98	12.25	5.89	13.05	5.48	14.15	6.45	12.38	47.88	16.01	13.73	14.23
Sambhi (Karnal)	10.9	11.12	7.80	11.61	6.32	13.12	5.35	13.79	6.49	12.41	47.70	15.87	13.41	15.50
Average	10.82	10.64	8.09	12.15	6.42	13.17	4.96	13.99				15.86	13.65	

DAT-Days after transplanting

Table 3: Effect of egg parasitoid, *Trichogramma chilonis* treatment used for management of pests on yield during 2022 & 2023

Treatment		Yield in q/ha Mean (2022)	% increase over control (2022)	Yield in q/ha Mean (2023)	% increase over control (2023)
<i>T. chilonis</i> @					
T ₁	30000/acre	41.27	13.07	33.04	14.16
T ₂	40000/acre	41.87	14.32	36.37	22.02
T ₃	50000/acre	42.47	15.53	37.07	23.49
T ₄	30000/acre	41.53	13.63	32.95	13.92
T ₅	40000/acre	41.93	14.45	36.81	22.95
T ₆	50000/acre	42.73	16.05	37.23	23.82
T ₇	Spray 30 & 50 DAT	43.20	16.96	39.43	28.08
T ₈	Control	35.87		28.36	
CD ($p < 0.05$)		1.08		2.92	
CV		3.1		4.69	

DAT-Days after transplanting

Table 4: Effect of egg parasitoid, *T. chilonis* treatment used for management of pests on natural enemy

Treatment	<i>T. chilonis</i> eggs@	Populations of Natural Enemies /10 hill					
		Kharif 2022			Kharif 2023		
		Mirid bug	Spiders	Coccinelid	Mirid bug	Spiders	Coccinelid
T ₁	30000/acre	0	16	1	0	16	1
T ₂	40000/acre	0	14	0	0	15	0
T ₃	50000/acre	0	16	1	0	16	1
T ₄	30000/acre	0	15	0	0	14	0
T ₅	40000/acre	0	11	0	0	12	0
T ₆	50000/acre	0	11	1	0	12	1
T ₇	Spray 30 & 50 DAT	0	5	0	0	5	0
T ₈	Control	0	14	1	0	15	1

Conclusion

It is concluded from present study that releases of *T. chilonis* parasitized eggs at fixed intervals were effective in managing rice leaf folder (*C. medinalis*) in basmati rice. Releases of 50,000 parasitized eggs per acre, initiated at 30 DAT and repeated at every 10 days' interval, significantly reduces leaf folder incidence. It is pertinent to mention here that pest population remain below economic threshold level during both years. On the basis of result so achieved at research farms, experiment was recommended at farmer fields with 50000 parasitized eggs released at same intervals and found significant reduction in pest population as compared with untreated. Based on results it is recommended that *T. chilonis* can be an effective, and sustainable alternative to insecticides for the management of rice leaf folder in basmati rice. This technology is safe for non-target insects, natural enemies and best fit in integrated pest management (IPM).

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