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Research Article

Resource efficient and cost reduction technology for *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) production

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ABSTRACT: In India, the egg parasitoid *Trichogramma chilonis* Ishii is generally mass produced on the eggs of rice moth, *Corcyra cephalonica* Stainton, however, in the present study, the cost of production of *T. chilonis* was studied on *Samia cynthia ricini,* eri silkworm, and was compared with rice moth. Rearing of *T. chilonis* on eri silkworm eggs showed higher benefit cost-ratio of 1.89 with a net profit of Rs. 4620, whereas *T. chilonis* when reared on the eggs of *C. cephalonica* recorded a benefit cost ratio of 1.28, with a net profit of Rs. 2379. The results revealed that in one hectare area, one trichocard made from eri silkworm eggs release that containing 3500 eggs. Each parasitized egg yields 9-10 adults, thus total adults account to about 35000–40000 adults ha^{-1}, while in case of trichocard made from rice moth eggs, the number of cards to be released in one hectare area are 2-3, since one trichocard made from rice moth eggs consit of 16000-17000 eggs. Hence, eri silkworm can be used as an alternate host to rice moth for rearing of *T. chilonis* as it is a resource efficient and cost reducing technology. Further, this production technology would be suitable for promoting localized production of eri silkworm at village level especially for tribal farmers, and unemployed youth.

KEY WORDS: Eri silkworm, rearing, rice moth, *Trichogramma chilonis*

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INTRODUCTION

In India, the egg parasitoid *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) is mass produced on the eggs of rice meal moth, *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae). Recent studies indicate that the production of *T. chilonis* on the eggs of eri silkworm is a farmer friendly system and yields trichogrammatids with superior biological attributes. Among the commercially exploited silkworms, eri silkworm is completely domesticated multi-voltine, polyphagous species, which is reared throughout the year.

In *Trichogramma* rearing, the two basic components are mass production of the host and the parasitoid. The quality of the trichogrammatids in the laboratory mostly depends on the quality of the host eggs on which they are reared at faster and cheaper rates which ultimately depends on the host nourishment. Therefore, the diet of the host is of potential importance to the nutritional quality of host eggs and the survival of *Trichogramma* (Finney and Fisher, 1964). Keeping in view the above facts, the present study of using eri silkworm, *Samia cynthia ricini* as an alternate host to rice moth for rearing egg parasitoid, *T. chilonis* was conducted.

MATERIALS AND METHODS

Facilities required for the production of *Corcyra cephalonica*

Working tables (120x85 cm), slotted iron racks (200x90x35 cm, with 5 partitions) are required for keeping the *Corcyra* rearing basins (30x30 cm). Besides these other items required are scissors, brushes, gum, glass tubes (15x2.5 cm), for collecting *Corcyra* adults, maize grains, groundnut powder, yeast, streptomycin sulphate, vitamin E capsules, proteinex and *Corcyra* eggs as larval diet.

Mass Rearing of host insect *Corcyra cephalonica*

Rice moth, *C. cephalonica* was cultured on broken grains of maize in plastic basins. Heat sterilized broken maize grains were added @ 2.5 kg per basin to which 100 g of groundnut meal and 5 g of yeast powder were added. To prevent bacterial contamination streptomycin sulphate 0.5 g, vitamin E tablets (half capsule), proteinex 2 g, *C. cephalonica* eggs 0.25cc

were used per basin. Likewise, 15 basins were charged. After 35-40 days, rice moth adults started emerging and lay eggs. Rice moth eggs collected from the mating drum were cleaned and pasted on a tricho cards which were then exposed to U.V. light (30 watt) for 30 minutes so that the embryo gets killed without damaging the egg yolk contents. Eggs were dried and then put into polythene bags containing nucleus parasitized cards in the ratio of 1:6 (parasitized eggs:fresh eggs) for parasitism The parasitoids emerging from the nucleus card parasitized the fresh eggs, which turn black after 5-6 days.

Cost of production of rice moth *Corcyra cephalonica*

The cost of production was calculated on the basis of the production costs for rearing the host insect as well as parasitoid. Labour was required for mass production and maintenance of host insect (*Corcyra*) for attending different activities, *i.e*., charging the basins with *Corcyra* larval diet; collecting the *Corcyra* adults emerged from the basins and transferring them to oviposition cage; feeding *Corcyra* adults, brushing, sieving, collection of rice moth eggs for making trichocard

Facilities required for production of eri silkworm

Working tables (120x85 cm), plastic basins (30x30 cm), eri adult cage (40x40x45 cm), eri pupal cage (30x30x35 cm) and castor leaves.

Mass rearing of eri silkworm

The larval culture of eri silkworm was maintained by rearing it on castor leaves (25days), cocoons formed were kept in pupal cages for adult emergence (15-19 days), males and females of eri silkworm were released into eri adult cages for mating. The collected egg masses were refrigerated at 9°C for 15 days, and then washed under tap water. After drying them for 5 minutes at room temperature, the eggs were treated with KOH solution (0.1%) and allowed to dry at room temperature for 5 minutes. Finally, KOH treated eggs were washed under tap water and were kept at room temperature for 5 minutes to dry. The eggs were separated into individual eggs, which were utilized for making eri trichocards. These cards were then introduced into glass tubes containing nucleus parasitized cards in1:6 ratios provided with fine streaks of 50 per cent diluted honey as feed for the adults of *Trichogramma chilonis*.

Cost of production of eri silkworm

Mass production and maintenance of eri silkworm culture also requires labour to attend different activities, *i.e*., providing castor leaves to eri silkworm larvae, changing feed and cleaning the basins on daily basis, collecting the cocoons and releasing them into egg laying cage for moth emergence, and mating, collection of egg masses from egg laying cage and making trichocard. The sale price of each trichocard was Rs. 50/- (for both *Corcyra* and eri tricho card).

RESULTS AND DISCUSSION

Trichogramma chilonis parasitized eggs produced during six months using rice moth as host insect were 42,80,000 and the number of Trichocards produced @ 16-17000 parasitized eggs per card were 214 (Table 1). *T. chilonis* parasitized eggs produced during six months using eri silk worm as host insect were 6,86,000 and the number of Trichocards produced @ 3500 parasitized eggs per card were 196 (Table 1).

The total cost of production of *Trichogramma* using rice moth eggs including the labour wages for rearing rice moth for two generations during six months period in 15 basins along with feed materials like maize grain, groundnut powder, yeast, streptomycin sulphate, protienex, vitamin-E tablets was 8321.30 (Table 2). The cost of production of *Trichogramma* parasitoid using eri silkworm eggs including castor seed cost and the labour charges for feeding eri silkworm eggs larvae with castor leaves was Rs. 5180.00 (Table 2). Rearing of *T. chilonis* on eri silkworm eggs has shown highest benefit cost ratio of 1.89 with a net profit of Rs. 4620.00 (Table 2), whereas *T. chilonis* when reared on the eggs of *C. cephalonica* recorded a benefit cost ratio of 1.28 with a net profit of Rs. 2378.70 (Table 2). The results revealed that for one hectare area, one trichocard (one trichocard per each release) made from eri silkworm eggs can be released

Table 1. Cost of production of *Trichogramma chilonis* as trichocards

Particulars	Trichocard using *Corcyra* eggs	Trichocard using eri silkworm eggs
Number of parasitized eggs produced	42,80,000	6,86,000
Number of Trichocards produced	214 (@ 16-17000 parasitized eggs/trichocard)	196 (@ 3500 parasitized eggs/trichocard)
Cost of production (Rs.)	8321.30	5180.00
Gross returns (Rs.)	214 Trichocards x Rs. 50/-= 10,700.00	196 Trichocards x Rs. 50/-= 9800.00
Net returns (Rs.)	2378.70	4620.00
Benefit cost ratio	1.28	1.89

Table 2. Comparison of cost of production of *Trichogramma chilonis* reared on eggs of eri silkworm and rice moth

Rice moth rearing cost			
Materials	Quantity/Period	Cost per unit (Rs.)	Total cost
Maize grain	75.50 kg	22.00	1650.00
Groundnut powder	3.00 kg	105.00	315.00
Proteinex	60.00 g	2.00	120.00
Vitamin-E tablets	15 nos.	3.00	45.00
Streptomycin sulphate	30 (vials)	8.21	246.30
Yeast	150 g	0.30	45.00
Labour wages	6 Months	900.00	5400.00
Misc. cost (Gum,Tricho card)	-	-	500.00
Total cost of production of *Trichogramma* on rice moth eggs:			Rs. 8321.30*
* Cost of production of 214 Trichocards using *Corcyra* eggs = Rs.8321.30			
Number of Parasitized *Corcyra* eggs produced in two generations = 4280,000 eggs = 214 Trichocards @ 16000-17000 parasitized eggs/ Tricho card.			
Eri silkworm rearing cost			
Castor seed	2.00 kg	240.00	480.00
Field operational costs	-	-	1200.00
Labour wages	6 Months	500.00	3000.00
Misc. cost (Gum,Tricho card)	-	-	500.00
Total cost ofproduction of *Trichogramma* on Esw eggs:			Rs. 5180.00**
**Cost of production of 196 Trichocards using Esw eggs = Rs.5180.00			
Number of parasitized eggs produced over four generations = 686,000 eggs = 196; Trichocards @ 3500 parasitized eggs/Tricho card.			

where in each trichocard consists of approximately 3500 eri silkworm eggs and number of adults emerging from each egg are 9-10 thus finally accounting about 35,000-40,000 adults ha^{-1}. The present results are in accordance with Chowdhury *et al.* (2016) according to them number of the (parasitoids) *T. chilonis* emerging from one egg of *C. cephalonica* is one. Rao *et al*. (1980) confirmed that 6-10 adults of *T. chilonis* emerged from one egg of *Acherontia styx*, while only 1-2 adults from one egg of *C. cephalonica*. Greenberg *et al*. (1996) studied the use of eri silkworm eggs for rearing *T. chilonis, T. dendrolimi T. cacoeciae, T. evanescens, T. pretiosum* and reported that the number of adults emerging from a single parasitized egg ranged from 27-60 with an average of 25 parasitoids.

Rathi and Ram (2000) reported that the size of *T. chilonis* males and females were bigger when developed in bigger sized eggs wherein the number of parasitoids emerged per egg was more from the larger egg host (*Amsacta moorei*) as compared to the smaller one (*C. cephalonica*). Lalitha *et al.* (2010) concluded that number of adult parasitoids (*T. chilonis)* emerged from a single parasitized egg of eri silkworm as 7-34, where as in case of trichocard made from rice moth eggs, the number of cards to be released in one hectare area are 2.5 per each release since one trichocard consists of 16-17000 rice moth eggs and number of adults emerging from each *Corcyra* egg is one. These results are in close agreement with findings of Lalitha *et al*. (2010) who reported that cost of production of Tricho card utilizing eri silkworm eggs required for release in one hectare area @ 50000 ha^{-1} was reduced by 47.60 per cent in comparison to that using *Corcyra* eggs.

Eri silkworm eggs, thus, can be used as an alternate host to rice moth for Trichocard production as the results revealed that for one hectare area, one trichocard made from eri silkworm eggs can be released where as in case of trichocard made from rice moth eggs, the number of cards to be released in one hectare area is 2.5. This production technology is suitable for promoting localized production of eri silkworm at village level especially for tribal farmers and unemployed youth.

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