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Role of Irradiated and Chilled Host *Sitotroga cerealella* Eggs to Enhance the Parasitic Potential of Egg Parasitoid *Trichogramma chilonis* (Ishii)

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Abstract: Studies were conducted to appraise the effect of gamma radiation5-50 Gyand chilling 2,4,6,8, 12, 24, 48 and 72h at -1°Con hatching and parasitism of *Sitotroga cerealella* by the egg parasitoid *Trichogramma chilonis* Ishii at 28±1°C and 50-60% R.H. Results revealed that the hatching percentage was not influenced by irradiation up to the dose of 15 Gy. Hatchability was considerablycondensed at higher doses, with minor hatching at 50 Gy.Generallythe parasitism on host eggs decreased with increasing age.Both irradiationand chilling increase the shelf life and considerably more number of eggs was parasitized on2-5-old-day irradiated and chilled eggs,when exposed to the female of *T. chilonis.* Highest rate of parasitism occurred at 2h and lowest at 72h. The rate of parasitism declined as the period of chilling increased. Prolong exposure to cold resulted in the death of embryos and reduced hatching. Moreover, irradiation resulted in thereducedage of host eggs and 20 and 25 Gyirradiation doses wereeffectual for inexpensive production of *T. chilonis.*

Key words: Radiation · Chilling · Hatching · Parasitization · Sitotroga · Trichogramma

INTRODUCTION

Integrated pest management bybiocontrol agents needs the mass scale availability of bio control agents which requires factitious host capable of producing many generations successfully [1]. Host age is a limited factor for selecting suitable laboratoryrearing of *Trichogramma*. It has a great influence on the biological activity, fertility and adult emergence [2].

Production of natural enemies in an efficient and economical way is a precondition for biological control programme. Substantialscientific advances have been made in mass rearing of natural enemies for augmentative biological control of pest [3].

Nuclear techniques have been used extensively in various biological control programmes.Irradiation plays significant role in the production of natural enemies. It has been reported that the parasitization was increased in the progeny of irradiated pests [4-9]. Marston and Ertle [10] tested the acceptability of irradiated moth eggs to *Trichogramma minutum* Rile and reported that irradiated eggs were more suitable as compared to normal for parasitoid development. Eggs of *Ephestiakuehniella* (Zeller) killed with ultravioletradiation for mass rearing of *Trichogramma* spp. Voegel *et al*. 1974 [11] To expand the establishment of augmented natural enemies in field condition, irradiated eggs were used as supplemental host individuals can be used as a host without fearing that the released host insects themselves be converted into pests [12].Treated young ones from irradiated parent of gypsy moth, *Lymantniadispar*,disseminated in an ordinary plantation were established to be adequate and appropriate hosts for certain amount of biocontrol agents [13, 14]. Irradiated adults of *Helicoverpaarmigera* (Hubner) and *Plutellaxylosrella* (L.) were released in certaincrops as hosts to increase the parasitoid population [15].

Cold injury of host eggs has also been used to improve parasitoid rearing programs for egg parasitoids, where the increaseddemand for the supply of *Trichogramma* parasitoids, prolong storage of eggs under chilled conditions would be necessary to have the continuous supply of host eggs *E. kuehniella* and *C. cephalonica* [2]. The host eggs exposed to temperature (super cooling points) distinctly below 0°C supported survival at later stages of egg development than fresh eggs [16]. A number of authors[17-19] have studied the effect of chilled host eggs on parasitism of *Trichogramma* spp.

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The objectives of this study was to examine the impact of radiation and chilling on the eggs of *Sitotroga cerealella* (Oliv.) at different ages for their suitability to rear the egg parasitoid *Trichogramma chilonis* (Ishii) through the estimation of percentage parasitization and also the effect of irradiation and chilling period on *S. cerealella* hatching.

MATERIALS AND METHODS

Impact of Gamma Radiation on Hatching of *Sitotroga cerealella:* Fresh eggs of *Sitotroga cerealella*were obtained from stock culture of bio-control laboratory of Nuclear Institute of Agriculture Tandojam. Five replications of five hundred eggs irradiated at different doses 5-50 Gy (with the interval of 5Gy) were placed in glass jars provided with wheat kernels as rearing media to record the hatch percentage.

Effect of Gamma Radiation on Egg Parasitization of *Trichogramma chilonis:* Eggs of *S. cerealella* were collected from stock culturereared under controlled condition. These eggs were sprinkled on the white paper cards having gum as sticking material. After one hour the cards were exposed to radiation doses 5-50 Gy. Each card containing 500 irradiated eggs exposed to 20 pairs of parasite *T. chilonis* in glass jarsuntil 7 days; to observe the effect of host age. The cards were detached from the jars after 24 hours, the parasitism (%) on each card and effect of age of host eggs for parasitization were recorded and compared with untreated control. The experiment was replicated five times.

Effect of Chilling on Hatching of *Sitotroga cerealella:* Five replication of *S. cerealella*= 24 h old-egg cards500eggs/ card were chilled at -1°C for 2,4,8,10,12,24,48 and 72h as compared to control (egg cards kept at rearing temperature).The cards were kept in glass jars on wheat kernels till hatching.

Effect of Chilling on Egg Parasitization of *Trichogramma chilonis:* Five replication of *S. cerealella*= 24 h old egg strip 500eggs/ strip were chilled at -1°C for 2, 4,8,10,12,24,48 and 72, h whichwere exposed to 20 pairs of parasitoids *T.chilonis*to allow parasitism for 24 hafter 1, 2, 3, 4, 5, 6 and 7 days intervals to observe the effect of host age. The parasitized eggs were kept in glass tubes to calculate the parasitism in each treatment and effect of host eggs age was also determined.

Data Analysis: Statistical analysis was conducted for LSD test when data was significantly varied in ANOVA by using Statistix® Version 8.1, Analytical Software, Inc. and Tallahassee, FL, USA.

RESULTS AND DISCUSSION

Radiation considerablycondensed the hatching percentage of the eggs treated with different radiation doses. The utmost hatching of 90.4 % was observed in control. The hatch percentage decreased as the radiation dose increased and it was negligible at the dose 50 Gy (0.6%). The hatching percent of eggs, irradiated with 5 Gy (88.6) was statistically at par with control, while, 20 Gy (76.4) was statistically parallel with 10 Gy(80.0) and 15 Gy (76.4) but significantly varied from control (Table 1). Similar results were obtained byShenishen-Z[20]and reported that mortality increased with risingradiation dose, as compared with unprocessed eggs.

Impact of Gamma Radiation Doses on Egg Parasitization: The results showed that the parasite preferred the fresh eggs to parasitize and the rate of parasitization decreased as the age of host eggs increased (Table 2). Irradiation increase the shelf life of host eggs and significantly higher number of eggs were parasitized on IInd, IIIrd and IVthold-day irradiated host eggs as compared to normal eggs. Thus, parasitization was significantly higher on the irradiated host eggs. The peak parasitization of 23.6, 20, 15.2, 13.2, 9, 3.8 and 0.8 % were monitored on Ist, IInd, IIIrd, IVth, Vth, VIth and VIIth day, respectively. Moreover, on irradiated eggs parasitization was recorded up to VII day's old eggs, whereas, it was up to Ivthday on normal eggs.

Table 1: Effect of gamma radiation on the eggs of *S. cerealella*

Dose Gy	Hatching percentage (%) (Mean ± SE)
5 Gy	88.6±3.43 a
10 Gy	80.0±6.28 b
15 Gy	81.6± 1.94 b
20 Gy	76.4±7.60 bc
25 Gy	72.4 ±2.88 cd
30 Gy	68.0 ± 4.58 d
35 Gy	40.4± 2.96 e
40 Gy	19.6 ±5.07 f
45 Gy	3.6±1.14 g
50 Gy	0.6 ±0.54 g
Control	90.4±1.94 a

In a column mean followed by same letter are not significantly different at P=0.05 LSD Test

Table 2: Effect of irradiation on suitability of host eggs for parasitization of *T. chilonis*

	Parasitization potential in host eggs at different age (days)						
Dose (Gy)	I st(Mean ± SE)	II nd(Mean ± SE)	III rd(Mean ± SE)	IV th(Mean ± SE)	V th(Mean ± SE)	Vi th (Mean ± SE)	VII th (Mean ± SE)
5	19.2±1.30 b	16.4 2.40 bc	11.2 ± 2.49cd	6.4 ± 2.30c	0.6 0.38 c	0.0± 0.00 c	0.0± 0.00 b
10	23.2±2.77 a	21.0 3.39 a	17.6 ± 3.84a	11.0 ±2.23ab	0.0 0.00 d	0.0 ± 0.00c	0.0± 0.00 b
15	20.2± 1.92 b	17.0 3.39bc	12.6 ± 2.70bc	11.8 ± 2.16a	0.8 0.38 c	0.0 ± 0.00c	0.0 ±0.00 b
20	23.6±1.14a	20.0 2.44ab	15.2± 2.76ab	13.2 ± 3.70a	9.0 1.50 a	3.8 ± 1.28 a	0.8 ± 0.38 a
25	24.4 ±2.70 a	19.8 3.03ab	13.2 ± 3.26bc	9.2 ± 2.58 b	4.2 1.90 b	1.4 ± 0.76 b	0.8 ± 0.38 b
30	19.2 ± 2.28b	16.4 2.40bc	13.2 ±3.11bc	9.4 ±1.14 b	4.8 1.56 b	1.8 ± 0.83 b	0.0± 0.00 b
35	17.8± 1.64 b	15.6 2.70c	14.6 ±3.04bc	5.4 ± 1.81 c	0.8 0.38 c	0.0 ± 0.00c	0.0 ± 0.00 b
40	15.2 ±1.92 c	13.4 3.97 cd	8.4 ± 1.94de	1.4 ± 0.67 d	0.0 0.00 d	0.0 ± 0.00c	0.0 ± 0.00 b
45	13.4±2.51 cd	7.6 2.28e	5.4 ± 2.30e	0.2 ± 0.44de	0.0 0.00d	0.0± 0.00c	0.0 ± 0.00 b
50	11.6 ±1.34 c	7.6 2.40e	1.4 ± 1.14f	0.0 ± 0.00 e	0.0 0.00 d	0.0 ± 0.00c	0.0 ± 0.00 b
Control	18.8±1.78 b	11.2 2.38de	7.2 ±2.77e	2.0 ± 0.70 d	0.0 0.00d	0.0 ± 0.00c	0.0 ± 0.00 b

In a column mean followed by same letter are not significantly different at P=0.05 LSD Test

Table 3: Effect of Chilling on hatching of *S. cerealella* eggs

Chilling period in hours	Hatching percentage (%) (Mean ± SE)
2	81.2±1.51 b
4	72.4±1.82c
8	54.8±3.30d
12	29.6±2.60e
24	7.2±1.29f
48	2.6±0.67fg
72	0.8±0.41g
Control	90.4±2.30a

In a column mean followed by same letter are not significantly different at P=0.05 LSD Test

The results revealed that radiation dose of 20 and 25 Gy can be effectively used to enhance the parasitic potential of the parasite as well as to decrease the age effect of host eggs.

It is well-known that fitness of host eggs for parasitization by *Trichogramma*sp. is reduced significantly with the boost in their age [21-25]. Thus, anadequateamount of fresh eggs areconserved to be used as hosts for production of parasitoids. Radiation delayed the host eggs development and enhanced the suitability for parasitization by natural enemies for *Muscadomestica*, *Ephestiakuehniella, Plodiainterpunctella* and *S. cerealella* [3,8,9,26].

The comparable properties were evaluated for parasitoids of certain dipteral and lepidopteron insects by Fatima *et al.* [3]. Hamed *et al.* [8] and Zapater *et al.* [26]. The same results were reported by Fatima *et al*. [27] that the radiation increased the incubation period of eggs of Angoumois grain moth which proved valuable in escalating the parasitic prospective of *T. chilonis* by using gamma radiation 20-25Gy. Hamed *et al*. [8] reported that parasitization was significantly higher on irradiated host eggs and it was observed up to VI th day old eggs. Tuncbilek *et al*. [9] determined that eggs of Indian meal moth and Angoumois grain moth treated with 200 Gy can successfully be used for mass rearing of *T. evanescens.*

Effect of Chilling on Hatchability of *Sitotroga cerealella:* Among the results of effect of chilling (at -1°C) on *S. cerealella* eggs for a period of 2, 4,8,10,12,24,48 and 72 h, the maximum hatchability of the eggs was observed at eggs chilled for 2 h (81.2%) comparing to that of the optimum temperature (90.4%),while the percent of hatching reached to 2.6% and 0.8% when the eggs were chilled for 48 and 72 h, respectively. Table 3 indicates significant differences for the percentage of hatchability at different period of chilling. It was noticed that by increasing the period of chilling, the mortality rate of embryowas increased and the hatching rate of eggs decreased. Our results are in agreement with Singh [28]and Mona and Mandarawy[2] who observed that advancement of chilling period of *Corcyra* and *E. kuehniella* eggsat (-1 to -4 °C) for 16 to 76 hcaused gradual declined in hatching due to adverse effect of cold on developing embryos.

Effect of Chilled *Sitotroga cerealella*eggs on Parasitism: Treatment of chilled*S. cerealella*= 24 h old eggs at -1°C for 2, 4,8,10,12,24,48 and 72 h beforeparasitization by *T. chilonis* is given in Table 4 maximum parasitism of host eggs was 49.4% for eggs chilled for period of 2 h for egg parasitoid *T. chilonis,* whereas the minimum 1.4% eggs

Table 4: Effect of Chilling on Parasitization of *S. cerealella* eggs

Chilling period in hours	Parasitization of host eggs at different age (days) (Mean ± SE)						
	I[st]	II[nd]	III[rd]	IV[th]	V[th]	VI[th]	VII[th]
2	19.8±1.08a	15.2±1.19 a	7.81.38± a	4.6±0.90b	2.4±0.90 a	0.0±0.00a	0.0±0.00a
4	17.4±1.71 a	11.2±1.94b	8.6±1.03 a	8.6±1.03a	1.2±0.41 b	0.0±0.00a	0.0±0.00a
8	13.8±1.78 b	7.2±1.19c	4.2±0.96 b	3.8±0.65 b	0.0±0.00 c	0.0±0.00a	0.0±0.00a
12	10.6±1.75 b	3.4 ±0.57d	1.8±0.65 c	1.8±0.41 c	0.6 ±0.67bc	0.6±0.67a	0.6±0.67a
24	6.8±1.08 c	2.4±0.83de	0.0±0.00c	0.0±0.00 d	0.0±0.00 c	0.0±0.00a	0.0±0.00a
48	4.2 ±0.82cd	1.4±0.57de	0.0±0.00c	0.0±0.00d	0.0±0.00c	0.0±0.00a	0.0±0.00a
72	1.4±0.57d	0.0±0.00e	0.0±0.00c	0.0±0.00d	0.0±0.00 c	0.0±0.00a	0.0±0.00a
Control	19.8±1.08 a	11.2±1.19 b	7.2±1.19a	2.0±0.35 c	0.0±0.00c	0.0±0.00a	0.0±0.00a

In a column mean followed by same letter are not significantly different at P=0.05 LSD Test

were parasitized at 72h chilling. The results showed significant differentiation in the parasitism of *T. chilonis* chilled for different periods. These results are similar to that of Torre *et al.* [29] who found that the percentages of *C. cephalonica* parasitism were reduced drastically as the chilling period advanced. Dass and Ram [30] described that the storage eggs of *C. cephalonica*at -6°C for longer than 8 days adversely affectedparasitism by *T. exiguum*. Hugar *et al.* [31] observed that parasitoid preferred fresh eggs for parasitization; when the chilling period of *C. cephalonica*eggs increased the parasitism decreased. These findings are also in agreement with the results of Mona and Mandarawy [2] who concluded that parasitism age of the host eggs and the chilling period are the important factors affecting the parasitism. The chilled for limited times were found to be preferred by the parasitoids. This may be due the shriveling of host eggs when chilled for longer period.

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