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COLD STORAGE OF *PECTINOPHORA GOSSYPIELLEA* (SAUND.) EGGS PARASITIZED BY *TRICHOGRAMMA* AND EFFECT ON SOME BIOLOGICAL PARAMETERS

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Abstract

Trichogramma evanescens Westwood and *Trichogrammatoidea bactrae* Nagaraja were stored at low temperature (8ºC) as immature stages in parasitized *P. gossypiella* eggs or as adults. Development of immature stages and emergence of adults were differed significantly according to species, age of stored parasitoids and storage period. Moreover, the adverse effect of low temperature extended to the next generation, as females activity of the following generation was found, significantly, lower compared to the control generation. The higher percentage of emergence, the higher percentage of females with successful parasitization and the higher numbers of eggs/parasitoid female were produced in case of storing the prepupal stage. On the contrary, old pupae (7-days after parasitism) of the two species were the most susceptible stage to the adverse effect of low temperature as the overall percentages of emergence averaged 47.7 and 47.8 %, respectively. Moreover, storage of the parasitized eggs 7 days old after stinging for 30 days, the produced females were completey unable to parasitize any of *P. gossypiella* eggs. The sex-ratio in progeny was always in favour of female whatever the species or the stored age. Lower percentages of females in progeny of the two species were generally recorded by increasing the storage period to 25 days.

Storage of adult females of the two parasitoids showed a degree of tolerance to the adverse effect of low temperature up to 3 days, however, all females that stored for 6 days failed to parasitize any egg. Furthermore, high percentages of progeny emerged form *P. gossypiella* eggs parasitized by *T. evanescens* and *T. bactrae* females that were stored at low temperature (8ºC) up to 4 days, but all progeny failed to develop in *P. gossypiella* eggs as the storage period was prolonged to 5 days.

Key words: *Trichogramma evanescens, Trichogrammatoidea, Pectinophora gossypiella* and storage

INTRODUCTION

The most common method of storing insects or prolonging their longevities is to keep them at low temperatures to reduce the rate of metabolism and activity (Richmond *et al.*, 1972; Lating and Eden 1990). In biological control programmes, large numbers of *Trichogramma* are needed for inundative releases and in most cases the target pest is too difficult and costly to be reared in sufficient numbers to satisfy the requirements of the release programme. Storage of parasitoids could add great numbers of parasitoids to be released whenever needed. Alba (1989) found that, when *T. chilonis* Ishii mass-produced in eggs of *Corcyra cephalonica* Station were stored at 10°C for a long time (26 days), the quality of female parasitoid was reduced with adverse effect on adult sex ratio.

The present study was conducted to determine the possiblility of storing *Trichogramma evanescens* Westwood and *Trichogrammatoidea bactrae* Nagaraja reared on eggs of *P. gossypiella* aims to develop a system to produce sufficient numbers of parasitoids for releasing programmes.

MATERIALS AND METHODS

Host Rearing: The pink bollworm, *Pectinophora gossypiella* (Saund.) eggs were used as hosts for the studied parasitoids. The eggs were obtained from a laboratory culture reared on artificial diet as described by Abd El-Hafez, Alia *et al.*, (1982) in the Integrated Pest Management Laboratory, Bollworms Research Department, Plant Protection Research Institute.

Parasitoid Rearing: *Trichogramma evanescens* (native parasitoid) and T*richogrammatoidea bactrae* (imported from USA in 1992) were reared on the pink bollworm eggs at the formerly mentioned laboratory. For efficient mass rearing of each parasitoid species, host egg sheets (2000 – 2500 eggs) were exposed to adults (100 – 150 individuals) into 0.4-liter glass jars provided with 10% sucrose solution for nutrition and covered with cloth-wrapped cotton kept in position by rubber band. Host eggs were replaced every 24 hrs to avoid superparasitism and the parasitized eggs were kept in clean glass vials (4 x 8.5 cm).

Experimental Techniques: This study was carried out in two sets for each *Trichogramma* species which were reared continuously on the pink bollworm eggs. In the first set, cards of the pink bollworm parasitized eggs were stored at 8 (7-9ºC) and 80 (75-85 % RH) after different periods of parasitism i.e.; 3hrs and 1, 3, 5 and 7 days for different storage periods (0, 5, 10, 15, 20, 25 and 30 days). The stored cards were transferred after storage periods to the rearing conditions {27 (26-28ºC) and 80 (75-85) % RH} and maintained until parasitoid's emergence. The emerged parasitoids were conuted, the percentage of survival was calculated and emerged females were confined in glass vials each with a new card (unparasitized) of the pink bollworm eggs and supplied by 10% sucrose solution as nutritive source. Female's longevity was calculated in addition to the proportion of females that successfully parasitized the host eggs, number of parasitized eggs per emerged female and sex-ratio of the produced progeny.

In the second set, the effect of storing *Trichogramma* adults at low temperature on their effectiveness was studied. A group of 20 freshly emerged females were stored at the same mentioned conditions for periods of 2, 3, 4, 5 and 6 days. After storage periods, each female was provided with a card of the pink bollworm eggs and 10% sucrose solution, then transferred to the breading conditions. Five days later, the number of parasitized eggs/female was determined, however, the percentage of survival and sex-ratio were calculated after adult progeny emergence.

Analyses of variance were done on all data (ANOVA) and Duncan's multiple range test was used to separate the means (Snedecor & Cochran 1980).

RESULTS AND DISCUSSION

From previous studies, the total development period (from egg to adult) of *T. evanescens* and *T. bactrae* (in *P. gossypiella* eggs) required about 8 days at 28ºC (Hutchison *et al.*, 1990; Abd El-Hafez, Alia, 1995). The developmental periods of different immature stages of these two species were determined by Flanders (1937) and Hutchison *et al.* (1990). From their studies, it could be stated that the incubation period was about one day and *T. bactrae* developed only through 2 instars, while that of *T. evanescens* had 3 instars. The periods of 2, 1.5 and 3.5 days were estimated for the larva, prepupa and pupa, respectively.

Storage of developmental stages

Development of immature stages and emergence after storage at low temperature: Regarding the present results, it could be concluded that *T.evanescens* stored at the prepupal stage (3 days after parasitism) was the most tolerant to the adverse effect of low temperature (79.5±1.5% emergence), however, *T. bactrae* showed most tolerant when stored at the first larval instar (one day after parasitism) as the percentage of adults' emergence averaged 74.3±1.9 %, Table 1. On the other hand, old pupae (7-days after parasitism) of the two species were the most susceptible to the adverse effect of low temperature as the overall percentage of emergence averaged 47.7±2.9 and 47.8 ±2.7, respectively.

Potentiality of *Trichogramma* females produced after storage as immature stages: Two indices were used to evaluate the effect of low temperature on the efficiency of emerged *Trichogramma females*: (1) percentage of females showing successful parasitization i.e.; females parasitized one egg or more, (2) number of parasitized eggs per emerged female. It appears that the higher percentages of females with successful parasitization were produced in case of storing the prepupal stage since the overall percentages of 92.39 and 89.3% of *T. evanescens* and *T. bactrae* females, respectively, showd successful parasitism, Table 2. Regarding data in this table, it could be noted that *T. evanescens* was generally more tolerant to the adverse effect of low temperature than *T. bactrae* when stored after 5 or 7 days from parasitism, as the percentages of females that showing successful parasitism reached 83.11 & 64.43% for the former species compared with 77.16 & 56.93 % for the latter one.

Data in Table 3 confirmed that storage of *P.gossypiella* eggs including prepupae of *T.evanescens* and *T. bactrae* are the most suitable since the total number of parasitized eggs/resultant female averaged 36.9 and 30.9 eggs, respectively, being the highest than all the remaining treatments. The reduction in the average number of parasitized eggs/female was more severe when *P. gossypiella* eggs containing pupae of either of the two parasitoid species were stored; i.e., after 5 or 7 days of parasitism (averages of 26.2 days & 20.5 and 19.3 & 16.8 parasitized eggs/female, respectively, Table 3. It is also worthmentioning that by storage of the parasitized eggs after 7 days of stinging for 30 days, the produced females were, completely, unable to parasitize *P. gossypiella* eggs.

Emergence and sex-ratio of *Trichogramma* progeny produced after storing their parents as developmental immature stages: Data presented in Table 4 clearly indicated high percentages of emergence from *P. gossypiella* eggs parasitized by *T. evanescens* and *T. bactrae* females that produced after low temperature (8ºC.) storage at different developmental immature stages of the parasitoid and for different periods up to 25 days. Generally, the overall percentages of emergence averaged 93.5 and 92.5% after development from eggs of treated females against 94.6 and 94.5 from control eggs, respectively. The sex ratio in progeny was always in favour of female. Generally, the overall percentage of females in progeny from stored eggs averaged 64.8 & 62.6 % against 65.8 & 69.8 % in control, respectively. Moreover, the long exposure of *T. bactrae* parental females to low temperature (25 days), reduced significantly, the percentage of females is progeny (54.6 %). In addition, storage of prepupal stage (3 days after parasitism) didn't influence the female's percentage in the progeny of either of the two parasitoid species, 65.3 %, Table 5.

Storage of adult females

Potentiality of *Trichogramma* females after storage: Table 6 shows the potentiality of stored females for parasitizing *P. gossypiella* eggs to be lower compared to the control females. The adverse of cold storage effect differed significantly according to the parasitoid species and storage period, however all females that were stored for 6 days failed to parasitize any eggs. The average number of parasitized eggs/ control female of *T. evanescens* and *T. bactrae* averaged 45.6 and 35.8 eggs/female, respectively. The ability of *T. evanescens* female to parasitize eggs decreased insignificantly to 44.8 and 35.1 individual/female after storing for 2 and 3 days, respectively at 8ºC. Increasing the storage period to 4 or 5 days caused significant decrease in the efficiency of the emerged females, so the number of eggs averaged 33.0 and 28.8 eggs/female, respectively. As for *T. bactrae* females, the number of parasitized *P. gossypiella* eggs by stored female increased, insignificantly, until 3 days of storage (39.9 and 38.4 eggs/female, respectively). However, increasing the storage period to 4 or 5 days, caused significant reduction in number of eggs/female that reached 14.32 and 9.1 eggs/female, respectively.

Emergence and sex ratio of *Trichogramma* female's progeny after storage: Data presented in Table 6, clearly indicated high percentages of emergence from *P. gossypiella* eggs parasitized by *T. evanescens* and *T. bactrae* females that was stored at 8ºC up to 4 days. However, all progeny failed to develop in *P. gossypiella* eggs as the storage period was prolonged to 5 days. Generally, the overall percentages of emergence averaged 92.65 and 90.22 %, while those from control eggs averaged 94.7 and 94.8 %, respectively. The sex ratio in progeny was always in favour of female, generally, the overall percentages of females in progeny of the two stored parasitoids (67.36 and 67.88 %) vary insignificantly than control (69.35 and 71.4 %).

The previously explained data indicated that when storage of *Trichogramma* is needed, the parasitized eggs are better to be stored when the parasitoid is at the prepupal stage (3 days after parasitism at 28ºC), as in this case, the produced parasitoid adults are of higher potentiality than storage at either of the remaining stages. Also, it is generally advised not to expose the parasitoid to low temperature when it is in the pupal stage. In addition, storage of *Trichogramma* adults to low temperature should be not more than three days.

The present results are in close agreement with those obtained by Alba (1989) for *Trichogramma* chilonis Ishii mass-produced in eggs of *C. cephalonica*, when stored at 10ºC for a long period (23 for 26 days). Conversely, Kilincer *et al.* (1990) stored *T. turkeiensis* and *T. embryophagum* in parasitized eggs of *S. cerealella* at 0, 4 and 8ºC and found that the 2 higher temperatures for one month did not affect parasitoid emergence. Also, Jalali and Singh (1992) in their studies on *T.achaeae, Trichogrammatoidea eldanae, T.chilonis* and *T. japonicum* found that the pupa was the most appropriate stage for storage, but they found that fecundity and longevity declined rapidly after storage for 14 days at 2 and 5ºC and 21 days at 10ºC. These dissimilarity of results may be interpreted on the basis of differences either in *Trichogramma* species or the rearing host (Marston and Ertle, 1973).

Table 1. Percentages of emergence ± SE (range) of *T. evanesces* and *T. bactrae* parasitoids from *P. gosypiella* eggs after storage as immature stages at 8°C for different periods.

Age of stored Parasitoids	Storage periods (days)							Mean	LSD 5 %
	control	5	10	15	20	25	30		
T. evanescens									
3 hr.	96.0^{Aa} ±0.83 88-100	90.6^{Ab} ±1.5 74-97	90.9^{Aa} ±1.2 82-100	70.3^{Bb} ±3.6 32-91	33.1^{Cd} ±3.5 14-74	29.7^{CDb} ±3.5 11-96	23.7^{Db} ±2.6 0-44	62.0^{c} ±2.7 0-100	**7.219**
1 day	96.4^{Aa} ±0.76 88-100	96.3^{Aa} ±0.73 90-100	90.4^{Ba} ±4.0 81-95	83.5^{Ca} ±1.3 71-91	46.2^{Dc} ±3.9 17-73	24.8^{Ebc} ±2.4 12-48	2.9^{Fc} ±1.03 0-14	63.0^{c} ±3.1 0-100	**5.225**
3 days	96.0^{Aa} ±1.1 84-100	94.0^{Aab} ±1.1 83-100	83.6^{Bb} ±1.5 73-100	86.7^{Ba} ±0.7 71-100	76.4^{Ca} ±3.3 43-100	66.5^{Da} ±2.6 43-88	53.2^{Ea} ±3.5 27-81	79.5^{a} ±1.5 27-100	**6.286**
5 days	95.8^{Aa} ±0.99 84-100	93.9^{ABab} ±1.4 73-100	90.3^{Ba} ±1.5 78-100	84.0^{Ca} ±2.3 65-97	67.4^{Db} ±2.5 50-98	61.2^{Ea} ±2.1 47-77	5.3^{Fc} ±5.64 0-15	71.1^{b} ±2.6 0-100	**4.888**
7 days	96.2^{Aa} ±0.99 84-100	84.0^{Bc} ±1.6 73-100	73.9^{Cc} ±2.3 61-94	29.8^{Dc} ±3.0 16-56	22.0^{Ee} ±2.1 10-47	20.3^{Ec} ±1.6 13-42	7.5^{Fc} ±1.7 0-26	47.7^{d} ±2.9 0-100	**5.457**
Mean ± SE	96.1^{A} ±0.4 84-100	91.7^{B} ±0.7 73-100	85.8^{C} ±0.9 61-100	70.8^{D} ±2.4 16-100	49.0^{E} ±2.4 10-100	40.5^{F} ±2.2 11-88	18.5^{G} ±2.1 0-81	64.6 ±1.2 0-100	**2.608**
LSD 5 %	**ns**	**3.565**	**4.194**	**7.021**	**8.530**	**6.866**	**6.107**	**2.204**	
T. bactrae									
3 hr.	90.4^{Aa} ±1.1 84-100	87.1^{Bb} ±1.3 75-100	63.2^{Cc} ±3.2 35-93	50.7^{Dd} ±1.5 41-62	38.9^{Ed} ±3.2 20-63	19.7^{Fd} ±2.16 7-38	14.0^{dF} ±2.2 0-33	52.5^{d} ±2.6 0-100	**6.050**
1 day	93.9^{Aa} ±1.1 84-100	92.7^{Aa} ±0.5 89-100	85.6^{Ba} ±1.5 70-94	85.7^{Ba} ±1.5 72-92	70.3^{Ca} ±1.9 50-83	61.2^{Da} ±1.6 43-75	31.0^{Eb} ±2.2 17-81	74.3^{a} ±1.9 17-100	**4.266**
3 days	93.5^{Aa} ±0.83 86-100	88.4^{Ab} ±1.5 74-97	75.9^{Bb} ±2.6 50-93	68.0^{Cc} ±2.6 50-86	51.1^{Dc} ±3.6 30-89	46.8^{Db} ±1.5 40-69	47.7^{Da} ±2.4 30-68	67.4^{b} ±1.7 30-100	**6.295**
5 days	94.1^{Aa} ±0.92 86-100	82.0^{Bc} ±1.9 63-97	77.9^{Bb} ±2.6 57-91	76.7^{Bb} ±3.1 50-93	59.3^{Cb} ±2.5 41-82	25.7^{Dc} ±3.2 11-52	23.1^{Dc} ±1.9 12-49	62.7^{c} ±2.4 11-100	**6.628**
7 days	94.0^{Aa} ±1.1 86-100	81.8^{Bc} ±1.9 68-94	69.1^{Cc} ±1.6 53-78	25.5^{De} ±3.4 9-56	25.1^{De} ±2.9 5-57	20.2^{Dcd} ±1.4 12-38	19.0^{Dcd} ±2.3 5.39	47.8^{e} ±2.7 5-100	**6.052**
Mean ± SE	93.9^{Aa} ±0.4 84-100	86.4^{B} ±0.78 63-100	74.4^{C} ±1.3 35-94	61.3^{D} ±2.4 9-93	49.0^{E} ±2.0 5-89	34.7^{F} ±1.9 7-75	27.0^{G} ±1.5 0-68	60.9 ±1.1 0-100	**2.626**
LSD 5 %	**ns**	**4.432**	**6.857**	**6.466**	**7.466**	**6.346**	**5.911**	**2.220**	

Means followed by the same upper letter at the same row or the same lower letter at the same column are not significantly different.
ANOVA yielded a significant difference between the two parasitoid species (LSD = 0.9883).

Table 2. Percentages of *T. evanesces* and *T. bactrae* females that showed successful parasitism to *P. gosypiella* eggs after storage as immature stages at 8°C for different periods.

Age of stored parasitoids	Storage periods (days)							Mean
	Control (0)	5	10	15	20	25	30	
T. evanescens								
3 hr.	100	100	100	100	81.8	45.5	40.0	81.04
1 day	100	100	100	100	100	32.0	4.5	76.64
3 day	100	100	100	100	100	80.0	66.7	92.39
5 day	100	100	100	100	100	81.8	0	83.11
7 day	100	100	100	75.0	60.0	16.0	0	64.43
Mean	100	100	100	95	88.4	51.06	22.24	79.53
T. bactrae								
3 hr.	100	100	100	100	82.6	41.7	34.8	79.87
1 day	100	100	100	100	100	73.9	13.64	83.93
3 day	100	100	100	100	100	77.3	47.8	89.30
5 day	100	100	100	70.8	65.2	56.5	47.6	77.16
7 day	100	100	100	56.0	34.8	7.7	0	56.93
Mean	100	100	100	85.36	76.52	51.42	28.77	77.44

Table 3. Mean ± SE (range) of parasitized *P. gosypiella* eggs / *T. evanesces* and *T.bactrae* females stored as developmental immature stages at 8°C for different periods.

Age of stored Parasitoids	Storage periods (days)							Mean	LSD 5 %
	control (0)	5	10	15	20	25	30		
T. evanescens									
3 hr.	46.1^{Aa} ±3.3 29-76	47.9^{Aa} ±2.9 25.72	40.8^{ABb} ±2.2 20-59	36.7^{Bb} ±1.9 23-51	26.9^{Cbc} ±3.3 0-46	9.9^{Dbc} ±3.2 0-44	7.9^{Db} ±2.3 0-37	30.9^{b} ±1.7 0-76	**7.750**
1 day	46.1^{Aa} ±3.3 29-76	43.6^{Aa} ±2.8 23-76	45.6^{Ab} ±2.7 20-63	46.9^{Aa} ±2.7 13-69	40.3^{Aa} ±2.9 11-59	5.9^{Bc} ±2.2 0-32	0.05^{Bc} ±0.05 0-1	32.6^{b} ±1.9 0-76	**7.217**
3 days	46.1^{ABa} ±3.3 29-76	48.8^{ABa} ±2.3 31-66	52.8^{Aa} ±2.9 24-68	41.8^{Bab} ±2.4 18-59	28.1^{Cb} ±2.1 10-40	19.4^{Da} ±2.9 0-44	21.3^{CDa} ±3.1 0-44	36.9^{a} ±1.5 0-76	**7.686**
5 days	46.1^{Aa} ±3.3 29-76	44.7^{Aa} ±1.8 27-56	29.8^{Bc} ±2.4 16-53	27.9^{Be} ±1.8 13-49	20.4^{Ccd} ±2.1 3-33	14.8^{Cab} ±1.8 0-26	0^{Dc}	26.2^{c} ±1.5 0-76	**5.850**
7 days	46.1^{Aa} ±3.3 29-76	31.2^{Bb} ±2.2 18-55	32.5^{Bcd} ±2.1 19-49	17.9^{Cdf} ±3.4 0-45	15.1^{Cd} ±2.2 0-32	2.8^{Dc} ±1.5 0-21	0^{Dc}	20.5^{d} ±1.6 0-76	**6.370**
Mean ± SE	46.1^{Aa} ±1.4 29-76	43.2^{AB} ±1.3 18-72	40.3^{B} ±1.4 15-68	34.2^{C} ±1.5 0-69	26.2^{D} ±1.4 0-59	10.6^{E} ±1.2 0-44	5.8^{F} ±1.1 0-44	29.5 ±0.75 0-76	**3.127**
LSD 5 %	**ns**	**6.912**	**6.937**	**7.002**	**7.222**	**6.802**	**4.836**	**2.632**	
T. bactrae									
3 hr.	38.0^{ABa} ±2.4 19-63	46.1^{Aa} ±3.1 15-63	43.2^{Aa} ±3.9 11-68	29.5^{BCa} ±2.8 10-54	24.9^{Ca} ±4.0 0-52	7.7^{Db} ±2.6 0-36	8.4^{Da} ±2.8 0-36	28.2^{ab} ±1.7 0-68	**8.753**
1 day	38.0^{ABa} ±2.4 19-63	43.2^{Aa} ±4.5 12-68	36.8^{ABab} ±3.4 13-61	29.2^{Ca} ±3.0 16-61	30.4^{BCa} ±2.4 11-51	9.95^{Db} ±2.0 0-26	2.3^{bc} ±1.4 0 -	27.1^{b} ±1.6 0-68	**8.078**
3 days	38.0^{Aa} ±2.4 19-63	37^{ABab} ±2.4 12-58	35.6^{ABab} ±1.9 18-52	36.2^{ABa} ±2.5 10-63	32.0^{ABa} ±3.1 10-60	28.1^{Ba} ±3.7 0-50	9.7^{Ca} ±3.0 0-44	30.9^{a} ±1.3 0-63	**8.009**
5 days	38.0^{Aa} ±2.4 19-63	31.5^{Bb} ±2.2 11-50	29.2^{Bb} ±2.4 8-59	13.7^{Cb} ±3.5 0-56	9.7^{CDb} ±2.0 0-24	7.6^{CDb} ±1.8 0-20	5.4^{Dab} ±1.6 0-21	19.3^{c} ±1.4 0-63	**6.534**
7 days	38.0^{Aa} ±2.4 19-63	29.2^{Bb} ±2.4 8-59	28.3^{Bb} ±2.1 15-42	17.0^{Cb} ±2.8 0-37	4.8^{Db} ±1.5 0-22	0.35^{Dc} ±0.26 0-5	0^{Db}	16.8^{e} ±1.4 0-63	**5.623**
Mean ± SE	38.0^{A} ±1.0 19-63	37.3^{A} ±1.6 9-68	34.6^{A} ±1.4 8-68	25.1^{B} ±1.5 0-63	20.3^{C} ±1.6 0-60	10.7^{D} ±1.4 0-50	5.1^{E} ±0.97 0-44	24.5 ±0.96 0-68	**3.325**
LSD 5 %	**ns**	**9.115**	**8.001**	**8.266**	**7.698**	**6.530**	**5.782**	**2.821**	

Means followed by the same upper letter at the same row or the same lower letter at the same column are not significantly different.

ANOVA yielded a significant difference between the two parasitoid species (LSD = 0.3504).

Table 4. Emergence percentages ± SE of progeny produced from *T. evanesces* and *T.bactrae* females stored as developmental immature stages at 8°C for different periods.

Age of stored Parasitoids	Storage periods (days)						Mean	LSD 5 %
	control (0)	5	10	15	20	25		
T. evanescens								
3 hr.	94.6^{Aa} ±0.93	94.4^{Aa} ±0.51	92.8^{ABb} ±0.82	91.2^{Bbc} ±1.17	90.2^{Bb} ±1.41	92.6^{ABab} ±0.95	92.6^{c} ±0.43	**2.804**
1 day	94.6^{Aa} ±0.93	94.9^{Aa} ±0.56	95.7^{Aa} ±0.86	94.2^{Aab} ±0.94	85.1^{Bc} ±2.28	96.1^{Aa} ±1.2	93.4^{abc} ±0.60	**3.483**
3 days	94.6^{Aa} ±0.93	89.4^{Bb} ±1.7	93.4^{Ab} ±0.79	93.5^{Aabc} ±1.01	92.3^{ABab} ±1.36	94.9^{Aab} ±0.73	93.0^{bc} ±0.49	**3.221**
5 days	94.6^{ABa} ±0.93	93.5^{ABa} ±1.4	95.9^{Aa} ±0.95	95.4^{Aa} ±1.4	96.3^{Aa} ±0.95	91.7^{Bb} ±1.45	94.6^{a} ±0.49	**ns**
7 days	94.6^{Aa} ±0.93	95.1^{Aa} ±0.88	94.6^{Aab} ±0.91	94.7^{Aab} ±1.01	91.3^{Bb} ±1.57	93.9^{ABab} ±0.84	94.0^{ab} ±0.44	**ns**
Mean ± SE	94.6^{A} ±0.32	93.4^{AB} ±0.40	94.5^{A} ±0.323	93.8^{B} ±0.423	91.0^{C} ±0.58	93.8^{B} ±0.47	93.5 ±0.177	**1.402**
LSD 5 %	**ns**	**2.989**	**ns**	**3.2489**	**4.166**	**3.4654**	**1.281**	
T. bactrae								
3 hr.	94.5^{Aa} ±0.91	89.9^{Ba} ±1.39	94.7^{Aa} ±1.26	93.3^{Aab} ±0.94	93.3^{Aab} ±1.16	88.7^{Ba} ±0.61	92.4^{a} ±0.48	**3.015**
1 day	94.5^{ABa} ±0.91	91.9^{BCa} ±0.996	92.1^{BCab} ±1.0	97.1^{Aa} ±0.88	93.7^{ABCab} ±1.72	89.9^{Ca} ±2.19	93.2^{a} ±0.59	**3.850**
3 days	94.5^{Aa} ±0.91	93.2^{Aa} ±1.63	92.7^{Aab} ±1.08	94.0^{Aab} ±0.97	92.5^{Aab} ±1.93	92.5^{Aa} ±1.1	93.2^{a} ±0.53	**ns**
5 days	94.5^{Aa} ±0.91	84.0^{Bb} ±2.83	93.9^{Aa} ±1.2	94.6^{Aab} ±1.78	94.8^{Aa} ±1.41	87.8^{Ba} ±2.26	91.6^{a} ±0.83	**5.194**
7 days	94.5^{Aa} ±0.91	91.5^{Aa} ±2.01	92.9^{Aab} ±1.07	92.6^{Ab} ±1.39	90.4^{Aab} ±1.43	90.0^{Aa} ±2.29	92.0^{a} ±0.65	**ns**
Mean ± SE	94.5^{A} ±0.32	90.1^{B} ±0.613	93.3^{A} ±0.41	94.3^{A} ±0.46	93.0^{A} ±0.63	89.9^{B} ±0.72	92.5 ±0.227	**1.824**
LSD 5 %	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	

Means followed by the same upper letter at the same row or the same lower letter at the same column are not significantly different.

ANOVA yielded a significant difference between the two parasitoid species (LSD = 0.5395).

Table 5. Percentages of females (sex ratio) ± SE in progeny produced from *T.evanesces* and *T.bactrae* females resulted after storage of immature stages at 8°C for different periods.

Age of stored Parasitoids	Storage periods (days)						Mean	LSD 5 %
	control (0)	5	10	15	20	25		
T. evanescens								
3 hr.	65.8^{ABa} ±1.5	63.3^{ABa} ±3.5	65.8^{ABa} ±2.17	71.5^{Aab} ±1.54	64.1^{ABb} ±3.3	55.8^{ABa} ±4.3	64.4^{a} ±1.6	ns
1 day	65.8^{Ba} ±1.5	62.0^{Ba} ±3.5	59.0^{Ba} ±3.0	74.93^{Aa} ±2.88	67.5^{ABb} ±1.96	61.2^{Ba} ±3.3	65.0^{a} ±1.4	**8.198**
3 days	65.8^{ABa} ±1.5	60.6^{BCa} ±3.6	66.4^{Ba} ±1.95	64.9^{Bbc} ±3.8	79.9^{Aa} ±2.46	54.0^{Ca} ±4.35	65.3^{a} ±1.8	**9.565**
5 days	65.8^{Aa} ±1.5	7.9^{Aa} ±1.7	62.9^{Ba} ±3.9	67.1^{ABabc} ±4.1	62.9^{Bb} ±1.44	54.9^{Ca} ±2.3	64.3^{a} ±1.3	**7.089**
7 days	65.8^{Aa} ±1.5	96.4^{Aa} ±4.9	50.5^{Ba} ±3.4	62.8^{Ac} ±3.3	60.9^{Ab} ±5.38	-	65.2 ±1.8	**12.56**
Mean ± SE	65.8^{A} ±1.01	65.3^{A} ±1.7	64.2^{A} ±1.5	68.3^{A} ±1.4	67.1^{A} ±1.8	56.5^{B} ±1.8	64.8 ±0.70	
LSD 5 %	**ns**	**ns**	**ns**	**7.948**	**9.40**	**ns**		
T. bactrae								
3 hr.	69.8^{Aa} ±1.32	68.4^{Aa} ±3.72	63^{ABbc} ±5.17	58.8^{BCab} ±2.08	69.3^{Aa} ±2.65	50.3^{Cb} ±2.8	63.4^{ab} ±1.6	**8.908**
1 day	69.8^{Aa} ±1.32	65.4^{ABa} ±4.5	59.6^{BCc} ±1.62	61.4^{ABa} ±4.47	68.6^{Aa} ±5.61	52.0^{Cb} ±3.8	62.0^{ab} ±1.86	**11.228**
3 days	69.8^{Aa} ±1.32	66.9^{ABCa} ±2.04	74.3^{Aa} ±2.59	59.2^{Cab} ±2.93	59.02^{Cab} ±3.38	62.5^{BCa} ±3.1	65.3^{a} ±1.4	**7.654**
5 days	69.8^{Aa} ±1.32	63.6^{ABa} ±3.43	0.2^{BCc} ±3.39	55.7^{BCab} ±3.08	58.4^{BCab} ±3.07	53.0^{BCb} ±2.1	59.6^{b} ±1.4	**8.196**
7 days	69.8^{Aa} ±1.32	69.1^{Aa} ±3.68	72.9^{Aab} ±4.13	51.25^{Bb} ±0.81	51.68^{Bb} ±1.07	-	62.9^{ab} ±2.06	**7.616**
Mean ± SE	69.8^{A} ±1.32	66.7^{AB} ±1.5	64.4^{BC} ±2.1	57.27^{CD} ±1.4	61.4^{C} ±1.9	54.6^{D} ±1.6	**62.6** **±0.75**	
LSD 5 %	**ns**	**ns**	**10.485**	**ns**	**10.135**	**8.311**		

-= not enough data for analyze.

Means followed by the same upper letter at the same row or by the same lower letter at the same column are not significantly different.

ANOVA yielded insignificant difference between the two parasitoid species at a probability of 5 %.

Table 6. Effect of storing adult females of *T.evanesces* and *T.bactrae* at low temperature on parasitized eggs, percentage of emergence and sex-ratio of the produced progeny.

Storage periods	***T. evanescens***			***T. bactrae***		
(days)	No. parasitized eggs/female	% emergence	Sex-ratio (% females)	No. parasitized eggs/female	% emergence	Sex-ratio (% females)
0	45.6^{a} ±2.1 (28-66)	94.7^{a} ±0.7	69.35^{ab} ±1.8	35.8^{a} ±1.5 (22-48)	94.8^{a} ±1.1	71.4^{a} ±1.12
2	44.8^{a} ±3.98 (0-70)	93.5^{ab} ±0.8	70.14^{a} ±2.1	39.9^{a} ±4.9 (0-66)	87.7^{b} ±1.7	68.1^{a} ±1.6
3	35.1^{ab} ±5.18 (0-61)	91.1^{b} ±1.3	65.1^{b} ±1.5	38.4^{a} ±4.3 (0-58)	90.4^{b} ±0.9	63.8^{b} ±1.4
4	33.0^{b} ±4.7 (0-64)	91.4^{b} ±1.1	64.9^{b} ±1.07	14.32^{b} ±4.4 (0-56)	87.99^{b} ±1.9	68.3^{a} ±1.06
5	28.8b ±4.62 (0-56)	-	-	9.1^{bc} ±3.7 (0-62)	-	-
6	0	-	-	0	-	-
Mean	31.2 ±2.04 (0-70)	92.65 ±0.5	67.36 ±0.86	22.8 ±1.98 (0-66)	90.22 ±0.8	67.88 ±0.71
LSD	**10.863**	**2.875**	**4.679**	**10.021**	**4.138**	**3.707**

Means followed by the same lower letter at the same column are not significantly different.

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التخزين بالتبريد لحشرة الترايكوجراما المتطفلة على بيض دودة اللوز القرنفلية *PECTINOPHORA GOSSYPIELLA* (SAUND.) وتأثير ذلك على بعض القياسات البيولوجية

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تم تخزين *Trichogramma evanescens* و*Trichogrammatoidea bactrae* على درجة حرارة منخفضة (٨ مْ) وذلك على صورة أطوار غير مكتملة النمو داخل بيض دودة اللوز القرنفلية أو أطوار بالغة بعد الخروج. وقد أظهرت النتائج أن اكتمال نمو الأطوار غير الكاملة داخل البيض المتطفل عليه وخروج الأطوار الكاملة قد اختلف معنوياً تبعاً لنوع الطفيل المخزن، عمر الطور المخزن وفترة التخزين. وعلاوة على ذلك امتد الأثر الضار للتخزين للجيل التالى، حيث انخفضت كفاءة إناث الجيل التالى معنوياً عن المقارنة. هذا وقد سجلت أعلى نسب لخروج الأطوار الكاملة وأعلى نسب من التطفل الناجح وأعلى عدد من البيض المتطفل عليه بأنثى واحدة من الطفيل فى حالة تخزين الترايكوجراما وهى فى طور ما قبل العذراء. وعلى العكس من ذلك، فإن طور العذراء الكبيرة العمر (٧ أيام من بداية التطفل) فى كل من نوعى الطفيل كان هو الأكثر حساسية للأثر الضار للحرارة المنخفضة حيث انخفضت النسبة العامة للخروج من البيض المتطفل عليه إلى ٤٧,٧ و ٤٧,٨ ٪، على التوالى. وأكثر من ذلك فإن الإناث التى تم تخزينها فى هذا العمر لمدة ٣٠ يوماً فقدت قدرتها تماماً على التطفل على أى من بيض دودة اللوز القرنفلية. ودائماً كانت النسبة الجنسية لصالح الإناث أياً كان نوع الطفيل أو عمر الطور المخزن، بينما سجلت أعداد أقل من الإناث بزيادة فترة التخزين إلى ٢٥ يوماً.

وفى حالة تخزين الطور الكامل للترايكوجراما، تحملت الإناث أضرار التخزين حتى ٣ أيام، بينما فشلت جميع الإناث التى تم تخزينها لمدة ٦ أيام فى التطفل على بيض دودة اللوز القرنفلية. وبالرغم من أن نسبة كبيرة من النسل قد نتجت وخرجت من البيض عند تخزين الإناث حتى ٤ أيام على درجة ٨ مْ إلا أن جميع النسل الناتج فشل فى استكمال نموه والخروج من بيض دودة اللوز القرنفلية المتطفل عليه عند زيادة مدة التخزين إلى ٥ أيام.