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Study on the response of *Trichogramma evanescence* Westwood (Hymenoptera: Trichogrammatidae) rearing to non-laboratory conditions with the assessment of resulting parasitoids efficiency

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Abstract

Laboratory experiments were conducted on *Trichogramma evanescence* immatures to detect their response to rearing and development under non-laboratory conditions mainly in cold weather and to detect the efficiency of resulting females. Rearing laboratory conditions were the controls. Hatching periods, adult emergence percentage, female's ratio in progeny, fecundity, longevity, general productivity, parasitization efficiency and the reduction in parasitization efficiency were investigated. Trichogrammatids emerged from both treatments were nearly similar in the investigated parameters except the hatching period which were prolonged about three times for those reared under non-laboratory conditions compared to the controls. The results revealed that, *T. evanescence* could be developed successfully under non-laboratory conditions.

Keywords: *T. evanescence*- Mass-rearing- Efficiency- General productivity- Parasitization efficiency.

Introduction

Insect's mass-rearing is an economic and income-generating sector aiming at producing efficient individuals with great numbers needed for various purposes as the biological control programs and scientific researches (Finny & Fisher, 1964) and (Joop *et al.* 1999). *Trichogramma* (Hymenoptera: Trichogrammatidae) is the most beneficial mass-reared and released parasitoid used in the biological control strategy to suppress lepidopteron pests (Hassan, 1993). Mass-production protocols depending on laboratory conditions for the production of high quality and efficient parasitoids acting well in the fields. *Trichogramma* parasitoids continue their development and reproduction in the field under environmental stresses or under hard conditions of the weather especially the cold weather. Nevertheless, the laboratory rearing culture might be subjected to urgent circumstances that may affect the product quality for example; power outages or sudden breakdown in incubators or laboratory devices, it is expected that rearing *Trichogramma* parasitoids under non-laboratory conditions mainly with the global climatic

changes and with cold weather will reduce the fitness components of released individuals required. Many authors have determined that the optimum rearing conditions affecting the parasitoid efficiency as those of (Hassan, 1993; Nagaraja, 2013; Hassan *et al.* 2018; Abbes, 2020; Pino, *et al*. 2020; Cherif *et al*. 2021; and Zhang *et al.* 2022). Also, pervious works described certain conditions for the successful production of the parasitoids comprising adequate temperature and humidity, others referred the failure of parasitoids mainly under the cold weather to random temperature and humidity and they required firm laboratory conditions to assure the success of reared *Trichogramma* parasitoids as those of (Berti and Marcano, 1993; Leatemia *et al.* 1995; Consoli and Parra, 1997). Others considered that mass rearing of the parasitoids could be accomplished under nature weather, and it could complete its life cycle normally as those of (Hutchison *et al*. 1990). It is known that hardening the parasitoid strain by alternating the rearing conditions or by the individual's deprivation or starvation for sometimes may provide the produced parasitoids with strength. Tougeron *et al.* (2019) stated that, in the context

of global change, modifications in winter conditions may disrupt the seasonal phenology patterns of organisms or modify the synchrony of closely interacting species and lead to unpredictable outcomes at different ecological scales. With the continuous mass-rearing of *T. evanescens* parasitoid throughout the year months, the author observed a new phenomenon occurred with the hatching period of the parasitoid as it extended for a long time (about three folds) than the normal hatching period which averaged about 9 days (Flanders, 1930). That phenomenon was occurred in cold weather under non-laboratory conditions, so this study was based on that notification to assess the impacts of that kind of parasitoid rearing on the fitness components of resulting parasitoids and to predict the reproduction and efficiency of produced parasitoids in fields under cold weather mainly with the current global climate changes. So, this work was established to investigate the impacts of non-laboratory conditions resembling field conditions on the biological parameters of emerged *Trichogramma* individuals in cold weather aiming at the production of high quality and efficient individuals acting well whenever it needed.

Materials and Methods

All the experiments were carried-out at Fayoum Laboratory of *Trichogramma*, Plant Protection Research Institute, Agricultural Research Center. Egypt. The rearing host eggs were *Sitotroga cerealella* Oliv. Rearing *S. cerealella* was accomplished as described by (Hassan, 1995) and *T. evanescens* rearing was done as mentioned by (Abd EL-Hafez, 1995). This work was designed to detect the adverse effects could be happened for *T.evanescens* in case it directly exposed to cold weather in the field to predict the efficiency of resulting Trichogrammatids. In this experiment, different immature developmental stages of *T. evanescens* at the egg, larva, pre-pupa and pupa stages were reared under two different rearing conditions: 1- Rearing with laboratory conditions (25±2°C, 75±5% R.H. with a photo period of 14:10 L: D) and it was the controls which was compared to 2- Rearing with the normal weather conditions (where there was no adjustment for temperatures or relative humidity nor photo periods). For each treatment; about 25 pieces of (1cmx1cm) of *T. evanescens* immature developmental stages were tested and

left till emergence. Then the number of days till emergence (hatching period) was counted to record the hatching period. After emergence, the emerged individuals were counted to record the percentage of adults, female's percentage in progeny was determined in each treatment. Then, twenty-five females from each treatment were placed individually in test tubes containing fresh *Sitotroga* eggs and provided with a droplet of honey as a diet. Daily inspection was done to count longevity of females and to count its fecundity (number of parasitized eggs). The general productivity (GP) was calculated according to Tshernyshev and Afonina (1995) as following:

GP= [Rate of emergence X Rate of produced females in progeny X Fecundity]

All data were processed by Independent T test and Descriptive Statistical Analysis using SPSS software version 25.

Results and Discussion

Influence of rearing treatments on hatching period

Rearing *T. evanescens* under the non-laboratory conditions treatment recorded significantly the longest hatching periods averaging (29.32; 28.52; 27.4 and 26.76 days) from egg, larva, pre-pupa and mature pupa stages, respectively. That values were about 3 times than those emerged under laboratory conditions with the average of (10.44; 9.36; 9.36 and 8.52) days from the previous immature stages, respectively. In general, the egg stage in the two treatments recorded the longest periods till adult's emergence (29.32 and 10.44 days) respectively (Fig. 1).

Influence of rearing treatments on percentage of emerged adults

Tested rearing treatments affected the adult emergence (F=6.197). Compared to the laboratory conditions treatment, the percentage of *T. evanescens* emergence attained (97.20%; 92.39%; 88.61% and 83.97%) from mature pupa, pre-pupa, larva and egg stages respectively. The lowest percentage of offspring (93.46%; 88.60%; 86.09% and 81.39%) emerged when immatures reared under non-laboratory conditions from pupa, pre-pupa, larva and egg stages respectively. Among treatments, the maximum emergence was recorded with pupa stage in both laboratory and non-laboratory rearing conditions (97.20% and 93.46%) respectively, while the lowest rates averaging (83.97% and 81.39%) were from the egg stage in both the treatments, respectively (Fig. 1).

Influence of rearing treatments on female percentage

Statistically, both rearing treatments had a significant effect on the produced females in progeny. It averaged (69.14%; 72.90%; 77.70% and 73.99%) with laboratory rearing treatments and (68.62%; 72.51%; 76.14% and 72.69%) with non-laboratory conditions treatment from egg; larva; pre-pupa and pupa stages respectively. In addition, the pre-pupa stage produced the highest percentage of females in progeny (Fig. 1).

Influence of rearing treatments on fecundity

Fecundity of *Trichogramma* females differed significantly in the tested rearing treatments Fig. (1). Females resulted from non-laboratory rearing conditions parasitized lower *Sitotroga* eggs with the means of (43.88; 46.0; 51.96 and 50.72) than those emerged under laboratory conditions which counted (44.36; 46.72; 52.88 and 51.52) eggs from stages of egg, larva, pre-pupa and pupa stages respectively. Fecundity of females emerged from pre-pupa stage had the highest fecundity with the means of (52.88 and 51.96 eggs) in laboratory and non-laboratory treatments (F=0.035) (Fig. 1).

Influence of rearing treatments on general productivity (GP)

The calculated general productivity of *T. evanescens* which presented in Figure (1) was reduced when they emerged from egg instar (24.51 and 25.75 females/female) with non-laboratory and laboratory treatments respectively. The highest GP (37.96 females/female) was recorded with pre-pupa from laboratory rearing treatment followed by pupa stage (37.05 females/female) with the same treatment, while those in non-laboratory treatment had close GP values to those of laboratory treatment (Fig 2). Obtained results of this work revealed that, non-laboratory rearing conditions had no obvious impacts on the efficiency of emerged Trichogrammatids, and they resembled those resulting with laboratory rearing conditions, the only difference between the two treatments was the obvious elongation in the hatching period which was extended for three times over those emerged under laboratory conditions. Therefore, those results could be used for different scientific, research and investment purposes as it could help the biological control applicators in detecting the accurate time of releasing *Trichogramma* parasitoids mainly in winter season. Also, it could simplify the rearing process. The present results could help in solving many obstacles facing insect breeders as for example; power outages or with sudden breakdown of incubators or devices needed for *Trichogramma* parasitoid rearing. Finally, it could help new breeders in making the rearing process easier and flexible; also the elongation of hatching period might provide emerged parasitoids with strength and resilience to face the different changes in the environmental stresses by alternating the conditions of rearing. In addition, the obtained results revealed that, *T. evanescens* females emerged from both treatments had parasitized offered *Sitotroga* eggs and gained high general productivity. Present results concerning the efficiency of resulting *Trichogramma* females under cold weather Corresponding results of Siam, 2017 and Hasan *et.al*. 2023 reported that, the tested developmental immature stages of *T.evanescens* could tolerate low temperatures and the resulting Trichogrammatids were efficient in parasitizing offered host eggs with high general productivity for their females and the mature pupa was the most susceptible stage to low temperature. The present results were on contrary with those of (Tabadero and Ceballo 2011 and Zhang *et al.* 2022) whose findings revealed that, *T. evanescens* females exposed to low temperature produced male biased sex ratio. Also, the results of El-Kazafy *et al*. (2021) revealed that, the developmental time affected the efficiency of emerged *Trichogramma* females and the early emerged ones were the highest quality females than those emerged late.

Conclusion

The good mass-rearing of *T. evanescens* parasitoids plays an important role in the effectiveness of parasitoids as bio-control candidates. From the above mentioned results it may be concluded that non-laboratory rearing conditions can be done to strengthen the strain in mass-rearing processes to establish a sustainable population of *T. evanescens.*

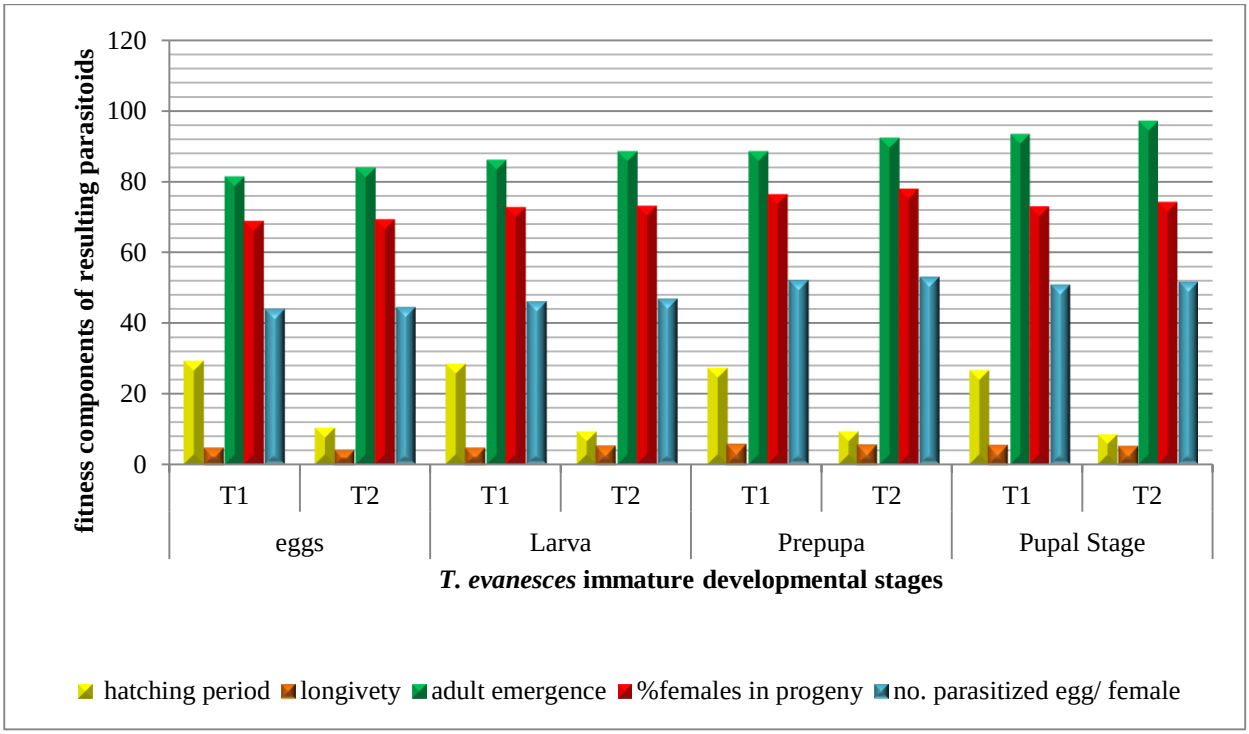

Figure 1. Effect of non-laboratory (T_1) and laboratory (T_2) rearing conditions of immature developmental stages of the parasitoid on hatching period, longevity, adult emergence, percentage of females in progeny and number of parasitized eggs.

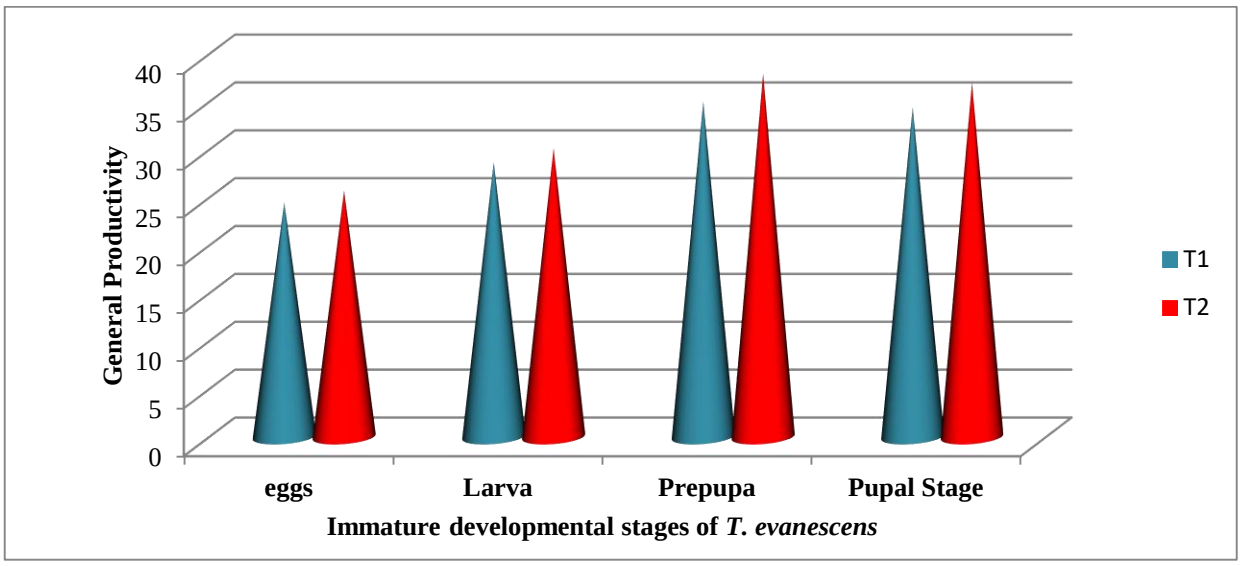

Figure 2. General productivity of *T. evanescens* females reared under non and laboratory rearing conditions.

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