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Effect of UV radiated *Corcyra cephalonica* eggs on biological attributes of *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae): A Review

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Abstract
The present study is aimed to find out the effect of UV radiation on *Corcyra* eggs and its effect on *Trichogramma*. There are not so many research works have been carried in the given area but a few which revealed that the UV radiation increased the adult and female emergence rate and it helps *Trichogramma chilonis* to parasitize *Corcyra* eggs in mother culture without any difficulty and if the eggs escape from the parasitoid, the radiation can damage the host eggs. Even though UV treatment disrupts physiology of the egg and stops further development, the nutrients available in such eggs may deteriorate with passing of time between irradiation and parasitoid introduction. Effect of this on parasitoids may not be realized in the first few generation. *Trichogramma* species face challenges in parasitizing eggs in normal conditions due to natural resistance mechanism evolved by the host. In this study it was noted that the longevity, fecundity and percentage emergence were enhanced by inducing stress factors, such as UV radiation to the eggs. These eggs can be used to successfully rear *T. chilonis* and for use as a biocontrol agent for lepidopteron pest.

Keywords: moths, rearing, UV, parasitoids, biocontrol

Introduction

Rice meal moth, *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) a stored grain insect pest is industrialized for mass production of many predators and parasitoids in the laboratory. Radiation play an important role in mass rearing of natural enemies because of its unique ability to slow down or stop the process of development of the host insect without affecting its quality. It increases the efficiency of mass rearing. It has been reported that the parasitization increased in the irradiated hosts (Hamed *et al.*, 2009 and Tucbilek *et al*., 2009) as irradiated eggs were found more suitable as compared to normal for parasitoids development. The irradiation of C. *Cephalonica* eggs are required to avoid emergence of its larvae as these eggs are used for mass-multiplication of *Trichogramma chilonis*. Irradiation of single layer of eggs stuck on cards with 15w germicidal tube light in a closed specially built chamber at a distance of 15-22.5cm for 5-6 minutes (Singh, *et al*., 1994) to 45 minutes (Manjunath,1985) ensured total mortality of eggs. These eggs remain good for parasitism, if used immediately. But refrigeration @4oC (not freezing) of UV treated eggs even for a short while will not ensure full parasitism (Bharti, 1994). In such a closed chamber, exposure at a distance of 17.5 cm for 15 minutes succeeded in arresting the embryonic development. It is desirable to have non – cannibalistic alternate hosts, amenable for laboratory mass production and acceptable to the parasitoids, these hosts include *Sitotroga, Ephestia, etc*, Sitotroga was found to be acceptable to *T. brasiliense Perk*., *T. achacae* Nag & Nagar., *T. japonicum* Westw. (Paddy & Sugarcane) and *T. bactrae* Nag. But due to its small size, a single egg can accommodate only one parasitoid individual while that of C. *cephalonica* being larger could accommodate up to 2-3 individuals. Even after parasitization, the *Sitotroga* eggs seem to be alive for some time since these also turn pinkish like fresh ones after 24 hrs. Such alternate hosts could be used for nucleus cultures. *T. pretiosum* Riley is known to produce more female progeny on eggs of *S. cerealella* and the potato tuber-moth. *Phthorimaea operculella Zell*. (Lepidoptera; Glelchiidae) as compared to those of *Helicoverpa armigera* Hub. (Lepidoptera. Noctuidae) in South Africa (Kfir, 1982).

Even though UV treatment disrupts physiology of the egg and stops further development, the nutrients available in such eggs may deteriorate with passing of time between irradiation and parasitoid introduction. Effect of this on parasitoids may not be realized in the first few generation. As a rule, a parasitoid attack live, healthy, active host and either the host activities stop immediately as in *Bracon* spp. or prolong for some time till or even after parasitoid larvae emerge as in *Cotesia* spp. and some other Microgasterines (Hymenoptera: Braconidae). Therefore, it is the live, active and healthy host that is required to sustain a normal, healthy parasitoid. Applying this rule, the eggs of *C. cephalonica* which are already killed (by irradiation) much before exposure for parasitism may serve at best as a perfect artificial host, their effect on the growth parasitoids over the period of generations has yet to be assessed. n the Philippines, the nucleus trichogrammatid colony is maintained on live *C. cephalonica* eggs. On third day of parasitism, the cards are placed on grains for the hatched larvae to move into grains without attacking adjoining parasitized eggs. However, the portion meant for field releases are taken from this nucleus culture every generation and bred on UV treated eggs and released immediately.

Perhaps No other entomophilous parasites have been seen extensively used as biological control against so many borer pests of different crops as species of *Trichogramma.* There probably have been more of egg parasites *Trichogramma* species cultured by man than parasites in any other genus. Among biological control agents, *Trichogrammatid* parasitoids were used worldwide (Senthil-Nathan et al., 2006) as they were found attacking the eggs of over 200 insect species (Manfield and Mills, 2004). The genus *Trichogramma* is gregarious endoparasites extensively used as Biological agent because they kill eggs of borer pests that cause serious damage. Mass rearing of *Trichogramma* spp., is an economically feasible methodology for control of many Lepidopteran pests (Wang *et al*, 2012).

Quite often, field collection trichogrammatids do not readily accept the factitious hosts with only a few females parasitizing; they however become fully adapted to the factitious hosts over the period of generations. Examples: *Trichogrammatoidea armigera* Nagraja *on C. cephalonica* and *Trichogramma chilonis Ishii* (cotton population) on *Sitotroga.* The examples also include the case of *Telenomus remus Nixon* (Hym., Scelionidae) on C. *cephalonica* (Kumar, *et al,* 1986). Such colonies may not produce desirable results against target pest in the field. Bigler *et al,* (1982) in Switzerland have shown that a lab strain of *T. evanescens* Westw. bred continuously on *Ephestia kuehniella* Zeller (Lep., Phycitidae) when released against *Ostrinia nubilalis* Hub. (Lep., Pyraustidae) gave 95% control in early stages. But after 100 generations of laboratory breeding, the effectiveness of the parasitoid diminished. It is hence also necessary that the lab colony be periodically augmented with field population. On the other hand, if the source population readily accepts lab hosts and maintains well even in the first generation, such colonies may work well in the field. An example was *T. chilonis ex*: Castor semi looper (CSL) bred over 100 generations on lab host preferred CSL when given a choice between C. *cephalonica* and CSL eggs in a small glass house experiment with potted castor plants (CIBC, unpublished data, 1974). Despite the fact that nutrients are available in the treated eggs supporting normal development of the parasitoid, long term rearing over several generations may have deleterious effect on the parasitoid.

Trichogramma species face challenges in parasitizing eggs in normal conditions due to natural resistance mechanism evolved by the host. This stress factor helps to increase in parasitization, emergence and viability rates in C. *cephalonica* eggs. These eggs can be used to successfully rear *T. chilonis* and for use as a biocontrol agent for lepidopteron pest.

Ultimately the farmers and people at large are the ones who should be benefitted in reducing the pest population in the field below the economic injury levels by inundative releases of these parasitoids. Therefore, the effectiveness of the laboratory–bred parasitoids (trichogrammatids in the present context) against the target pests is the one which becomes the main issue in the process. Hence, it is absolutely necessary to take all the aforesaid factors into consideration while scheming for commercial or otherwise mass production of trichogrammatids. There are many works have been conducted on longevity of wild strain of *Trichogramma chilonis* in which the longevity of wild strain of *Trichogramma chilonis* was significantly higher than in 3.5 and 4.5 h exposure time of UV radiation than other exposure time as in research of Balabantaray et. al., 2021 [1]. The adult emergence was significantly higher in 3.0 h UV treated in compare to normal eggs and the female emergence in also significantly higher (3h with >81%) than other UV exposure period as per the experiment of Cherif *et. al*., 2021 [7].

In the experiment of Balabantaray et. al., 2021 [1], it was also revealed that the adult emergence was significantly higher (>97%) in 3.0 and 4.5h than other exposure time. Female emergence was 86.06% with 4.5 h exposure time, that was significantly higher than 30 minutes to 5.0 h exposure time. The longevity of laboratory strain of *Trichogramma chilonis* was significantly higher than in 3 h and 5h exposure time of UV radiation than other exposure time.

Successful parasitization and subsequently normal adults' emergence was found from these irradiated eggs. UV rays used had damaged the host embryo due to smaller size and thin outer layer of the eggs, the damaged embryo could not develop into next stage. At the same time, damaged embryo had helped the *Trichogrammatid* for successful parasitization.

The Ultraviolet (UV) portion of the spectrum is widely used as germicide and as an attractant for insects in embryological – physiological studies and for the surface disinfection of insect eggs. A number of investigators have considered the possibility of using UV- rays to control, or at least to suppress development of various species of stored products insects Irradiation is effective against stored grain pest as it causes mortality as well as sterility in insects depending on the dose and time of exposure.

In mass rearing of the egg parasitoids, *Trichogramma* spp., the Rice Meal moth, *Corcyra cephalonica* Stainton is used as a factitious host. Hatching of the host larvae from unparasitized eggs is detrimental because of their habit of cannibalism and webbing which results in loss of parasitized eggs. Earlier studies have indicated that irradiation of host eggs prevent the embryonic development and remain acceptable to *Trichogramma* spp, (Breniere, 1965 a& b; Calderon and Navarro, 1971; Voegele *et.al*. 1974 and Bruce, 1975) [2, 3, 6, 18].

Conclusion

The UV radiation increased the adult and female emergence rate and it helps *Trichogramma chilonis* to parasitize *Corcyra* eggs without any difficulty and if the eggs escape from the parasitoid, the radiation can damage the host eggs. Even though UV treatment disrupts physiology of the egg and stops further development, the nutrients available in such eggs may deteriorate with passing of time between irradiation and parasitoid introduction. Effect of this on parasitoids may not be realized in the first few generation. *Trichogramma* species face challenges in parasitizing eggs in normal conditions due to natural resistance mechanism evolved by the host. In this study the longevity, fecundity and percentage emergence were enhanced by inducing stress factors, such as UV radiation to the eggs. These eggs can be used to successfully rear T. chilonis and for use as a biocontrol agent for lepidopteron pest.

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