



Multi-parasitism: a promising approach to simultaneously produce *Trichogramma chilonis* and *T. dendrolimi* on eggs of *Antheraea pernyi*

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With 3 figures and 2 tables

Abstract: *Ostrinia furnacalis* is considered the main insect pest on maize throughout Asia and both *Trichogramma dendrolimi* and *T. chilonis* are the major species used for control in Northeast China. However, the suboptimal control effect of *T. dendrolimi* (requiring releasing high numbers of parasitoids), as well as the suboptimal production efficiency of *T. chilonis* in mass-rearing facilities, have reduced to some extent their application. Given these challenges, we evaluated under laboratory conditions the possibility of simultaneously producing *T. dendrolimi* and *T. chilonis* on *Antheraea pernyi* eggs using multi-parasitism at different ratios (*T. dendrolimi*: *T. chilonis*: fresh *A. pernyi* eggs = 1:4.7:70, 1:3.5:70, 1:2.8:70, and 1:2.3:70). Our data showed that *T. dendrolimi* and *T. chilonis* could be successfully co-produced on *A. pernyi* eggs. The parasitism rate and the number of emerged parasitoids per egg were significantly higher in multi-parasitism than in mono-parasitism conditions whereas the emergence rate (> 92%) and the number of female remained constant; suggesting a high host quality. When the parasitoids: hosts ratio increased, all these biological parameters decreased significantly whereas the emergence rate was still constant. A two years of field experiments enabling to evaluate the ability of the parasitoids produced from mono- and multi-parasitized wasps to control *O. furnacalis*, demonstrated that the control of the pest population was higher when parasitoids were produced under multi-parasitism than under mono-parasitism conditions (83% vs. 68%, respectively). The results of this study provided useful information for a more effective and economical method of controlling *O. furnacalis* and developing *Trichogramma* products using multi-parasitism.

Keywords: biological control; mass rearing; co-production; *Ostrinia furnacalis*; alternative host

1 Introduction

Maize is one of the most important cereal and feed crops worldwide but a major factor limiting production in Asia is the incidence of the Asian corn borer, *Ostrinia furnacalis* (Crambidae), considered the main pest species, causing significant reductions in total grain yields annually (Huang et al. 2020). Moreover, global changes such as global warming and agricultural intensification (e.g. simplification of planting patterns and extensive use of pesticides) have made it

more difficult to effectively control this pest (Li et al. 2009), notably leading to increasing occurrence of multivoltinism (Liu et al. 2021).

Trichogramma spp. are used as biological control agents of lepidopteran pests in control programs throughout the world (Smith 1996; Desneux et al. 2010; Tabone et al. 2010; El-Arnaouty et al. 2014; Zang et al. 2021). *Trichogramma* parasitoids, including *T. ostrinae*, *T. dendrolimi* and *T. chilonis*, have been widely used as augmentative biological control agents to control *O. furnacalis* for several years, of which