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Survival and development of *Campoletis chlorideae* on various insect and crop hosts: implications for *Bt*-transgenic crops

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Abstract: The parasitic wasp, *Campoletis chlorideae* is an important larval parasitoid of *Helicoverpa armigera* a serious pest of cotton, grain legumes and cereals. Large-scale deployment of *Bt*-transgenic crops with resistance to *H. armigera* may have potential consequences for the development and survival of *C. chlorideae*. Therefore, we studied the tritrophic interactions of *C. chlorideae* involving eight insect host species and six host crops under laboratory conditions. The recovery of *H. armigera* larvae following release was greater on pigeonpea and chickpea when compared with cotton, groundnut and pearl millet. The parasitism by *C. chlorideae* females was least with reduction in cocoon formation and adult emergence on *H. armigera* larvae released on chickpea. Host insects also had significant effect on the development and survival of *C. chlorideae*. The larval period of *C. chlorideae* was prolonged by 2–3 days on *Spodoptera exigua*, *Mythimna separata* and *Achaea janata* when compared with *H. armigera*, *Helicoverpa assulta* and *Spodoptera litura*. Maximum cocoon formation and adult emergence were recorded on *H. armigera* (82.4% and 70.5%, respectively) than on other insect hosts. These studies have important implications on development and survival of *C. chlorideae* on alternate insect hosts on non-transgenic crop plants, when there is paucity of *H. armigera* larvae on transgenic crops expressing *Bt*-toxins.

Key words: *Achaea janata*, *Helicoverpa armigera*, *Mythimna separata*, *Spodoptera litura*, alternative hosts, biocontrol, transgenics, tritrophic interactions

1 Introduction

The larval endoparasitoid, *Campoletis chlorideae* Uchida (Hym., Ichneumonidae), parasitizes diverse insect species of Lepidoptera (Yan and Wang 2006), however, information on its parasitism potential, development and survival on different insect and crop hosts is scanty. Under natural conditions, *Helicoverpa armigera* (Hübner) is the most preferred host of *C. chlorideae* on a number of crops, such as cotton, groundnut, chickpea, pigeonpea, sorghum and pearl millet (Patel and Patel 1972; Bhatnagar et al. 1982; Kumar et al. 1994). However, introductions of transgenic crops have raised the concerns regarding their impact on natural enemies (Sharma and Ortiz 2000).

The eggs of *C. chlorideae* hatch in 1.0–1.5 days, total egg + larval development period takes about 7–8 days, and the larval feeding is completed on the *H. armigera* larva (Sharma and Dhillon 2005). On completion of larval development, the *C. chlorideae* larva emerges from the host larva. It weaves a cocoon around itself and the pupal period extends for about 6 days. Post-embryonic development of *C. chlorideae* is completed in about 13–14 days.

Considerable progress has been made over the past two decades in handling and introduction of novel genes into crop plants to impart resistance to biotic stresses, tolerance to abiotic stresses, improve nutrition and increase crop yields. Genes from bacteria, such as *Bacillus thuringiensis* (*Bt*), have been deployed successfully for pest control through transgenic crops on a commercial scale (Hilder and Boulter 1999; Sharma et al. 2001). Transgenic cotton cultivars with resistance to *H. armigera* have been released for cultivation in several countries (James 2005), while transgenic chickpea (Ramakrishna et al. 2005) and pigeonpea (Sreelatha et al. 2005) with resistance to this pest are currently under development. To ensure a sustainable deployment of transgenic insect-resistant plants, it is important to assess their compatibility with other control tactics including the natural enemies. The *Bt* proteins prolong the larval period, reduce cocoon formation and adult emergence of *C. chlorideae* when reared on *Bt*-intoxicated *H. armigera* larvae (H. C. Sharma, unpublished data; Zhang et al. 2006). Therefore, deployment of *Bt*-transgenic pigeonpea, chickpea and cotton with resistance to *H. armigera* might have a considerable influence on the activity and abundance of *C. chlorideae* in different agro-ecosystems. Thus, there is a need to generate information on influence of insect and crop hosts as alternatives for the development and survival of *C. chlorideae* under the situations of large-scale cultivation of *Bt*-transgenic crops. Therefore, the