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PrePub-Article

Highly diversified crop systems can promote the dispersal and foraging activity of the generalist predator *Harmonia axyridis*

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With 6 figures

Abstract: High plant biodiversity and landscape food provision stability is known to have a positive impact on biocontrol services provided by natural enemies. However, few studies have assessed how differential spatial and temporal crop richness actually impact biocontrol services, and notably how natural enemies may spill-over among crops. Within this framework, using a four-cage maze system under laboratory conditions, we evaluated the effect of a diversified crop system (four crops, namely cotton, tomato, squash and soybean) and low diversified crop systems (one single crop), on the generalist predator *Harmonia axyridis* (Pallas) and its predation capacity on aphids. The system varied food availability both in space, i.e. different cages, and in time, i.e. different dates of resources implementation. In general, the effects of crops on the natural enemies' traits observed in the diversified crop system resulted from the average effects of the individual low diversified crop systems; the impact of the predator was highly dependent on the plant. Low diversified crop systems actually proved to be either very suitable for the predator's development (tomato and squash), or not at all (soybean and cotton), but inversely suitable in reducing pest population with lower efficacy in tomato and squash and higher efficacy in soybean and cotton. The spillover of the ladybird was strongest in the squash low diversified crop system and lowest in the cotton one, other systems showing intermediate spillover values. In the diversified crop system, the ladybird presence was always closely related to plant presence, and aphid populations were maintained at a stable population increase. Still, the predator was also found in cages lacking plants, as opposed to the low diversified crop systems; this hinted at the potential of the highly diversified crop system to promote ladybird dispersal and increase foraging activity. We demonstrate that increasing crop diversity in agroecosystems may help promote biocontrol services provided by *H. axyridis* by promoting its spillover between crops (e.g. while the plants are senescing and/or when they are harvested).

Keywords: polyculture, monoculture, resource diversity, ladybird, generalist predator, aphid

1 Introduction

Modern agricultural practices, such as using chemical control on insect pest populations, have multiple side effects on other insect communities, including negative effects on natural enemies, thereafter named "NEs" (Kareiva 1987, Desneux et al. 2007, Lew et al. 2009, Hallmann et al. 2014, Tejada et al. 2015, Heimbach et al. 2017). By simplifying agricultural landscapes, modern agriculture leads to a reduction in habitat stability which is defined by the capacity of a habitat to maintain NEs, through the spatial and temporal continuum of their resources, a key parameter to maintain biocontrol services (Rand et al. 2006, Woodcock et al. 2016, Gurr et al. 2017). A growing body of evidence suggests that naturally occurring NEs could replace chemical inputs to control pest populations in many cases (Desneux et al. 2006, Rasgdale et al. 2011, Lu et al. 2012, Wratten et al. 2012, Jonsson et al. 2014, Biondi et al. 2018, Karp et al. 2018, Jactel et al. 2019). The lack of habitat stability and/or food sources may lead to a decrease in arthropod biodiversity and could reduce biocontrol services provided by natural enemies (Veres et al. 2013, Martin et al. 2016). Continuity of nutritional resources is a key aspect for maintenance of food-web stability (Vasseur et al. 2013, Schellhorn et al. 2015). Habitat management to keep NEs in the fields and increase biocontrol is a key aspect used in Conservation Biological Control (CBC) (Eilenberg et al. 2001, Lundgren et al. 2009; Chailleux et al. 2014). This Technique consists in manipulating the habitats in order

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