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Effects of floral and extrafloral resource diversity on the fitness of an omnivorous bug, *Orius insidiosus*

Lorena Pumariño[1], Oscar Alomar[1] & Jonathan G. Lundgren[2]*

[1]*Entomology, IRTA, Carretera de Cabrils, km. 2, E-08348 Cabrils, Barcelona, Spain, and* [2]*North Central Agricultural Research Laboratory, USDA-ARS, Brookings, SD 57006, USA*

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Abstract

Habitat manipulation and increasing biodiversity are important approaches that enhance biological control of pests, but it is important to evaluate the relative benefits of specific plant species when designing conservation programs. *Orius insidiosus* Say (Hemiptera: Anthocoridae) is an important predator of thrips and aphids that also feeds on plants. It is the target of conservation biological control programs. Despite *O. insidiosus*' relevance, little is known about the effects of plant subsidies on predator performance or nutritional status. Here, we examined the influence of restricting the pollen and nectar resources of five plant species (alyssum, buckwheat, phacelia, fava bean, and chamomile), and how increasing plant diversity affects *O. insidiosus* fecundity, survival, and nutritional status. Plant species varied in their suitability for *O. insidiosus*, which was driven in part by the availability of the pollen or nectar resources. Offering plants as a mixture did not improve fecundity; however, the plant least preferred for oviposition under no-choice tests (fava bean) became the preferred egg-laying site when the plants were offered in combination. We conclude that the benefits obtained by *O. insidiosus* vary among plant species, and that increasing plant diversity can have unpredicted, positive effects on insect fitness.

Introduction

Increasing biodiversity in natural and managed ecosystems can increase pressure on herbivores and improve pest management through biological control (Andow, 1991; Landis et al., 2000; Gurr et al., 2003; Lundgren et al., 2009; Letourneau et al., 2011). Natural enemies could be augmented through either an improvement in their fitness, attraction from neighboring habitats, or an increase in their oviposition rate (Alomar & Wiedenmann, 1996; Lundgren et al., 2009). Fiedler & Landis (2007a,b) suggested that a viable strategy to conserve natural enemies within a habitat would be to mix plant species such that floral resources would be available over a long duration of time. The most beneficial plant species should be identified and provided, either alone or in combination, to selectively enhance the abundance of each natural enemy under study. It is important to determine the extent to which an increase in biodiversity affects beneficial arthropods.

*Correspondence: Jonathan G. Lundgren, NCARL, USDA-ARS, 2923 Medary Avenue, Brookings, SD 57006, USA. E-mail: jonathan.lundgren@ars.usda.gov

Plant resources (pollen, floral, and extrafloral nectar, or plant sap) are used by natural enemies as food sources (Wäckers et al., 2005; Lundgren, 2009). As a result, the provision of flowering plants can enhance the effectiveness of natural enemies by increasing their longevity, fecundity, and predation or parasitism rates (Berndt & Wratten, 2005; Begum et al., 2006; Lee & Heimpel, 2008). Specifically, sugar feeding improves the fitness and performance, and affects the nutrient status in parasitoids (Olson et al., 2000; Lee et al., 2004; Chen & Fadamiro, 2006; Nafziger & Fadamiro, 2011) and predators (Lundgren & Seagraves, 2011; Seagraves et al., 2011). Research has long supported the importance of nectar feeding for parasitoid life histories, but nectar resources for predators have received less attention until recently. The impact of different pollen and nectar sources on predator survival, longevity, or development should be quantified as insect conservation programs are developed for specific natural enemies.

Several factors affect the relative preferences of natural enemies for specific plant species, of which accessibility and quality of the nectar and pollen are particularly important (Colley & Luna, 2000; Ambrosino et al., 2006; Hogg et al., 2011). Floral architecture restricts which insects can

