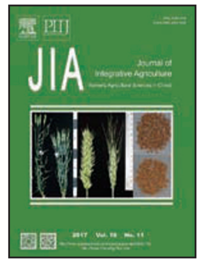
Journal of Integrative Agriculture 2017, 16(11): 2534–2546

Available online at www.sciencedirect.com

ScienceDirect



RESEARCH ARTICLE

Effects of sesame nectar on longevity and fecundity of seven Lepidoptera and survival of four parasitoid species commonly found in agricultural ecosystems

LIU Kai[1, 2*], ZHU Ping-yang[3, 4*], LÜ Zhong-xian[1], CHEN Gui-hua[3], ZHANG Jing-ming[1], LÜ Yao-bing[1], LU Yan-hui[1]

[1] *State Key Laboratory Breeding Base for Zhejiang Sustainable Pest and Disease Control, Institute of Plant Protection and Microbiology, Zhejiang Academy of Agricultural Sciences, Hangzhou 310021, P.R.China*

[2] *State Key Laboratory of Biocontrol, School of Life Sciences, Sun Yat-sen University, Guangzhou 510275, P.R.China*

[3] *Jinhua Plant Protection Station, Jinhua 321017, P.R.China*

[4] *School of Agricultural and Wine Sciences, Charles Sturt University, New South Wales 2800, Australia*

Abstract

Ecological engineering involves the use of plants to promote establishment, survival and efficiency of natural enemies in agricultural systems. Some plant species may be hosts or provide resources to some pest species. We assessed the risks and benefits of sesame (*Sesamum indicum* L.), as a nectar source for seven economically important Lepidopteran pest and four parasitoid species in a range of vegetable crop systems. Our results showed that the mean longevities of arthropod parasitoids *Pteromalus puparum* (L.), *Encarsia sophia* (Girault & Dodd) and male *Microplitis tuberculifer* (Wesmael) were significantly extended when fed on sesame flowers compared to the water control. Sesame flowers had no effect on adult longevities and fecundities of six out of the seven Lepidoptera pest species tested except *Plutella xyllostella* (L.) females laid more eggs when fed on sesame flowers. It is likely that the increased fecundity is due to accessibility to nectar at the bottom of corolla because of their smaller body sizes. Our findings provide a first step towards better understanding of the risks and benefits of using sesame to implement ecological engineering for the management of vegetable pests.

Keywords: Lepidopteran pests, natural enemies, flowering plant, risks and benefits assessment, ecological engineering

1. Introduction

Ecological engineering has been studied in several crop systems and has been shown that strategies to conserve natural enemies can improve pest management (Wäckers *et al*. 2007; Lundgren *et al*. 2009; Simpson *et al*. 2011; Gurr *et al*. 2004, 2012a, 2015; Balzan *et al*. 2014; Jamont *et al*. 2014; Maselou *et al*. 2014; Zhu *et al*. 2014; Lu *et al*. 2015). The studies revealed the importance of honeydew, nectar and pollen as food sources to enhance adult longevity and reproductive rate and dispersal of natural enemies (Wäckers

Received 13 February, 2017 Accepted 10 May, 2017
LIU Kai, E-mail: liukai5088@126.com; Correspondence LÜ Zhong-xian, Tel: +86-571-86404077, Fax: +86-571-86404225, E-mail: luzxmh@163.com
* These authors contributed equally to this study.

doi: 10.1016/S2095-3119(17)61665-4

and van Rijn 2005, 2012; Irvin *et al*. 2007; Winkler *et al*. 2009a; Biondi *et al*. 2016; Tena *et al*. 2016; Zhao *et al*. 2017).

Parasitoids are important biological control agents of numerous pest species (Macfadyen *et al*. 2015). Many of them require sugar resources, such as floral nectar, for nutrition during the adult stage (Wäckers 2004). Feeding on floral resources has been shown to increase the longevity of adult parasitoids and parasitism rates (Baggen and Gurr 1998; Lavandero *et al*. 2006; Winkler and Wäckers 2006; Winkler *et al*. 2009a; Zhu *et al*. 2013a, 2015). At the same time the floral resources can also benefit some pest species (Kevan and Baker 1983; Winkler *et al*. 2005b; Winkler and Wäckers 2006; Wäckers *et al*. 2007; Williams and Roane 2007; Géneau *et al*. 2012; Gurr *et al*. 2012b; Parolin *et al*. 2012; Balzan and Wäckers 2013). Thus in order to develop a well-balanced ecological engineering strategy, it is important to identify plant species that have relatively higher benefits to natural enemies than to pest species (Wäckers *et al*. 2007; Wratten *et al*. 2012). This selectivity can be based on differences in preference on flowers, ability to access floral resources, as well as differences in nectar compositions (Wäckers 2005). While many parasitoids can feed on floral nectar (Kevan and Baker 1983), the exploitation of floral nectar is often limited to open and accessible flowers (Winkler *et al*. 2009a), as their abilities to extract nectar are constrained by their mouthparts structures (Jervis *et al*. 1993; Patt *et al*. 1997; Baggen *et al*. 1999; Wäckers 2001; Bianchi and Wäckers 2008). Different responses to floral nectar composition and nectar viscosity also play important roles (Wäckers 1999, 2001; Romeis and Wäckers 2002; Winkler *et al*. 2005a).

In our previous studies, we showed that the presence of sesame (*Sesamum indicum* L.) flowers in rice fields enhanced the performance of natural enemies and did not benefit to the main Lepidopteran pest species such as the stem borers (*Sesamia inferens* and *Chilo suppressalis*) and leaf folders (*Cnaphalocrocis medinalis* and *Marasmia patnalis*) (Zhu *et al*. 2013a, b, 2014, 2015; Lu *et al*. 2015). Responses of Lepidoptera pests and parasitoids to sesame flowers in vegetable crops are however less known (Liu Y Q *et al*. 2014). In this paper, we report laboratory evaluations of risks and benefits of sesame used as a food resource for parasitoids in vegetable cropping systems by evaluating the effects of nectar-providing sesame flowers on fitness parameters of several vegetable Lepidopteran pests and their parasitoids.

First, we determined the nectar accessibility of the various species by examining the sesame floral architecture. Next, we evaluated adult longevities and fecundities of adult Lepidoptera when exposed to individual sesame flowers. In order to verify whether the seven Lepidoptera pest species were able to access the sesame nectar, we examined the mouthpart structures and morphology of each pest species, and compared them with the sesame floral architecture. From the results we determined the risks and benefits of sesame to the respective pest and parasitoid species.

2. Materials and methods

2.1. Plants and insects

Seeds of *S. indicum* (a landrace from Zhejiang Province, China), were collected from a field in Jinhua City, Zhejiang Province (29.0833°N, 119.6500°E) and grown in the laboratory as previously described by Zhu *et al*. (2013a). Commercial seeds of a cruciferous vegetable (*Brassica oleracea* L. var. *capitata* L.), Jingfeng 1, were used as the host plant for Lepidoptera pests. Seeds were sown in plastic pots (8 cm in diameter, 6 cm in height) filled with soil and thinned to one plant per plot at 20 days after emergence. Plants were grown in the greenhouse with an average temperature of (24.5±5)°C and 78% relative humidity, and exposed under natural light with day lengths ranging from 13.5–14 h.

Seven key Lepidoptera pest species of crucifers and four related Hymenoptera parasitoids were evaluated (Table 1).

2.2. Effects of *S. indicum* floral resources on adult longevity and fecundity of Lepidoptera pests

A pair of freshly emerged (<24 h) adults of each pest species (except for *Plutella xyllostella*) were placed into cylindrical mylar film cages (20 cm high, 9 cm in diameter). They were subjected to three treatments: a flower of *S. indicum* (excised and placed into water soaked cotton wool) plus a water-soaked cotton ball (sesame flowers kept turgid by placing the cut end within water-soaked cotton wool), a cotton ball with 10% v/v honey water solution, and a water-soaked cotton ball as control. Each cylindrical mylar film cage containing the treatment was covered with a piece of gauze. Folded stencil paper (about 10 cm×10 cm) was provided for adult moths to lay their eggs. Cages were placed in a fully randomized design with 15–20 concurrent replicates in a controlled climate room set at (26.0±1)°C, 70–90% RH, 12 h D:12 h L. Nutrient sources in all treatments were changed daily and the adult longevity and numbers of eggs laid were aslo recorded daily.

A pair of freshly emerged (<24 h) *Plutella xylostella* adults and a piece of *Brassica oleracea* leaf were placed into glass tubes (7 cm high, 2.5 cm in diameter) to stimulate *P. xylostella* to lay eggs with a transparent weighing paper inside for adult moth laying eggs and were subjected to the same three treatments described above. Tubes were placed in a fully randomized design with 20 concurrent replicates in a