Available online at www.sciencedirect.com

SCIENCE @ DIRECT®

Biological Control 33 (2005) 56–64

Biological Control

www.elsevier.com/locate/ybcon

Orius insidiosus (Say) as a predator of the soybean aphid, *Aphis glycines* Matsumura

Claire E. Rutledge*,[1], Robert J. O'Neil

Department of Entomology, Purdue University, Smith Hall, 901 W. State Street, West Lafayette, IN 47907-2089, USA

Received 13 September 2004; accepted 4 January 2005

Abstract

The soybean aphid, *Aphis glycines* Matsumura, a pest of soybeans in Asia, invaded North America recently. The indigenous generalist predator *Orius insidiosus* (Say) is common in Midwestern US soybean fields throughout the soybean-growing season. From its phenology and abundance, we hypothesize that this predator could act to suppress soybean aphid population growth by attacking aphids during the critical period when aphids are first colonizing soybean fields. Therefore we conducted a series of laboratory assays of *O. insidiosus* to evaluate the conditions under which it may effectively suppress aphid population growth. We conducted a standard functional response experiment and found that *O. insidiosus* had a maximum attack rate of 19.25 (±0.06 SE) aphids in 24 h. We examined the ability of *O. insidiosus* to suppress aphid population growth over a four-day period in microcosms with different numbers of aphids, plant sizes, and plant numbers. We found that predators were able to effectively suppress aphid population growth, but that their efficacy depended upon the number of prey present and characteristics of the plant on which prey were found. Further, we showed that *O. insidiosus* was able to suppress aphid population growth below starting densities for an extended time period (12 days). These results suggest that under certain conditions, *O. insidiosus* can effectively suppress aphid population growth and that they may be key factors influencing aphid population dynamics in soybeans.

Keywords: Soybean aphid; *Aphis glycines*; *Orius insidiosus*; Biological control; Population suppression

1. Introduction

The soybean aphid, *Aphis glycines* Matsumura (Homoptera: Aphididae), a pest of soybeans in Asia, recently invaded North America. Soybean aphids were discovered infesting soybean fields in the Midwest in the summer of 2000, and by 2003 had been found in over 21 states and three Canadian provinces (Ragsdale et al., 2004). The soybean aphid reduces yield directly via plant feeding and indirectly through virus transmission and reduction in seed protein content (D'yakonov, 1975; Halbert et al., 1986; van den Berg et al., 1997; Wang et al., 1994). In a Wisconsin study, high levels of aphid infestation in 2003 were associated with up to 50% reduction in yield (Meyers and Hogg, 2003). We have seen yield reductions of up to 25% in Indiana (RJO unpublished data). The aphid has served as a keystone pest, triggering insecticide applications in soybean fields throughout the US and Canada. For many locations, this was the first time ever that soybean fields were treated for any insect pest.

In Asia, the soybean aphid is attacked by braconid and aphelinid parasitoids, fungal pathogens, and predatory coccinellids, chamaeymyids, syrphids, anthocorids, and chrysopids (Chang et al., 1994; Heimpel et al., 2004; Quimio and Calilung, 1993; van den Berg et al., 1997; Wang and Ba, 1998). In Indonesia, naturally occurring populations of the coccinellid *Harmonia arcuata* (Fab.) and the staphylinid *Paederus fuscipes* Curtis play important roles

* Corresponding author. Fax: +1 203 974 8502.
E-mail address: Claire.Rutledge@po.state.ct.us (C.E. Rutledge).
[1] Present address: Connecticut Agricultural Experiment Station, 123 Huntington St., New Haven, CT 06504, USA.

1049-9644/$ - see front matter © 2005 Elsevier Inc. All rights reserved.
doi:10.1016/j.biocontrol.2005.01.001

in aphid population dynamics (van den Berg et al., 1997). In the Midwestern United States, surveys of the natural enemies of the soybean aphid have shown that predators commonly dominate the natural enemy community (Rutledge et al., 2004). Although aphid populations can drop precipitously during fungal epizootics (Ragsdale et al., 2004) and occasionally parasitism rates can be locally high, predators remain the most significant natural enemy in midwestern soybean fields (Rutledge et al., 2004).

A common predator in Indiana, and other midwestern soybean fields, is *Orius insidiosus* (Say) (Heteroptera: Anthocoridae) (Bary, 1973; Clements and Yeargan, 1997; Raney and Yeargan, 1977; Rutledge et al., 2004). *O. insidiosus* is a generalist predator, and its population dynamics in soybean fields have been linked to both thrips population levels (Isenhour and Marston, 1981; Kampmeier, 1984; RJO, unpublished data) and soybean flowering (Isenhour and Marston, 1981). Both nymphs and adults have been observed eating soybean aphids in the field (Rutledge et al., 2004), and *O. insidiosus* can complete its life cycle on a diet of soybean aphids in the laboratory (RJO, unpublished data). *O. insidiosus* is generally present in Indiana soybean fields when soybean aphids arrive. During the aphid's initial colonization of the crop *O. insidiosus* is typically the numerically dominant predator (Rutledge et al., 2004).

In annual crop systems, such as soybeans, early season predators have the potential to suppress populations of invading pests before the pests reach high population levels (Chang and Kareiva, 1999; Murdoch et al., 1985; Symondson et al., 2002; Wiedenmann and Smith, 1997). The presence of *O. insidiosus* in soybean fields when soybean aphids arrive suggests that it could have a significant impact on aphid population growth, and potentially suppress aphid outbreaks. In 2001 this potential was indicated by an inverse relationship between number of weeks that *O. insidiosus* colonized a field before soybean aphid arrival, and eventual severity of the soybean aphid infestation (Rutledge et al., 2004). The coincidence of *O. insidiosus* with respect to soybean aphid arrival and subsequent dynamics suggest that predation by *O. insidiosus* early in the invasion cycle can be key to preventing an aphid outbreak (see also Landis and van der Werf, 1997).

Factors other than phenology affect a predator's ability to suppress pest populations. Among these are the density and distribution of prey (Flaherty and Huffaker, 1970; Hassell, 1978; Kareiva and Perry, 1989; Kareiva and Sahakian, 1990; Solomon, 1949). For foliar searching predators like *O. insidiosus* (Coll and Ridgway, 1995; Isenhour and Yeargan, 1981), encounter rate between predators and prey will be influenced by both number of prey present and size of the plant upon which prey are located (see O'Neil, 1997). Because these predators traverse the plant to find prey, density of prey can change either through change in prey number or through changes in plant size. Although the impact of plant size on *O. insidiosus* predation has been assessed in other systems (Coll et al., 1997), its reaction to changes in soybean plant size is not known.

Distribution of prey can also affect their encounter rate with predators (Evans, 1976). In soybeans, soybean aphids are at first sparsely distributed among plants (Ragsdale et al., 2004). As time continues the frequency of occupied plants increases, but numbers of aphids per plant remains low. It is only after most plants in a field have at least one aphid that numbers of aphids per plant increase. Spatial distribution of aphids therefore changes over time. A searching predator must accommodate these changes to encounter and attack enough aphids to influence the aphid's population growth. It is not known how the aphid's distribution pattern affects *O. insidiosus* predation, but if *O. insidiosus* is to suppress early-season aphid population growth it must be able to locate aphids among plants, particularly when aphid numbers per plant are relatively low.

To better understand the conditions under which *O. insidiosus* might impact population dynamics of soybean aphid, we examined several facets of the interaction between soybean aphids and *O. insidiosus* in the laboratory. We determined the maximum attack rate of *O. insidiosus* preying on soybean aphids by measuring its functional response. We then conducted a series of experiments to assess the ability of *O. insidiosus* to suppress aphid population growth during initial aphid colonization conditions, specifically examining number and distribution of aphids, and size of soybean plants. We created different densities of aphids by changing the number of aphids on a plant, and by changing the size of the plant. We examined how aphid distribution affects the ability of *O. insidiosus* to suppress population growth by measuring aphid population growth when aphids were dispersed among plants. Finally, we assessed the ability of the predator to suppress soybean aphid populations over an extended time period. This time period was approximately equal to the length of time when aphid population density in the field is similar to the densities we tested in the laboratory. Our objectives in these experiments were to better understand how these characteristics of the aphid-predator-soybean dynamic affect aphid population growth and to gain insight into the potential of predators like *O. insidiosus* to influence aphid outbreaks in soybeans.

2. Materials and methods

2.1. Plants and insects

2.1.1. Soybeans

Soybeans (var. Beck 366NRR, Beck Hybrids, Atlanta, IN) were planted four to a pot in 26 cm pots using