FUTURE OF BIOCONTROL FOR SOYBEAN APHID

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Introduction

The soybean aphid, *Aphis glycines*, is a serious pest of soybean in Wisconsin and the upper Midwest. An import from China, the initial detection in 2000 of the soybean aphid in North America was in Wisconsin (Wedberg et al., 2001). Midwestern entomologists responded to the challenge of soybean aphid management by working together to determine a treatment threshold (Ragsdale et al., 2007) to use in conjunction with insecticidal control. In addition, research on soybean plant resistance is underway and is showing great potential as a tool for soybean aphid management (Hill et al., 2006a,b, Diaz-Martin et al., 2007). A third important management tactic, and the topic of this report, is biological control (or biocontrol) of the soybean aphid. We use the term biological control in its broadest context to include the actions of all types of aphid natural enemies – predators, parasitoids and pathogens - and species that are naturally occurring as well as those under human manipulation. We will focus our comments on predators and parasitoids. Soybean aphid is attacked by a number of pathogenic fungi (Nielsen and Hajek, 2005), but we have not observed pathogens to be a significant source of aphid mortality in Wisconsin.

Predators

A complex of insect predators attacks the soybean aphid in Wisconsin (Table 1). The most commonly encountered predator of the nine listed is the Asian lady beetle. Ironically, this predator is also an exotic species from China that was intentionally introduced into the southeastern U.S. and arrived in Wisconsin in the late 1990s. The Asian lady beetle is an aggressive and voracious predator of soybean aphids, but unfortunately it has significant negative attributes as well. The seven spotted lady beetle is an exotic species as well, having arrived in Wisconsin in the early 1980s.

Table 1. Soybean aphid predators commonly found in Wisconsin.

Species	Order: Family	Predatory stage(s)
Lady beetles	Coleoptera: Coccinellidae	Larva & Adult
Asian lady beetle (*Harmonia axyridis*)		
Seven spotted lady beetle (*Coccinella septempunctata*)		
Pink lady beetle (*Coleomegilla maculata*)		
Minute pirate bug (*Orius insidiosis*)	Hemiptera: Anthocoridae	Nymph & Adult
Damsel bugs (*Nabis* species)	Hemiptera: Nabidae	Nymph & Adult
Lacewings		
Green lacewings (*Chrysoperla* species)	Neuroptera: Chrysopidae	Larva
Brown lacewings (*Hemerobius* species)	Neuroptera: Hemerobiidae	Larva
Predatory flies		
Syrphid flies (many species)	Diptera: Syrphidae	Larva
Aphid midge (*Aphidoletes* sp.)	Diptera: Cecidomyiidae	Larva

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Parasitoids

Predators have responded to the soybean aphid invasion, and collectively they help suppress aphid numbers and lessen the impact of the pest on soybean productivity. However, a major component of the suite of natural enemies that typically attack pest aphids – parasitoids – is largely missing for the soybean aphid. These parasitoids are tiny, non-stinging wasps. The female uses her "stinger" to lay an egg inside an aphid, where the wasp larva feeds, develops, and eventually kills the host aphid. Parasitoids fill an important niche – they have much shorter generation times than do predators and can thus "keep up" better with growing aphid populations, plus parasitoids often provide better control than do predators at low aphid densities early in the season.

To address this absence of soybean aphid parasitoids, a collaborative project involving university and federal (USDA) entomologists has sponsored exploration in China and other Asian countries to find and collect parasitoids of the soybean aphid. Promising species are shipped to quarantine facilities in the U.S. to be evaluated for potential establishment against soybean aphid here. While in quarantine, each of the parasitoid species is studied to assess its potential effectiveness to control soybean aphids as well as to ensure insignificant risks for safety and non-target effects. This approach, which is known as "importation" or "classical" biological control, has been successfully employed for a number of other exotic insect pests.

More than a dozen parasitoid species are now in quarantine in the U.S., and one species, known only by its scientific name *Binodoxys communis*, has been fully vetted (e.g. Wyckhuys et al., 2008) and obtained USDA and selected state permits for release in soybean fields. *B. communis* was released in six states (IA, IN, MN, MI, and SD, as well as WI) during 2008, at 32 separate sites across the region, and the parasitoid was subsequently recovered at most of the release sites. We made seven releases in Wisconsin, which are detailed in Table 2. We monitored each of these sites weekly, and we recovered parasitoids at all but the Muscoda site. However, *B. communis* must survive the winter and be recovered in 2009 before truly successful establishment can be determined.

Table 2. 2008 Wisconsin releases of *Binodoxys communis* for soybean aphid biological control.

Date	Location	Numbers released	Initial/Final Aphid Numbers (per plant)
2 July	West Madison Ag Research Station #1	1,000	0.9/616
	West Madison Ag Research Station #2	1,000	2.2/540
14 July	Dodge County (Columbus)	500	7.1/981
	Winnebago County (Ripon)	500	10.1/852
5 August	Grant County (Muscoda)	1,000	125/345
	Dane County (Lodi)	1,000	92/260
18 August	Dane County (Deerfield)	3,000	152/239

During the past two summers (2007 and 2008), we have also encountered a native parasitoid, *Lysiphlebus testaceipes*, attacking soybean aphids in significant numbers in Wisconsin. We had observed *L. testaceipes* in previous years, but only sporadically and in very low numbers. This parasitoid is known to have an extremely broad host range of aphids it will attack. It is possible that *L. testaceipes* is adapting to the presence of the soybean aphid, in essence expanding its host range to include soybean aphid, and if so it may be a significant natural enemy in future years.

Conclusions

Soybean aphid biological control is an important consideration in managing this pest. Future efforts should be directed at establishing additional parasitoid species to enhance the overall effectiveness of biological control. In addition, there is need to determine how best to integrate the three major control tactics (biological control, plant resistance, and chemical control), to ensure they are compatible plus take advantage of potential synergies. For example, soybean plants with resistance to the aphid will likely reduce reliance on insecticides for aphid control, thus minimizing the harmful effects of insecticides on natural enemies. Also, it is conceivable that plant resistance may enhance biological control by slowing the soybean aphid's population growth rate, thus giving natural enemies an edge in the struggle between predators and prey, and again reducing the need for insecticidal inputs.

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