Landscape Management for Functional Biodiversity

Edited by:

John Holland, Bärbel Gerowitt, Oscar Alomar, Felix Bianchi, Lisa Eggenschwiler, Maarten van Helden, Camilla Moonen, Hans-Michael Poehling and Walter Rossing

IOBC wprs Bulletin
Can surrounding landscapes be predictive of in-field pest infestation?

Peter B. Goodell, Kris Lynn-Patterson, Robert J. Johnson
University of California, Statewide IPM Program and Cooperative Extension, Kearney Agricultural Center, 9240 South Riverbend Ave., Parlier, CA 93648, USA

Abstract: Lygus hesperus is a key pest in the cotton Integrated Pest Management system of the San Joaquin Valley of California, USA. By legal regulation, fields must remain free of any cotton plants from December until planting in March which prohibits arthropods from using cotton as an overwinter site. L. hesperus is required to annually immigrate and a cotton field must rebuild its entire arthropod food web during the production season, March until September. We propose using community mapping approaches to understand the risk of L. hesperus infestation to an individual cotton field based on surrounding crop mosaic. In 2011, we sampled arthropod populations from selected cotton fields and mapped surrounding crops to a distance of 3.2km. Using spatial tools, we sliced concentric rings of 0.8, 1.2 and 3.2km around the cotton field and calculated the frequency of crops within each ring. Comparing the abundance of known crops which act as sources or sinks of L. hesperus to the maximum infestation in and number of insecticide applications to a field, patterns emerged to indicate relative risk of crop assemblages. Understanding such patterns in the landscape creates the opportunity for a community to develop planned landscapes to mitigate this key pest.

Key words: cotton, IPM, landscape scale, community level management, Lygus hesperus

Introduction

There are many factors which influence the movement of polyphagous insects into a field (Kennedy and Storer, 2000). Of importance is the relationship between crops or plants that act as sources (those places from which arthropods originate) or sinks (those crops into which they move). A prime example of this relationship is Lygus hesperus (Knight), Hemiptera, Miridae, a key pest of cotton in the San Joaquin Valley of California. A polyphagous and highly mobile insect, L. hesperus moves between fields in search of stable habitat.

Since cotton is produced as an annual crop, all L. hesperus populations must migrate into a cotton field from surrounding sources and build to damaging populations (Stern, 1969; Goodell, 2009). Of the 250 potential crops or weeds in the San Joaquin Valley that could surround an individual field, less than 10 are recognized as important hosts for L. hesperus population buildup (Mueller et al., 2005).

Cotton is not a preferred host, but is one of the latest maturing crops in the agro ecosystem and acts as a sink of last resort for L. hesperus in the surrounding area. Of these hosts are the most significant source and at what distance do they influence an individual cotton field were questions addressed by recent research (Carrière et al., 2006). A ring analysis approach was used to conduct a stepwise regression to select a subset of relevant explanatory variables and then perform an analysis at 12 spatial scales (ring distance from 250 to 3900 m). In Arizona, key sources for L. hesperus were identified as alfalfa seed, alfalfa hay, and uncultivated areas (Carrière et al., 2006). Within the San Joaquin Valley, alfalfa seed was positively correlated to L. hesperus density while, alfalfa hay and safflower (Carthamus tinctorius L.) had variable associations indicating the potential impact of management. Our objective in this study was to increase our capacity to predict how much of a L. hesperus threat surrounding crops pose to an individual cotton field.
Material and methods

Insect sampling
As part of a farm demonstration program to encourage more sustainable farming practices, weekly field samples were gathered from 17 focus cotton fields in western Fresno, Merced and Madera Counties during the period from 10 June 2011 to 19 August 2011. Each sample consisted of 50 sweeps across the top third of the cotton plants using a standard 1 m sweep net. *L. hesperus* were counted in the field and reported as adults or nymphs per 50 sweeps. Four samples were taken from each field but the average of total *L. hesperus* (adults and nymphs) for the four samples will be reported.

Community based GIS mapping and analysis
There is no public mapping of crops within the area of this study so a publicly available web based GIS service was provided for participants to create a community based landscape map (Lynn-Patterson, 2011).

Using ArcGIS 10, spatial analysis buffer tools were used to create three concentric rings; a field boundary to 804m (ring 1), 804m to 1609m (ring 2) and 1609 to 3218m (ring 3) (Fig. 1). Field information was extracted from fields within those buffer rings and summarized as a histogram. Only five cotton fields were utilized to review *L. hesperus* and crop landscape surrounding the fields. These fields are representative of the range of *L. hesperus* populations and crop diversity in the study area.

![Rings surrounding a cotton field. Crops and their area within each of three concentric rings were calculated.](image)

Results and discussion

In the three rings surrounding the 17 cotton fields, there were a total 33,791 ha containing 21 different crops or settings. The most common crops included cotton, tomato, winter grain, alfalfa hay, almonds, corn, melons, pomegranates and fallow land (Fig. 2). *L. hesperus* population densities ranged from 4.5 to 10.7 per 50 sweeps and all fields were treated at least once for this pest.

![Frequency of crops surrounding the field.](image)

Table 1. Peak *Lygus* population density (%Insect/50sweets) and insecticide applications

<table>
<thead>
<tr>
<th>Field Id</th>
<th>Peak Density (%Insect/50sweets)</th>
<th>Date of Peak</th>
<th>No. Insecticide Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>B31</td>
<td>4.5</td>
<td>17-Aug</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>4.7</td>
<td>19-Aug</td>
<td>2</td>
</tr>
<tr>
<td>31</td>
<td>5.0</td>
<td>15-Jul</td>
<td>2</td>
</tr>
<tr>
<td>33</td>
<td>7.7</td>
<td>29-Jul</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>10.7</td>
<td>15-Jul</td>
<td>2</td>
</tr>
</tbody>
</table>

At the other extreme, Field 9 was sprayed twice. These fields probably did not need to mitigate their movement. Thus the insecticide...
Figure 2. Frequency of crops surrounding cotton in the San Joaquin Valley of California. Ring 1 = 0–804m, Ring 2 = 804–1609m, Ring 3 = 1609–3218m.

Fields 10 and B31 (Table 1) had cotton and alfalfa as the most abundant surrounding crops and recorded the lowest number of insects and insecticide applications. The abundance of cotton and low populations supports the evidence that cotton acts as a sink (Carrière et al., 2006) rather than a source of *L. hesperus* to neighboring cotton fields. The abundance of alfalfa provides an attractive sink, especially when it is managed to preserve habitat strips. The late appearance of *L. hesperus* populations also indicates harvest period of tomatoes but was too late to threaten the cotton yield.

Table 1. Peak *Lygus* population densities and crops surrounding cotton field. Number of insecticide applications is for *Lygus* only.

<table>
<thead>
<tr>
<th>Field Id</th>
<th>Peak Density (Insects/50spw)</th>
<th>Date of Peak</th>
<th>Number of Insecticides Applications</th>
<th>Top Three Surrounding Crops (Average of 3 rings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B31</td>
<td>4.5</td>
<td>17-Aug</td>
<td>1</td>
<td>Cotton, Alfalfa, Tomatoes</td>
</tr>
<tr>
<td>10</td>
<td>4.7</td>
<td>19-Aug</td>
<td>2</td>
<td>Cotton, Alfalfa, Tomatoes</td>
</tr>
<tr>
<td>31</td>
<td>5.0</td>
<td>15-Jul</td>
<td>3</td>
<td>Cotton, Fresh Corn, Safflower</td>
</tr>
<tr>
<td>33</td>
<td>7.7</td>
<td>29-Jul</td>
<td>2</td>
<td>Almond, Melons, Tomatoes</td>
</tr>
<tr>
<td>9</td>
<td>10.7</td>
<td>15-Jul</td>
<td>4</td>
<td>Uncultivated, Cotton, Safflower</td>
</tr>
</tbody>
</table>

At the other extreme, Field 9 was surrounded by uncultivated land consisting of open ground (Table 1). These fields probably did not act as sources of *L. hesperus*, but could not mitigate their movement. Thus the insects were required to keep moving across the landscape...
until they died or reached the cotton field. Safflower bordering cotton provided a primary and
continual source of pests.

In between were examples that demonstrated the importance of cotton in a landscape
(Field 33) as well as managing a potential source, safflower (Field 31). Even though the
landscape of Field 33 did not have strong sources, there was sufficient area to concentrate
threatening populations to remaining cotton fields. In the case of Field 31, a community effort
was utilized to manage the major source (safflower) with insecticides to mitigate the
movement of *L. hesperus*.

These fields illustrate the complexity of predicting infestation based on surrounding
crops and the commitment required of a community to confront this complexity. In summary
there are four main considerations when attempting to predict *L. hesperus* based on
surrounding landscape:

1. Strength of source to produce *L. hesperus*
2. Distance from source to cotton field
3. Number of fields providing alternative host between source and cotton field (or lack thereof)
4. Management employed to source fields (population control or habitat preservation)

Acknowledgements

The authors wish to thank all the farmers and Pest Control Advisors who contributed to this
project and especially the cooperation of L. Gallegos and M. Gibbs of the Sustainable Cotton
Project. This project was funded in part by Cotton Incorporated and through an agreement
with the State Water Resources Control Board and U.S. EPA - Clean Water Act Section 319.

References

A GIS-based approach for areawide pest management: the scales of *Lygus hesperus*
movements to cotton from alfalfa, weeds and cotton. Entomol. Exp. Appl. 118(3):

Goodell, P. B. 2009: Fifty years of the integrated control concept: the role of landscape

Kennedy, G. G. & Storer, N. P. 2000: Life system of polyphagous arthropod pests in
temporally unstable cropping systems. Annu. Rev. Entomol. 45: 467-493.

Lynn-Patterson, K. 2011: Web site: Lygus RAMP Community Mapping Project
(www.ckac.edu/programs/Web-basedGIS/). UC Kearney Agricultural Center. Accessed
11/30/11

Mueller, S. C., C. G. Summers, and P. B. Goodell 2005: Composition of *Lygus* species found
in selected agronomic crops and weeds in the San Joaquin Valley, California. Southwest
Entomol: 30(2): 121-127.

Stern, V. M. 1969: Interplanting alfalfa in cotton to control *Lygus* bugs and other insects. Proc
Tall Timber Conference on Ecological Animal Control by Habitat Management, Tall

Carabid beetles as a bioindicator of GMO’s

Marcin Grabowski, Zbigniew T. Dwave
Department of Applied Entomology and
toxin (Cry1, Cry3) expression in plants, target or non-target herbivores, in
agroecosystems of maize. Carabid larvae contact with toxins (Cry1, Cry3) express
indicators. The GM varieties expressing carnivorous and phytophagous carabids are
problem is the diversity of pathways by target organisms. Ground-dwelling beetles
agroecosystems of maize. Carabid larvae contact with toxins (Cry1, Cry3) express
indicators. The problem of the GMO’s in agroecosystems of maize. Carabid larvae contact
with toxins (Cry1, Cry3) express

Abstract: The international discussions on modified plants (GMP) (EFSA 2008)

integrated control concept: the role of landscape

Selection of indicator species is crucial for the robustness of the assessment (ERA) and evaluation of GM crops on the environment. In our approach, we propose the use of carabid beetles as a bioindicator of GMO effects. The effectiveness of this approach is supported by previous studies demonstrating the ecological and biological importance of carabid beetles in agroecosystems, which include GM crops. The carabid beetle community is sensitive to environmental changes and can provide valuable information on the potential impacts of GM crops. Our research focuses on the identification of key carabid species that could serve as indicators of the effects of GM crops on their populations. We will evaluate the effectiveness of these indicators using a combination of field studies and laboratory experiments. These studies will be conducted in representative agroecosystems containing GM crops, with a particular focus on areas where carabid beetles are abundant and diverse. The results of this research will contribute to the development of a more comprehensive understanding of the potential impacts of GM crops and the effectiveness of bioindicators in monitoring these effects.