Spatial pattern of infestation risk and management of brown marmorated stink bugs (BMSB) in field corn and soybean

P. Dilip Venugopal
Galen Dively
William Lamp

Department of Entomology,
4112 Plant Sciences Bldg
University of Maryland
College Park, MD 20742
Introduction

Pest movement patterns and control

• Pest distribution patterns across non-crop to crops influenced by species-specific behavior.

• Pest insect movement into crops can be non-random and directional (Stinner et al. 1983).

• Knowledge about immigration and settlement into crop, used to effectively control insect pests (Nestel et al. 2004).
BMSB in field corn and soybean

• BMSB a serious pest in mid-Atlantic agronomic row crops.

• Fewer research projects on grain crops and soybean, than speciality crops

• Particularly, few research studies on BMSB movement into field corn and soybean in relation to adjacent non-crop habitat

• Chemical control options widely used
Objectives

• To characterize BMSB pattern of infestation in field corn and soybean, along non-crop edges.

• To determine the influence of different adjacent non-crop habitats on BMSB population abundance in field corn and soybean fields.

• To determine differences in abundance at different distances from edges of field corn and soybean.

• To devise effective and efficient BMSB control treatment strategies for field corn and soybean.
Methods – Field sampling

• Adjacent habitat types
  Corn – Alfalfa, Buildings, Open, Sorghum & Woods
  Soybean – Buildings, Corn, Open & Woods

• Abundances estimated at 0-50 feet into field corn and soybean

• 2-4 replicate fields / Adj. Hab.
  based on availability

• 3-4 transects/field

• Sampled 3-5 times
Methods – Field sampling

- Direct visual counts of BMSB on
  - 10 consecutive corn plants and
  - On all plants within a half of 1m radius plot in soybean (1.55 m²)

- Sampled between
  - July – Aug 2012 (Corn)
  - Aug – Sept 2012 (Soybean)

- Corn - Beltsville & Clarksville, MD

- Soybean – Beltsville & Keedysville, MD

Photo: Peter Coffey
Statistical Analyses
Characterizing BMSB Infestation Pattern

Modified from Duelli & O’brist 2003 and Tscharntke et al. 2005

Table 1. Four-step decision path for the ecological optimal fit of all species’ distributions into one of the

<table>
<thead>
<tr>
<th>Decision-tree rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Significant dispersers (according step 1, see Data ..., Nind &gt; 0 at starting point of transect)</td>
</tr>
<tr>
<td>• Peak numbers at first or second position of transect</td>
</tr>
<tr>
<td>• More than 50% of all individuals caught within 20 if any is false</td>
</tr>
<tr>
<td>• 66% of all individuals in the first half of total tran 25% of all individuals in the first quarter of total 1</td>
</tr>
<tr>
<td>• Peak numbers at first or second position of transect if any is false</td>
</tr>
<tr>
<td>• Significant dispersers but p2 &gt; 0 (number of indivi if false</td>
</tr>
</tbody>
</table>

Statistical Analyses – Adjacent Habitat Influence & Distance from Edge

- Generalized linear mixed models (GLMM)
  - Poisson Distribution
  - Sampling fields as repeated measures
  - Site wise analyses for each crop
  - R package lme4 (v0.999999-0; Bates et al. 2012)

- Adjacent Habitat * Distance from field edge
  - If interaction not significant, then individually tested

- Post-hoc Multiple Pair-wise comparisons of group Means (MCP)
  - R package multcomp (v1.2-14; Hothorn et al. 2012)
Results

BMSB Infestation Pattern

Data pooled across fields and sampling occasion

“Species that colonize crops from noncrop habitats” – Duelli & O’brist 2003
Results

BMSB Infestation Pattern

Ecotone  “species that are typically found at the interface of crop and non-crop habitats” – Duelli & O’brist 2003
Results

Adjacent Habitat * Distance

Repeated measures GLMM

Type III Wald $X^2$ tests

Adjacent hab:Distance

Wald’s $X^2 = 8.321$, $df = 21$, $p = 0.62859$  

NS
**Results**

**Adjacent habitat influence**

Repeated measures GLMM

Adjacent Habitat Significantly influenced overall BMSB abundance in soybean fields

Wald’s $X^2 = 60.44$, df = 3, $p = 4.734e-13***$

Mean abundances of BMSB (1.55 m$^{-2}$) -1 Soybean Beltsville

$I = 95\%$ CI
Results

Distance from edge influence

Repeated measures GLMM

BMSB abundance significantly vary at different distances from edge

Wald’s $X^2 = 265.5$, df=7, $p = 2.2e-16$ ***
Results

Adjacent Habitat*Distance

Repeated measures GLMM

Type III Wald $X^2$ tests Adjacent Hab:Distance Wald’s $X^2 = 47.6664$, df = 21, $p = 0.0007633 ***$

MCP - Significant differences
Corn 10-40 feet > Open
Woods 0-30 feet > Open

Mean abundances of BMSB (1.55 m²⁻¹)

Distance from Edge (feet)  |  $I = 95\%$ CI

- Buildings
- Corn
- Open
- Woods
Results

Adjacent Habitat*

Distance from edge

<table>
<thead>
<tr>
<th>Distance from Edge (feet)</th>
<th>Mean abundance of BMSB (10 corn plants⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
</tr>
</tbody>
</table>

Alfalfa
Buildings
Sorghum
Woods

I = 95% CI

Repeated measures GLMM

Type III Wald $X^2$ tests

Adjacent Hab : Distance Wald’s $X^2 = 39.2303$, df = 18, $p = 0.002653$ **

MCP - Significant differences

Woods 10-40 feet > Alfalfa
Woods 5-30 feet > Buildings
Woods 10-30 feet > Sorghum

Corn Clarksville
Summary and Conclusions

• BMSB infestation pattern
  – Behaviorally classified as ‘Disperser’ – Clumped at the margin
  – Ecotone classification in corn a result of field condition

In Soybean
  – Overall Beltsville abundance lower than past years; Highest along woods, then buildings. Lowest in fields next to open areas
  – Overall Keedysville abundance high, and threshold levels
    – While abundance along woods higher, not significant from corn and buildings
    – Lowest in fields next to open areas.
  – Abundance adjacent to corn highly variable between sites - signifies local population context.

In Field Corn
  – Overall abundance low.
  – Abundance along woods greater than buildings, alfalfa & sorghum.
  – Beltsville abundance too low for any meaningful analysis.
BMSB control strategies

- Chemical treatments can be limited to field edges, up to 40 feet in field and entire field treatment probably not required.

- Prioritize edges along woods, buildings over open areas.

- In certain conditions, fields with edges along open areas probably do not need treatment.

- Probably no treatment required in field corn, if numbers are similar to this year’s in most of MD.
Acknowledgements

MD Ext. Fac.
Terry Patton
Kevin Conover (Beltsville),
Tim Ellis (Keedysville),
David Justice (Clarksville),
USDA–BARC - David Swain

Funding
United Soybean Board
Maryland Soybean Board
MD Grain Producers
Cosmos Club Foundation
Gahan Fellowship – UMD ENTM

Data Collection

Cerruti Hooks, Emily Zobel

Lamp lab folks - Alan Leslie, Bob Smith, Bridget Delay, Ellie Stevens, Ryan Gott