BMSB in Ornamental Systems

Ornamentals Commodity Team Participants and Participating Institutions:
University of Maryland – Paula Shrewsbury (*coordinator*), Pedro Barbosa, Bryon Butler, Stanton Gill, Holly Martinson, Karen Rane, Mike Raupp, Dilip Venugopal
University of Delaware – Brian Kunkel
Rutgers University – George Hamilton
USDA ARS Horticultural Crops Research Lab, Corvalis, Oregon – Jana Lee
Oregon State University – Peter Shearer, Nik Wiman

Many graduate students, post docs, technicians, and stakeholders

BMSB SCRI Stakeholder Advisory Meeting 2014

arch Initiative

Collaborating Institutions

University of Delaware
ARS
Penn State
The State University of New Jersey Rutgers
Northeastern IPM Center
Washington State University
Cornell University
University of Maryland
VirginiaTech
OSU Oregon State University
NC State University

Stop BMSB .org

Ornamental Systems

(woody and herbaceous plants: nurseries, landscapes, greenhouses, high tunnels)

Current grant (2014)

Objs. 1.2, 1.3: **Damage, phenology and impact of BMSB in ornamental systems**

Objs. 3.1, 3.2: **Crop specific IPM programs in ornamental systems**

Renewal grant

Obj. 1.2: Damage (direct, indirect)

Obj. 1.3.1: Determine BMSB phenology and impact on specific specialty crops

Ornamental Nurseries

Why nurseries?

- **Economically important:**
  - **#2 Ag Sector in MD 2008: ~ $2 billion green industry gross receipts**
- **High plant diversity**
- **Large blocks of trees**

BMSB

- **Potentially damaging pest**
- **Must immigrate, emigrate**
- **Feed throughout season**
- **Broad use of ornamentals**

Examine abundance, host use and selection, movement patterns, and damage

Goals:

- **Develop IPM programs**
  - **Biology and ecology**
  - **Monitoring (plant species, spatially, temporally)**
  - **Host plant resistance, susceptibility**

- **Design BMSB out of landscapes**
  - **Reduce plant damage**
  - **Minimize nuisance pest issue**

Monitoring in Oregon Nurseries

	Target	Plants	BMSB
2011	14 sites in Canby and Dayton	Cherry, Crabapple, Elm, Euonymus, Hawthorne, Mixed hedge, Pear, Plum (unsprayed), Poplar, Syringa	Sep 8 (beat), Oct 7 (trap) in plum
2012	16 sites spread over 100 miles	Apple, Cherry, Conifer, Cornus, Crabapple, Euonymus, Hawthorne, Laurel, Mixed hedge, Oak, Plum (unsprayed), Rose	☹ Despite high efforts 0 BMSB
2013	3 sites in Canby, Dayton, Portland	Mixed hedge near abandoned orchard, Plum (unsprayed), Retail mix	Aug 14 – Oct (trap) 25 BMSB
2014	**4 sites in Canby and Corvallis**	**Ornamental plum (unsprayed), ornamental cherry next to hazelnuts, cherry laurel, and conifer mix**	**July 15 – Oct 22 (trap & beat), 300+ BMSB**

- **Each site has a Pyramid trap and Beat 100 plants**
- **One site has been repeatedly sampled since 2011, BMSB were caught one month earlier with much higher numbers than last year (300+ vs. 25)**

J. Lee, USDA ARS, Corvalis, OR

Woody Ornamentals (MD)

- **Abundance over time**
- **Host utilization**
- **Movement patterns**
- **Plant phenology x resource use**
- **Damage by BMSB**

BMSB Egg Abundance Over Time

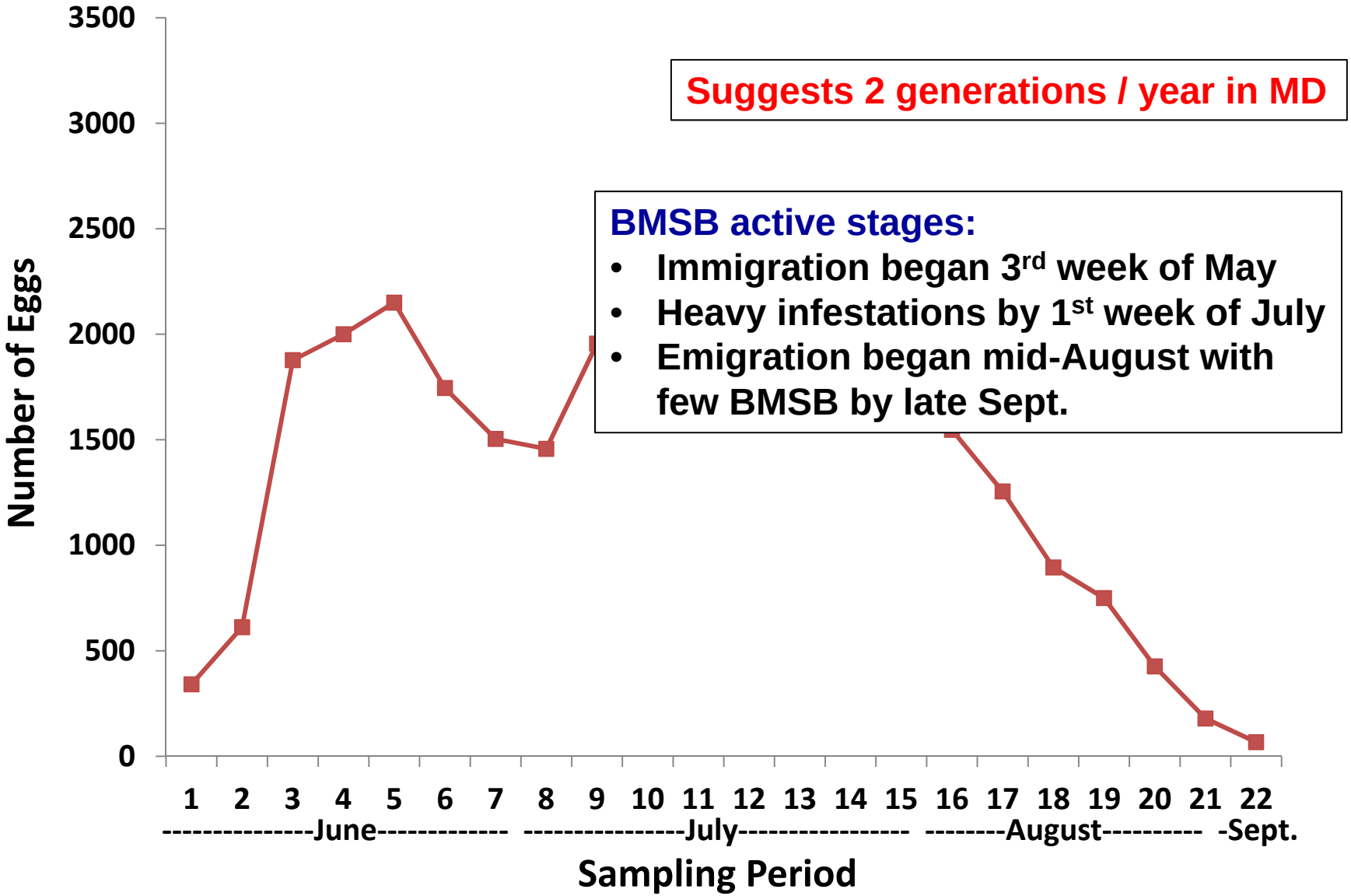
- **Sampled three nurseries at regular intervals from late May through September 2012 and 2013**
- **Visual searches of foliage on *Acer*, *Prunus*, and *Ulmus***

Photo by Steve Black

Photo by Ruppert Nurseries

Total Number of BMSB Eggs

2013



Suggests 2 generations / year in MD

BMSB active stages:

- **Immigration began 3rd week of May**
- **Heavy infestations by 1st week of July**
- **Emigration began mid-August with few BMSB by late Sept.**

Goal: Design BMSB out of landscapes

Objectives:

1. Identify trees and shrubs used by different life stages

2. Elucidate taxonomic affinity of different life stages (gymnosperms vs angiosperms by stadia)

3. Determine relationship between host origin and BMSB abundance (Asian vs non-Asian)

4. Examine effects of reproductive structures on host use

Study Sites

Raemelton Farm:

Adamstown, MD

Frederick Co.

~300 Acres

BMSB pressure

~4 Years

Sampled 2011-2013

Study Sites

Ruppert Nurseries:

Laytonsville, MD

Mongomery Co.

~800 Acres

BMSB pressure

~5 Years

2 Sites

Sampled 2012-2013

Sampling Methods

2011-2013

1 min visual count per tree:

Leaves ▪ Fruit ▪ Bark

BMSB stages:

Egg Masses

Early Nymphs (1st -3rd)

Late Nymphs (4th -5th)

Adults

Sampling Methods

2011-2013

Identified Tree

Genus ▪ Species ▪ Cultivar

***Amelanchier canadensis* 'Glenform'**

Geographic Origin

Asian ▪ Non-Asian

Taxonomic Classification

Angiosperm ▪ Gymnosperm

Survey Methods

2013 - 2014

Fruit Stage

Absent

Immature fruit

Mature fruit

Scope of Study

5,474 individual plants

53,995 tree visits

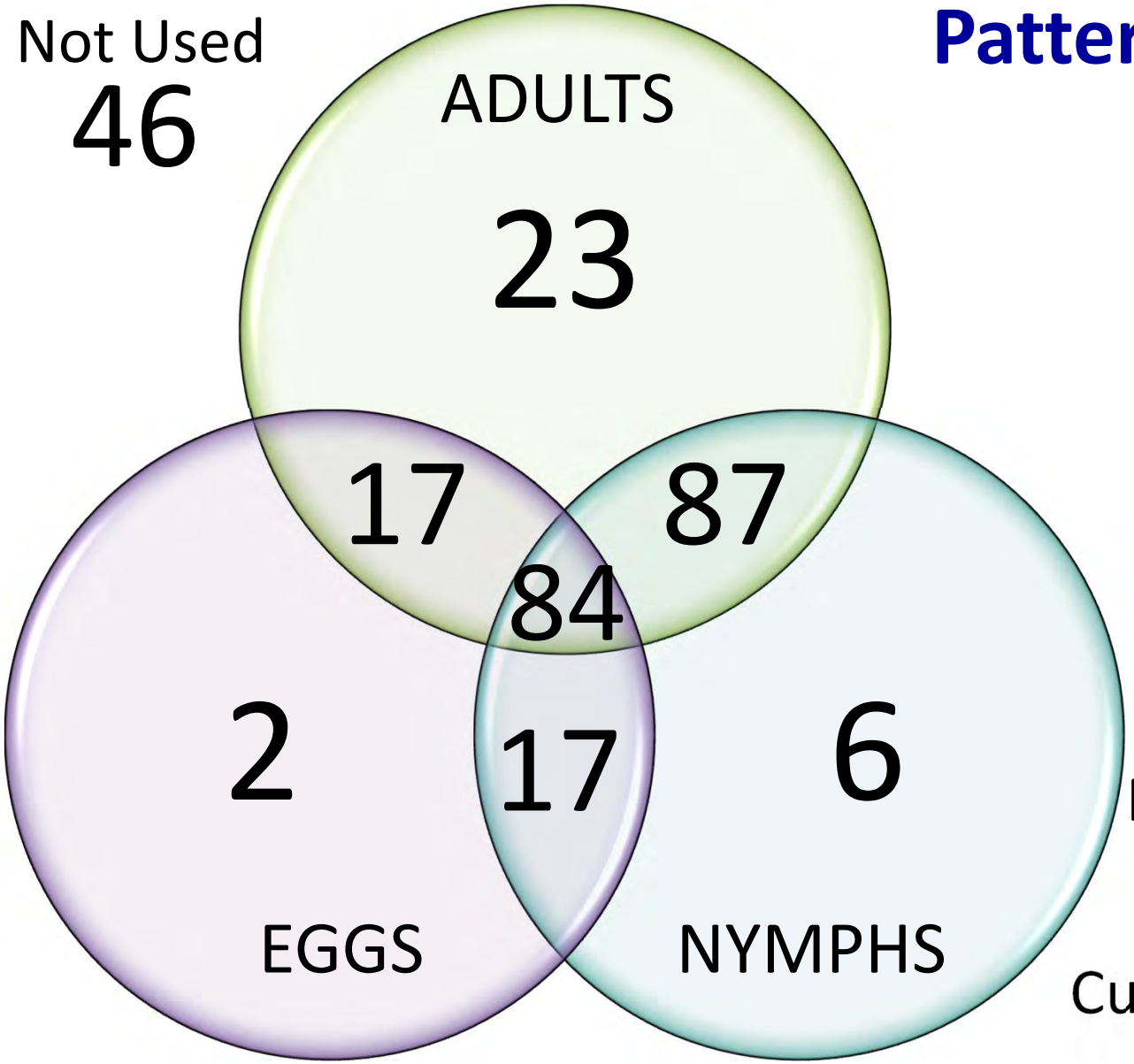
36,900 stink bugs and egg masses

Ornamental Host Use Patterns

Confirmed:
19 host species
7 genera

Identified:
89 new host species
(175 cultivars)
13 non-host species
(43 cultivars)

Patterns of Host Use



Total cultivars sampled: 259

Total used by any stage: 213

Cultivars used by
Eggs: 104 (40%)
Nymphs: 184 (71%)
Adults: 198 (76%)

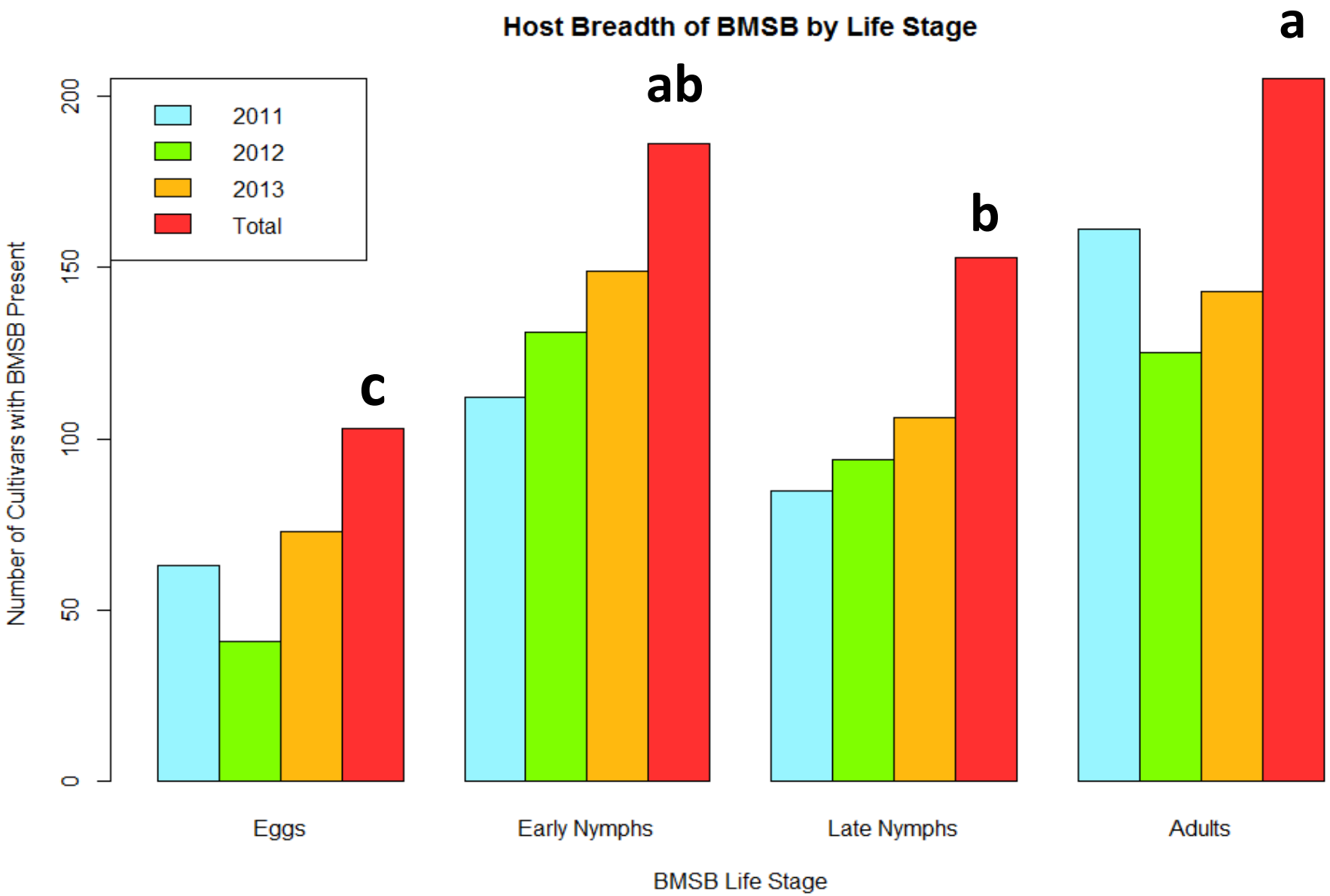
Cultivars not used: 46

2011-2013

82 % of cultivars used

E. Bergmann et al., UMD

Does host breadth vary among life stages?



Top 15 Hosts: Active Stages

Rank	Cultivar	Taxonomic Classification	Geographic Origin	Ave. BMSB
1	*Syringa pekinensis* 'Zhang Zhiming'	Angiosperm	Asia	5.573
2	*Sophora japonica* 'Millstone'	Angiosperm	Asia	4.444
3	*Evodia daniellii*	Angiosperm	Asia	4.333
4	*Syringa pekinensis* 'Morton'	Angiosperm	Asia	3.636
5	*Acer x freemanii* 'Jeffersred'	Angiosperm	N. America	3.333
6	*Cercis canadensis* 'Alba'	Angiosperm	N. America	2.844
7	*Acer pensylvanicum*	Angiosperm	N. America	2.563
8	*Hibiscus syriacus* 'Satin Blue'	Angiosperm	Asia	2.25
9	*Malus* 'Mary Potter'	Angiosperm	Asia	2.212
10	*Cornus florida x kousa* 'Celestial'	Angiosperm	Hybrid	2.143
11	*Cercis canadensis* spp.	Angiosperm	N. America	2.116
12	*Ulmus americana* 'Valley Forge'	Angiosperm	N. America	2.062
13	*Ficus carica* 'Chicago Hardy'	Angiosperm	Europe	1.978
14	*Acer rubrum* 'Brandywine'	Angiosperm	N. America	1.968
15	*Acer rubrum* 'Franksred'	Angiosperm	N. America	1.955

Top 15 Hosts: Egg Masses

Rank	Cultivar	Taxonomic Classification	Geographic Origin	Ave. # of Egg Masses
1	*Evodia daniellii*	Angiosperm	Asia	0.75
2	*Quercus robur* 'Fastigiata'	Angiosperm	Europe	0.056
3	*Ulmus americana* 'Valley Forge'	Angiosperm	N. America	0.052
4	*Liquidambar styraciflua*	Angiosperm	N. America	0.052
5	*Cercis canadensis*	Angiosperm	N. America	0.045
6	*Ficus carica* 'Chicago Hardy'	Angiosperm	Europe	0.044
7	*Acer rubrum* 'Franksred'	Angiosperm	N. America	0.038
8	*Cladrastis kentukea*	Angiosperm	N. America	0.038
9	*Tilia tomentosa* 'Sterling'	Angiosperm	Europe	0.038
10	*Cladrastis kentukea* 'Perkins Pink'	Angiosperm	N. America	0.037
11	*Acer saccharum* 'Legacy'	Angiosperm	N. America	0.037
12	*Acer rubrum* 'Brandywine'	Angiosperm	N. America	0.036
13	*Acer x freemanii* 'Jeffersred'	Angiosperm	N. America	0.034
14	*Malus* 'Prairifire'	Angiosperm	Asia	0.034
15	*Acer pensylvanicum*	Angiosperm	N. America	0.031

Species not used by eggs, nymphs, adults (46 cultivars)

- *Abies nordmanniana (1)*
- *Acer davidii (1)*
- *Acer palmatum (6)*
- *Aesculus hippocastanum (1)*
- *Cedrus atlantica (1)*
- *Cedrus deodara (1)*
- *Cercidiphyllum japonicum (1)*
- *Chamaecyparis obtuse (5)*
- *Cornus kousa (1)*
- *Ginkgo biloba (1)*
- *Hamamelis x intermedia (2)*
- *Juniperus chinensis (1)*
- *Physocarpus opulifolius (1)*
- *Picea breweriana (1)*
- *Picea koraiensis (1)*
- *Picea meyeri (1)*
- *Picea omorika (1)*
- *Picea pungens (6)*
- *Pinus cembra (1)*
- *Pinus densiflora (1)*
- *Pinus koraiensis (1)*
- *Pinus nigra (1)*
- *Pinus parviflora (1)*
- *Pinus strobus (1)*
- *Pinus thunbergii (1)*
- *Prunus mume (1)*
- *Prunus serrulata (1)*
- *Sequoiadendron giganteum (1)*
- *Thuja plicata (1)*
- *Tsuga canadensis (1)*

Patterns of Host Use

Plant Classification

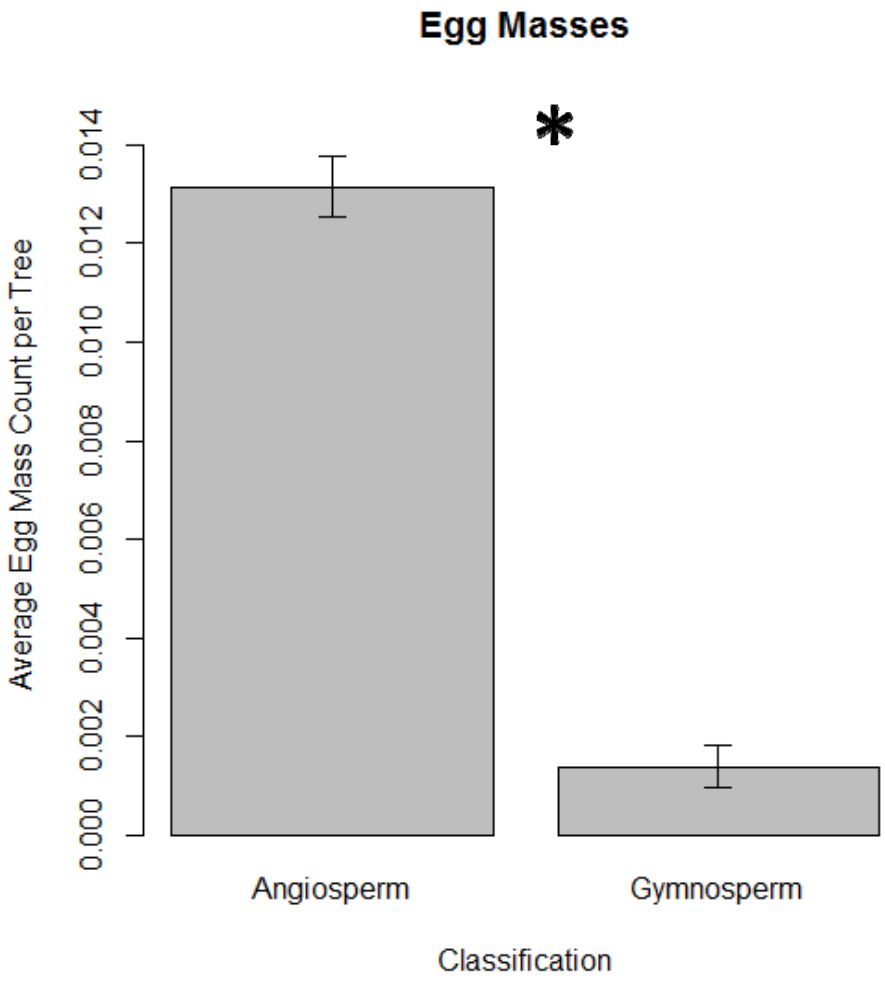
Do Angiosperms and Gymnosperms differ in their use by BMSB?

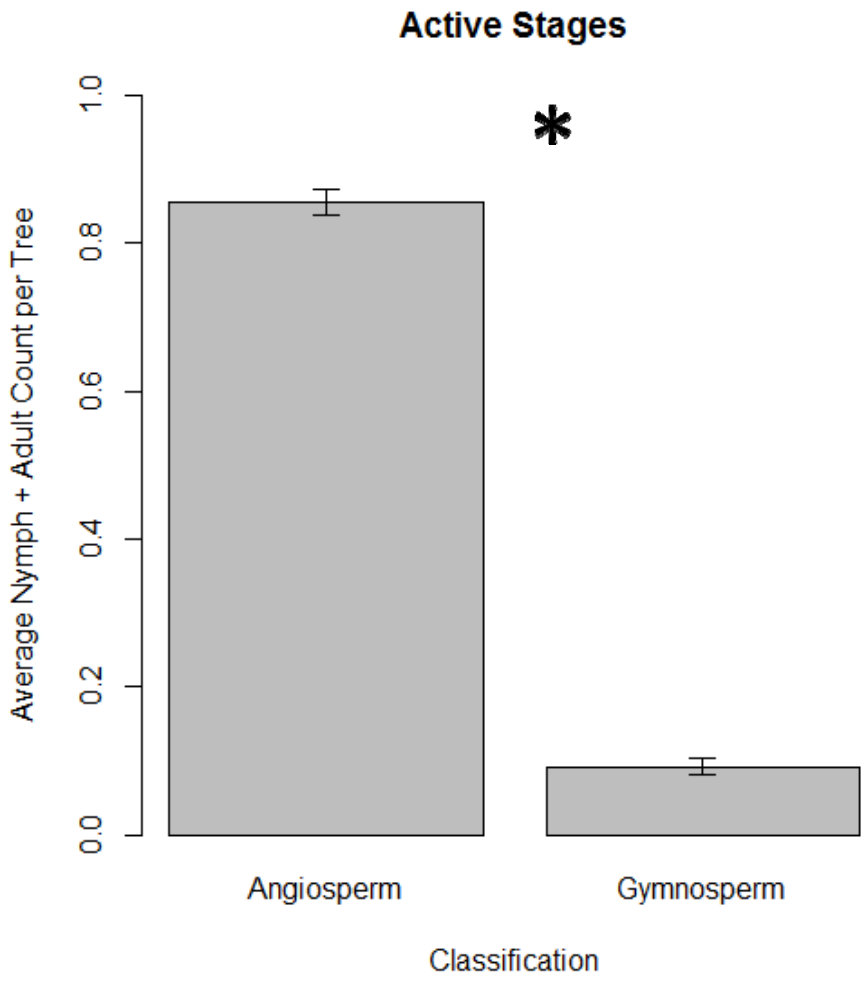
Host Origin

Does host use differ between plants of Asian and non-Asian origin?

Host Classification

* =significant at $P \leq 0.001$





Host Origin

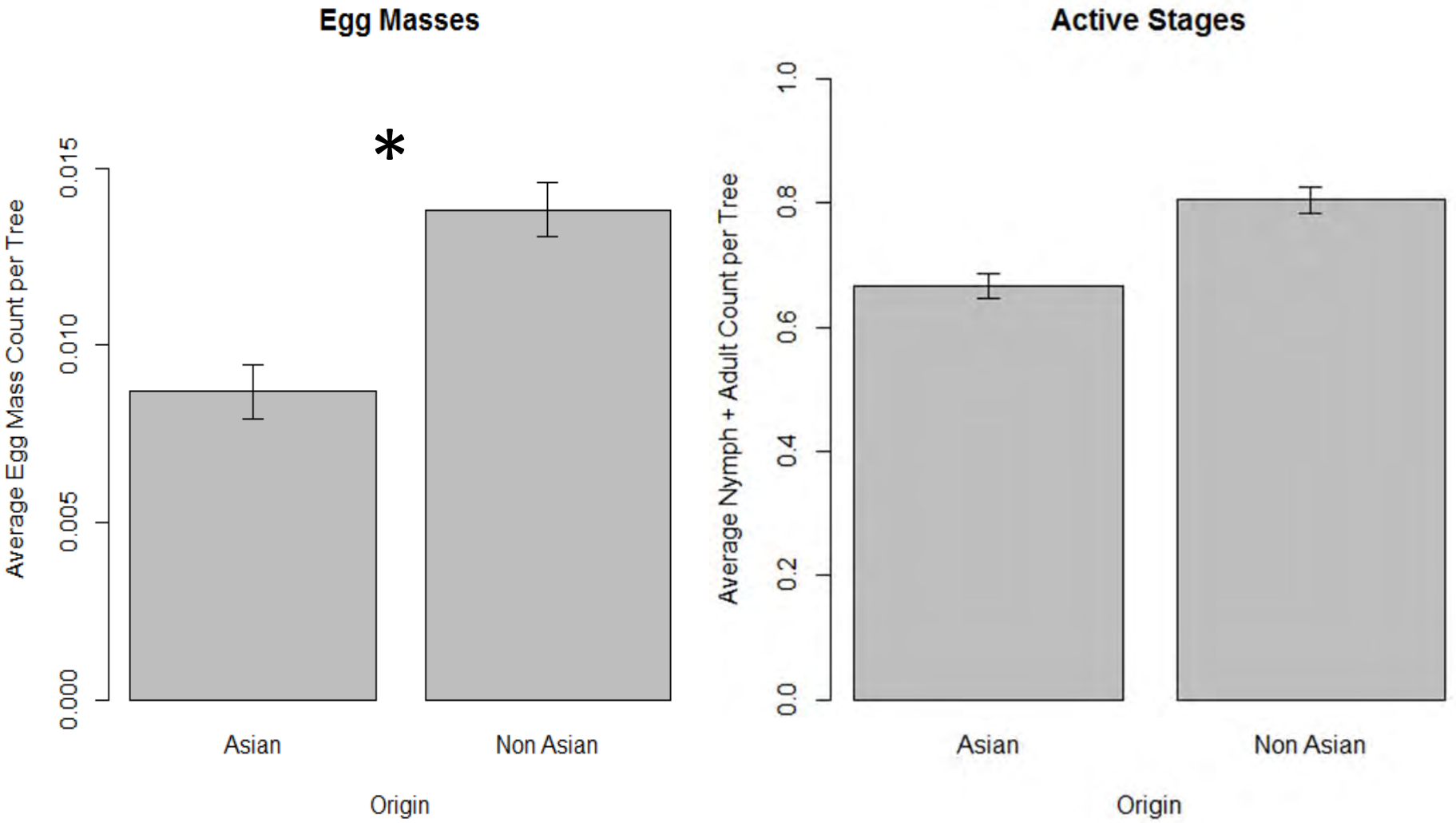
Does host use differ between plants of Asian and non-Asian origin?

1. Herbivores utilize plants they "know" evolutionarily – host specialization
   Prediction: Abundance Asian > Non-Asian

2. Herbivores exploit evolutionarily naïve hosts – defense free space
   Prediction: Abundance Non-Asian > Asian

Host Origin

* =significant at $P \leq 0.05$

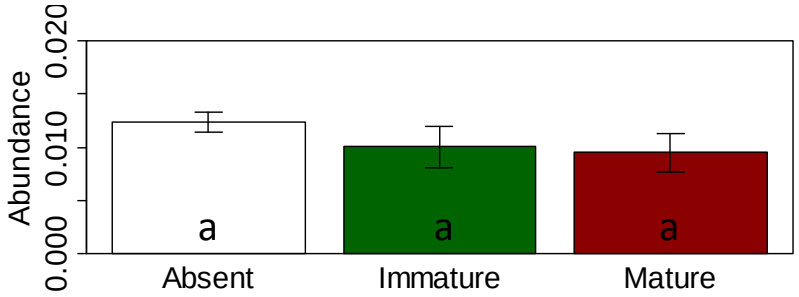


Do BMSB track resources in diverse woody plant nurseries?

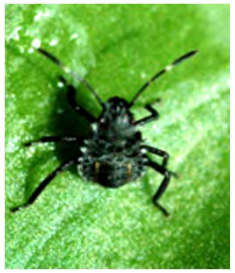
1. Do BMSB utilize trees with fruits? Does that depend on fruit maturity?
2. How does the timing of fruiting influence BMSB abundances?
3. Does fruit removal depress BMSB abundances?

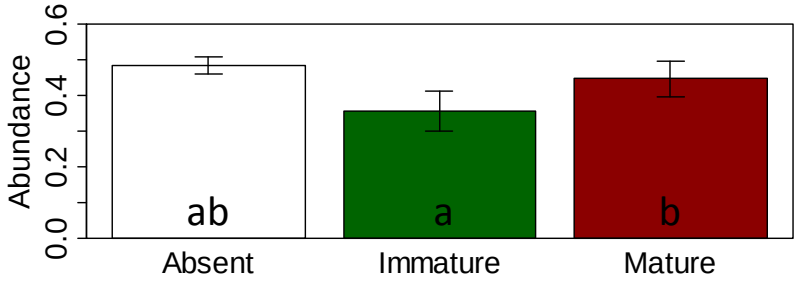
Large-scale Observational Study

Fruit Removal Experiment

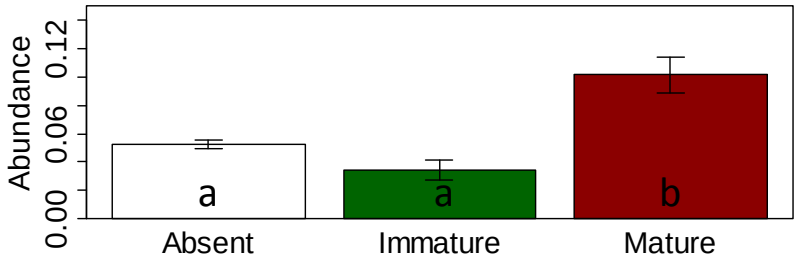


Egg Masses
$\chi^2 = 0.31$; P = 0.86

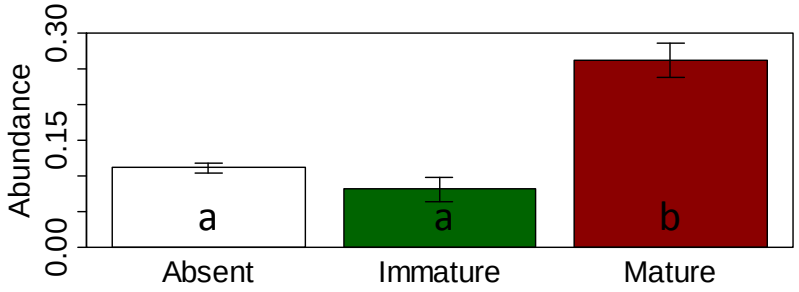




Early Instars
$\chi^2 = 5.61$; P = 0.06

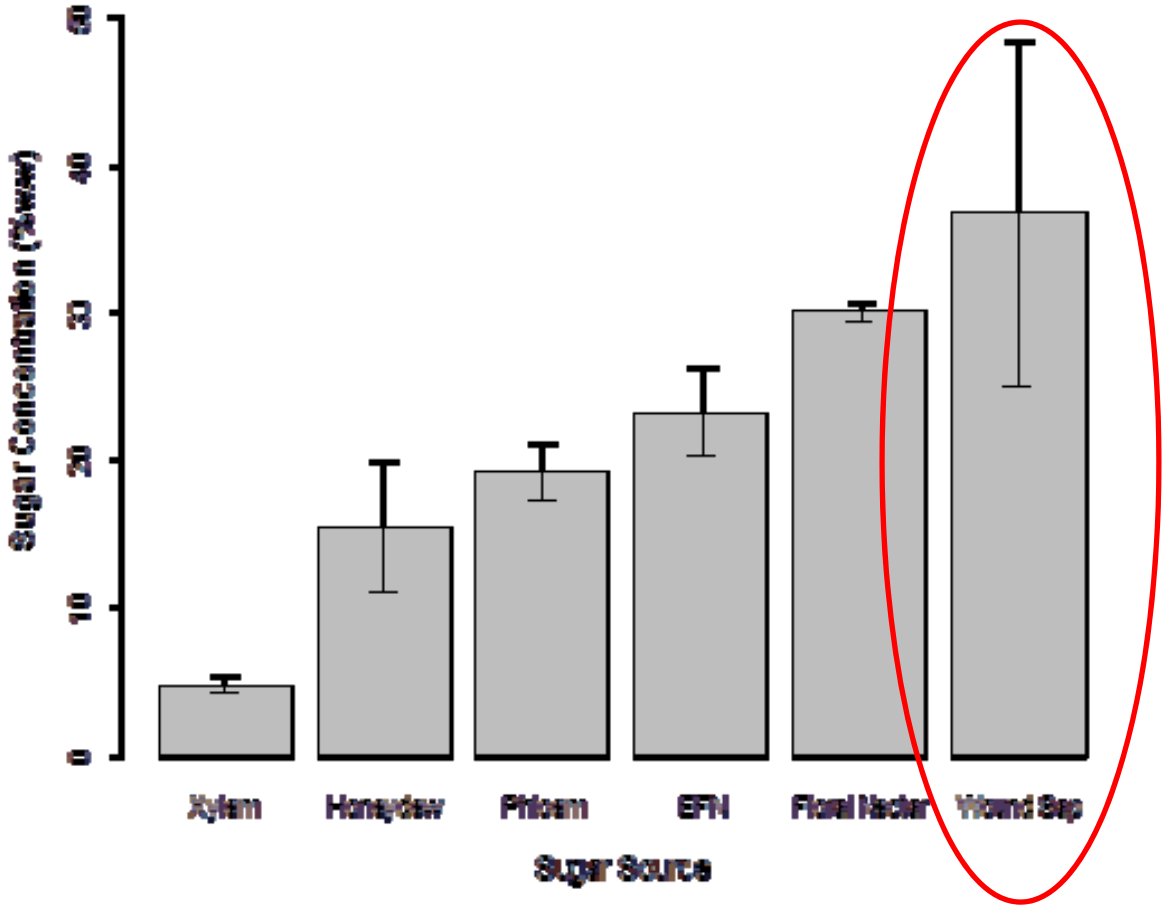


Late Instars
$\chi^2 = 6.24$; P = 0.044



Adults
$\chi^2 = 20.00$; P = 0.00005

Adults feed through bark, wounds attract Hymenoptera



Martinson, H.M., M.J. Raupp, and P.M. Shrewsbury. 2013. Invasive stink bug wounds trees, liberates sugars, and facilitates native Hymenoptera. Ann. Entomol. Soc. Am. 106(1): 47-52

BMSB feeding damage to woody trees

Possible damage

Direct feeding

Indirect as disease vector

BMSB Bark Feeding Damage Study

- **Objective**
  - **to determine the impact of BMSB bark feeding on ornamental tree stock (plant growth and disease transmission)**

Methods:

Plants – Elms, Maples

BMSB densities – 0, 15, 30 / trunk

Measure

- **tree growth**
- **injury to bark**
- **disease**

Summary of Findings

- BMSB highly polyphagous: used 82% of 259 cultivars
- Discovered 46 non-host cultivars
- Adults use the widest range of hosts, oviposit on a smaller range of hosts

- Angiosperms strongly favored over gymnosperms

- Non-Asian hosts preferred for oviposition overall
  - Variation exists
- Active stages did not prefer Asian to Non-Asian hosts overall
  - Pattern varied among congeners of different genera

- Plants with ripe fruit favored by late nymphs and adults

Progress Toward IPM Programs in Ornamental Systems

Designing BMSB-free Landscapes

- **Avoid use of:**
  - **Plants highly utilized by BMSB**
  - **Angiosperms (deciduous)**
  - **Plants that are native to the U.S. (non-Asian) (?)**
  - **Plants that produce fruit**
- **Incorporate use of less utilized plants**
- **Incorporate plants that favor native natural enemies**

Designing BMSB-free Landscapes

- **Reduce BMSB abundance in landscapes that surround homes, structures, etc.**
- **Should reduce abundance of BMSB entering structures to overwinter (nuisance pest)**

Research Based Information Sustaining IPM Programs

- **BMSB biology / phenology**
  - **Determined significant life cycle activities (eggs, nymphs, adults)**
  - **2 generations/yr; active May – Sept.**
- **BMSB patterns in ornamental host use**
  - **Host utilization patterns on woody ornamental, herbaceous perennial (identified host and non-host plants)**
  - **Appear to track resources (ex. fruit, seed)**
- **Spatial dynamics and movement**
  - **Immigration / emigration; edge effects; patch dynamics; resource tracking**
  - **Landscape plants / overwintering populations in structures**
- **Chemical efficacy**
  - **No consistent significant damage to date; low demand**
- **Biological control**
  - **Native egg parasitoids / predators are suppressing BMSB (~58% egg mortality)**
  - **Plant species, hosts that favor native natural enemies**

Acknowledgements

Field Crew

Chris Riley
Ryan Wallace
Sean Harris
Dylan Reisinger
Kevin Beiter
Kris Keochinda
Colleen McMullen
Ben Corwell
Caroline Brodo
Ashley Jones
Nancy Harding
Chris Sargent

Nursery Cooperators

Steve Black,

Raemelton Farm

Kelly Lewis, Nick Groves,

Ruppert Nursery

Funding

USDA-NIFA-SCRI
#2011-51181-30937
UMD MAES

MD Agricultural Experiment Station,
Project# MD-ENTO-8732