

# **Update on Biological Control of BMSB with Asian Parasitoids**

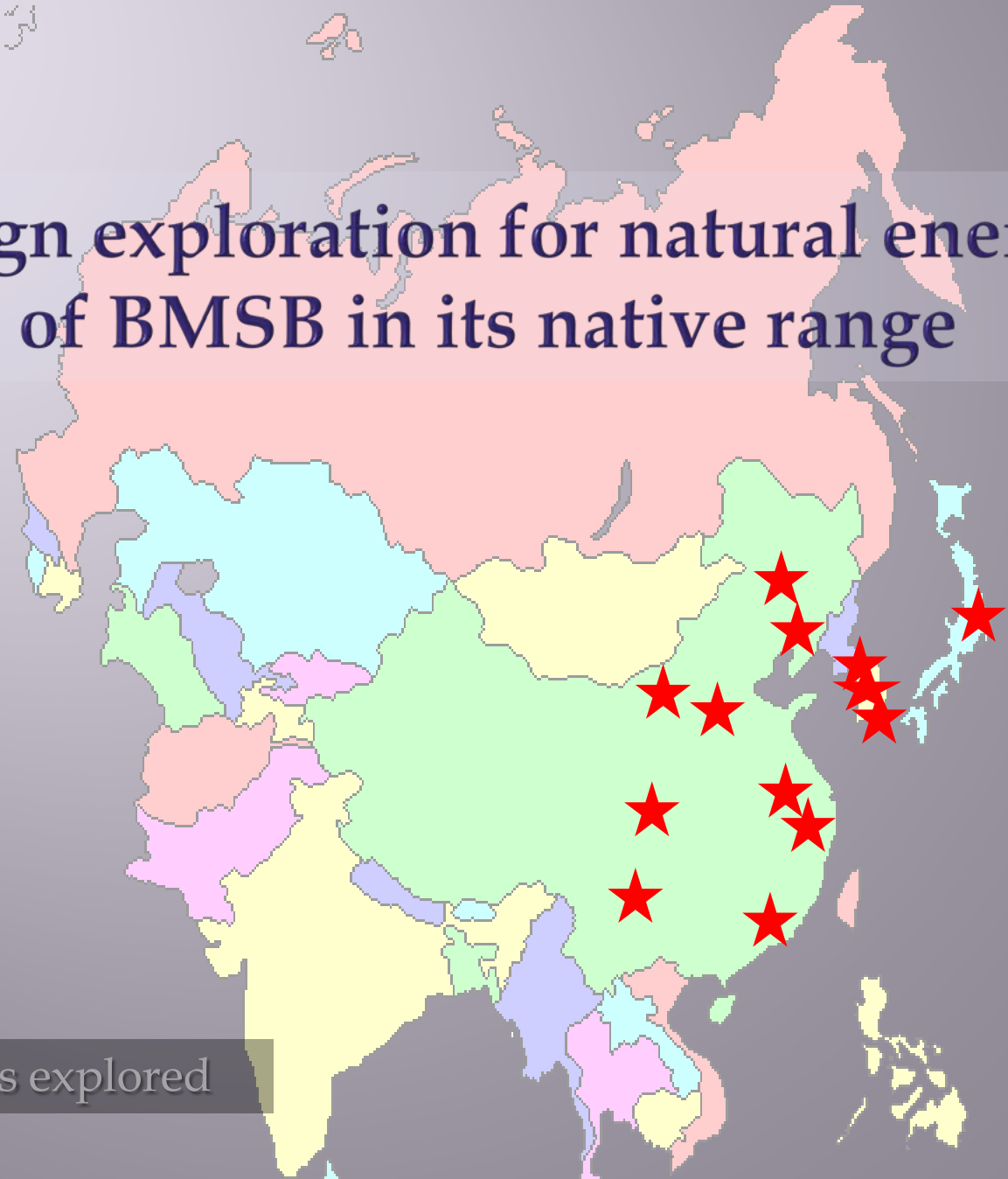
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# Foreign exploration for natural enemies of BMSB in its native range

★ Locations explored



# Asian *Trissolcus* spp.



**30+ parasitoid populations at ARS BIIR**  
maintained for host range and efficacy testing

China: *Trissolcus japonicus (halyomorphae)*

(Beijing 2007, Beijing 2009, Nanjing 2009)

Japan: *Trissolcus mitsukurii* (Tsukuba 2007)

*Trissolcus japonicus (plautiae)* (Tsukuba 2007, 2012)

*Trissolcus flavipes* (Tsukuba 2007, 2012)

*Trissolcus itoi* (Tsukuba 2012)

*Trissolcus* spp. (Tsukuba 2012)

S. Korea: *Trissolcus japonicus (plautiae)* (Seoul 2009, 2010)

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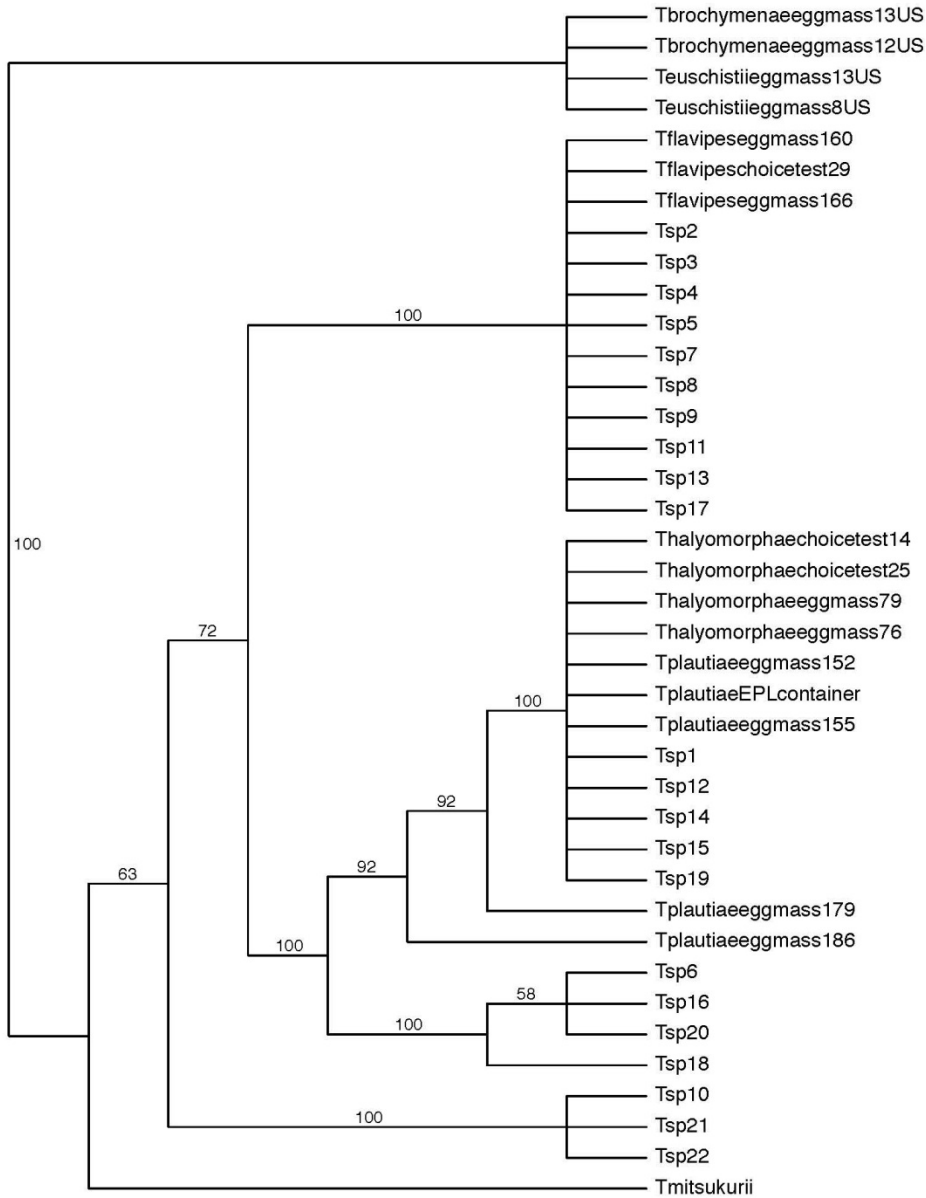
*Trissolcus itoi* (Tsukuba 2012)

*Trissolcus* spp. (Tsukuba 2012)

S. Korea: *Trissolcus japonicus (plautiae)* (Seoul 2009, 2010)

# combined COI & ITS2

Bootstrap consensus tree



→ native *Trissolcus*

→ *Trissolcus flavipes*

→ *Trissolcus japonicus*

→ *Trissolcus* "sp" ??

→ *Trissolcus* "sp" ??

→ *Trissolcus* "sp"

→ *Trissolcus* "sp" ??

→ *Trissolcus itoi*

→ *Trissolcus mitsukurii*

## **Funding for Host Range Evaluations:**

Farm Bill funding (APHIS PPQ)

NIFA SCRI multi-institution BMSB grant

## **Collaborators:**

University of Delaware

Florida Dept. Agriculture & Consumer Services, Division of Plant Industry

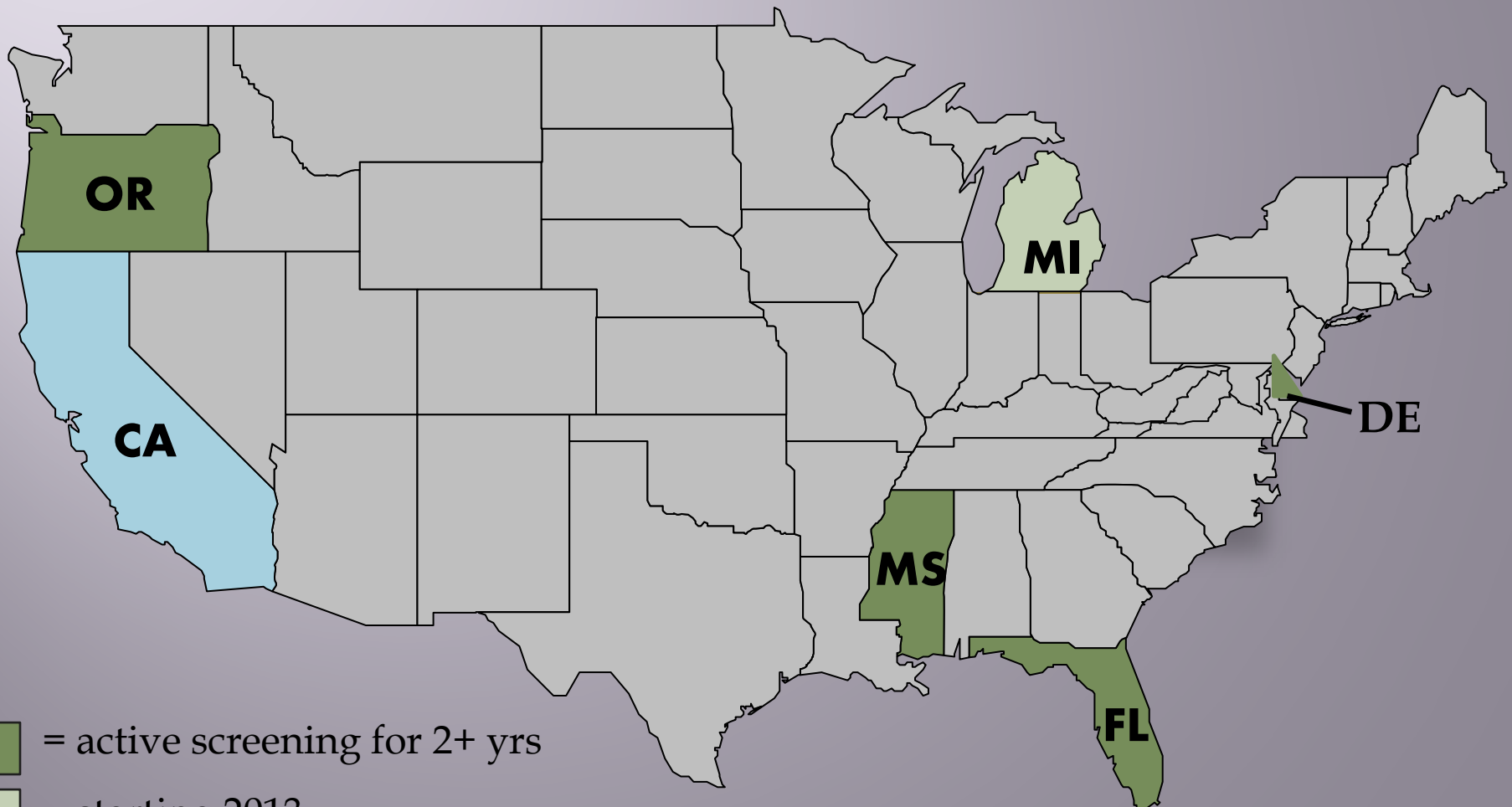
MSU – Michigan State University – Department of Entomology




Oregon Department of Agriculture

Oregon State University – Department of Horticulture

USDA-ARS Stoneville & Mississippi State University, MS

# Host Specificity Screening



-  = active screening for 2+ yrs
-  = starting 2013
-  = pending funding





# *Trissolcus japonicus* (= *halyomorphae*)



- ▣ **Solitary egg parasitoid** of Pentatomidae
- ▣ **Short development time** – 2 to 3 weeks
- ▣ **Multiple generations/season**
- ▣ **Female-biased sex ratio**
- ▣ **High parasitism rates** in the native range (60 to 80%)



# Host Specificity Screening

- Standard test protocol for all collaborators
- Parasitoid females used in the tests:
  - ❖ 24 h old
  - ❖ Mated but naïve (no previous experience)
  - ❖ 24 h exposure to each egg mass
- 20 replicates of each non-target species



# Screening Procedures



## No Choice Test

Single egg mass of non-target species:



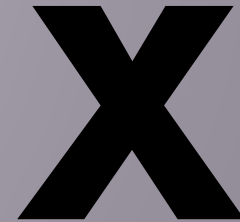
Followed by a BMSB control for an additional 24 hours:



**no attack of  
non-target**



**no parasitism  
recorded**



**no further  
testing  
required**



# Screening Procedures



## No Choice Test

Single egg mass of non-target species:



Followed by a BMSB control for an additional 24 hours:



**Non-target  
attacked**

**Parasitism  
recorded**

## Choice Test

One egg mass each of the target and non-target species:



Presented together

# Screening Procedures

## Measures of host acceptability:

- Attack rate (# eggs parasitized/egg mass)
- Proportion of undeveloped parasitoids in eggs
- No. of viable adult parasitoids emerged
- Size of emerged parasitoids
- Sex ratio (proportion adult males : females)





Genus	Species	State Tested	Genus	Species	State Tested
<i>Alcaeorrhynchus</i>	<i>grandis</i>	FL	<i>Holcostethus</i>	<i>abbreviatus</i>	OR
<i>Banasa</i>	<i>dimiata</i>	DE, OR	<i>Holcostethus</i>	<i>limbolarius</i>	FL, DE
<i>Banasa</i>	<i>euchlora</i>	DE	<i>Homaemus</i>	<i>proteus</i>	FL
<i>Brochymena</i>	<i>quadripustulata</i>	DE	<i>Hymenarcys</i>	<i>nervosa</i>	DE
<i>Chinavia</i>	<i>hilaris</i>	OR, DE	<i>Loxa</i>	<i>flavicollis</i>	FL
<i>Chinavia</i>	<i>marginata</i>	FL	<i>Megacopta</i>	<i>cribraria</i>	FL
<i>Chlorochroa</i>	<i>ligata</i>	OR	<i>Menecles</i>	<i>insertus</i>	DE
<i>Chlorochroa</i>	<i>saucia</i>	DE	<i>Mormidea</i>	<i>pama</i>	FL
<i>Chlorochroa</i>	<i>sayi</i>	DE	<i>Murgantia</i>	<i>histrionica</i>	FL, DE
<i>Chlorochroa</i>	<i>senilis</i>	DE	<i>Nezara</i>	<i>viridula</i>	FL
<i>Cosmopepla</i>	<i>intergressa</i>	OR	<i>Oebalus</i>	<i>pugnax</i>	FL, DE
<i>Cosmopepla</i>	<i>lintneriana</i>	DE	<i>Orsilochides</i>	<i>guttata</i>	FL
<i>Edessa</i>	<i>bifida</i>	FL	<i>Orsilochides</i>	<i>guttata</i>	FL
<i>Edessa</i>	<i>floridan</i>	DE	<b><i>Perillus</i></b>	<b><i>strigipes</i></b>	<b>FL</b>
<i>Euschistus</i>	<i>conspersus</i>	OR	<b><i>Podisus</i></b>	<b><i>maculiventris</i></b>	<b>FL, DE</b>
<i>Euschistus</i>	<i>quadrator</i>	FL	<i>Proxys</i>	<i>punctulatus</i>	FL
<i>Euschistus</i>	<i>servus</i>	FL, DE	<b><i>Stiretrus</i></b>	<b><i>anchorago</i></b>	<b>FL, DE</b>
<i>Euschistus</i>	<i>tristigmus</i>	DE	<i>Thyanta</i>	<i>custator</i>	OR, DE, FL
<i>Euschistus</i>	<i>variolarius</i>	DE, OR	<i>Thyanta</i>	<i>custator accerra</i>	DE
<b><i>Euthyrhynchus</i></b>	<b><i>floridanus</i></b>	<b>FL</b>	<i>Trichopepla</i>	<i>semivittata</i>	DE

# DE Host Range Test List

species in testing	species to be tested (if available)
<i>Chinavia hilaris</i>	<i>Banasa calva</i>
<i>Cosmopepla lintneriana</i>	<i>Banasa dimiata</i>
<i>Edessa florida</i>	<i>Banasa euchlora</i>
<i>Euschistus servus</i>	<i>Brochymena quadripustulata</i>
<i>Euschistus tristigmus</i>	<i>Chlorochroa saucia</i>
<i>Euschistus variolarius</i>	<i>Chlorochroa sayi</i>
<i>Murgantia histrionica</i>	<i>Chlorochroa senilis</i>
<b><i>Podisus maculiventris</i></b>	<i>Holcostethus limbolarius</i>
<i>Thyanta custator</i>	<i>Hymenarcys nervosa</i>
<i>Thyanta custator accerra</i>	<i>Meneclis insertus</i>
<i>Trichopepla semivittata</i>	<i>Mormidea lugens</i>
	<i>Oebalus pugnax</i>
	<i>Perillus bioculatus</i>
	<b><i>Stiretrus anchorago</i></b>

# No Choice Tests : No successful parasitism

Genus	Species	State	No Choice	Choice
<i>Euschistus</i>	<i>conspersus</i>	OR	Negative	X
<i>Euschistus</i>	<i>quadrator</i>	FL	Negative	X
<i>Euschistus</i>	<i>servus</i>	DE, FL	Negative	X
<i>Euschistus</i>	<i>variolarius</i>	OR	Negative	X
<i>Megacopta</i>	<i>cribraria</i>	FL	Negative	X
<i>Mormidea</i>	<i>pama</i>	FL	Negative	X
<i>Murgantia</i>	<i>histrionica</i>	DE, FL	Negative	X
<i>Nezara</i>	<i>viridula</i>	FL	Negative	X
<i>Oebalus</i>	<i>pugnax</i>	FL	Negative	X
<i>Piezodorus</i>	<i>guildinii</i>	FL	Negative	X
<i>Proxys</i>	<i>punctulatus</i>	FL	Negative	X



# No Choice Tests : some parasitism recorded\*

(\*further tests in progress to determine impact)

Genus	Species	State	No Choice	Choice
<i>Banasa</i>	<i>dimiata</i>	DE, OR	+	+
<i>Chinavia</i>	<i>hilaris</i>	DE, OR	+	(in progress)
<i>Chinavia</i>	<i>marginata</i>	FL	+	negative
<i>Chlorochroa</i>	<i>ligata</i>	OR	+	(in progress)
<i>Euthyrhynchus</i>	<i>florianus</i>	FL	+	(in progress)
<i>Holcostethus</i>	<i>limbolaris</i>	DE, FL	+	(in progress)
<i>Orsilochides</i>	<i>guttata</i>	FL	+	(in progress)
<i>Podisus</i>	<i>maculiventris</i>	DE, FL	+	+
<i>Thyanta</i>	<i>custator</i>	DE, FL, OR	+	+

*Trissolcus japonicus* : No-Choice Tests (DE)  
 (data shown are preliminary)

	# Replicates to date	# Attacks	Non-target Host			BMSB - Control		
			% Parasitism (mean)	% Parasitoids emerged (mean)	Sex ratio (mean; proportion male)	% Parasitism (mean)	% Parasitoids emerged	Sex ratio (mean; proportion male)
<i>Chinavia hilaris</i>	8	1	1	0	-	100	99	0.16
<i>Euschistus servus</i>	11	0	0	0	-	91	91	0.09
<i>Podisus maculiventris</i>	16	11	44	72	0.06	75	97	0.09
<i>Thyanta custator</i>	18	5	8	0.0	-	88	97	0.12

Note the different levels of acceptance & successful emergence  
 between non-target and BMSB

# Non-target attack: choice vs. no-choice

(data shown are preliminary)

	No-choice			Choice		
	Proportion of Egg Masses Attacked	Proportion Of Eggs Parasitized (mean)	Sex Ratio (proportion male; mean)	Proportion of Egg Masses Attacked	Proportion Of Eggs Parasitized (mean)	Sex Ratio (proportion male; mean)
<i>Chinavia marginata</i>	0.36	0.02	0.38	0	-	-
<i>Podisus maculiventris</i>	0.40	0.22	0.14	0.25	0.07	0.21
<i>Thyanta custator</i>	0.51	0.40	0.40	0.25	0.04	0.50

Note reduced levels of attack in Choice vs. No-choice conditions

# Further Assessments

## I. *Choice Tests*

## II. *Behavioral Observations*

- Searching Behavior (role of plant texture, chemical cues etc.)
- Patch Residence Times & Leaving Tendency
- Oviposition Behavior
- Intra- and Interspecific Competition

## III. *Role of Parasitoid Physiology*

- Effect of parental experience & physiology on host choice behavior
- Effect of host choice on offspring (sex ratio, fitness, size)

*Thank you!*



*Trissolcus mitsukurii*

Photo: Steve Valley - ODA