Synergy of aggregation pheromone with MDT in trapping of brown marmorated stink bug

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Plautia stali
Brown-winged green stink bug

ggregation pheromone is methyl (*E*,*E*,*Z*)-2,4,6-
decatrienoate (MDT); produced by male and
attractive to both males and females

IDT attracts other insects which do not
produce it!

Halyomorpha halys

Glaucias subpunctatus

Chinavia hilare

+ several tachinid species

DT attracts other pentatomids which do not produce it. This cross-attraction is not uncommon and includes other stink bug species; *why?*

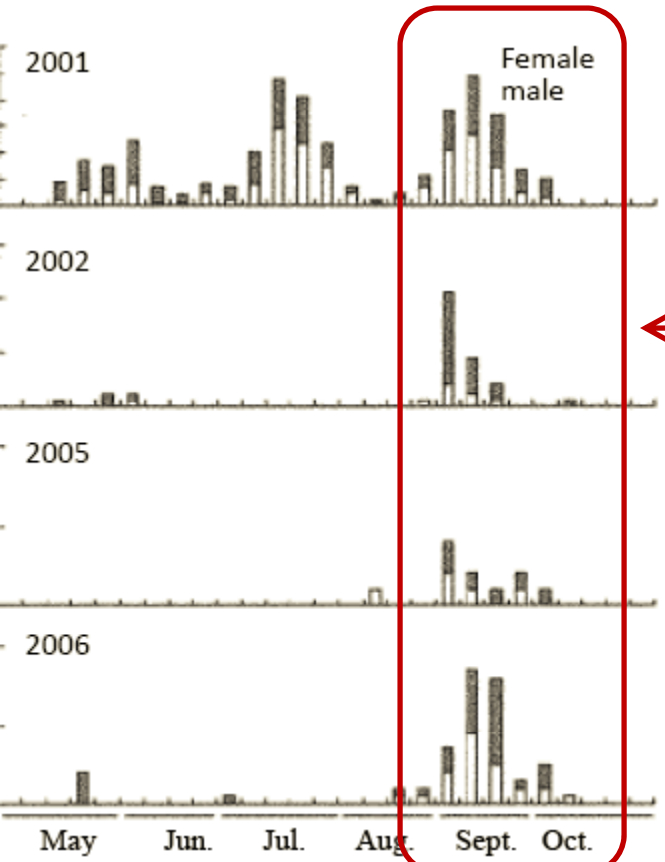
food signal for polyphagous species

overwintering site signal

promotes aggregation which passively protects them from natural enemies

Halyomorpha halys

Brown marmorated stink bug



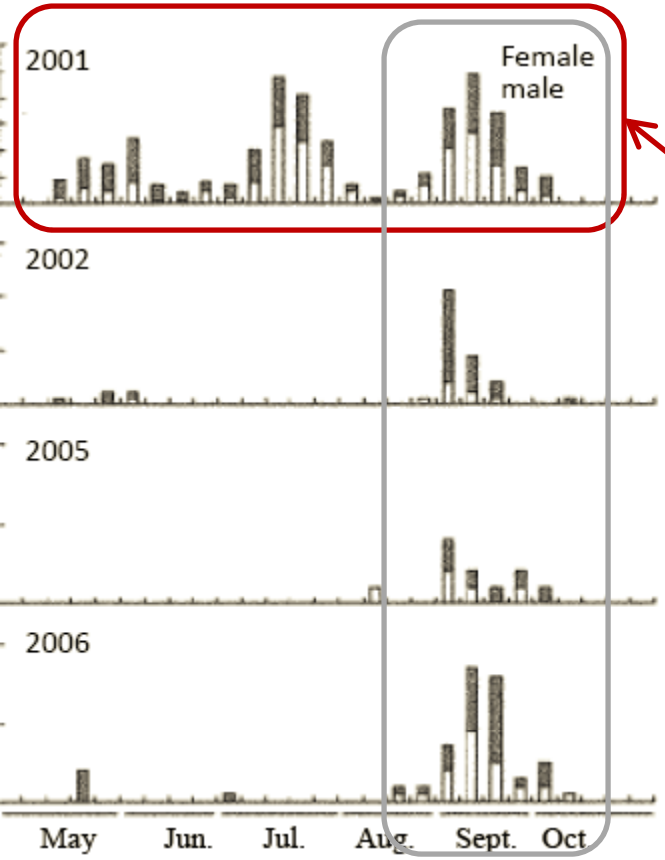
1: Seasonal changes in the number of *Halyomorpha halys* ults captured in traps baited with synthetic aggregation eromone of *Plautia crossota stali* in a coppice in Akita efecture in 2001, 2002, 2005 and 2006. Bars: total number adults captured in 6 traps.

Asian native

responsive to MDT

... but in most years, almost exclusively late in the season

Halyomorpha halys
Brown marmorated stink bug



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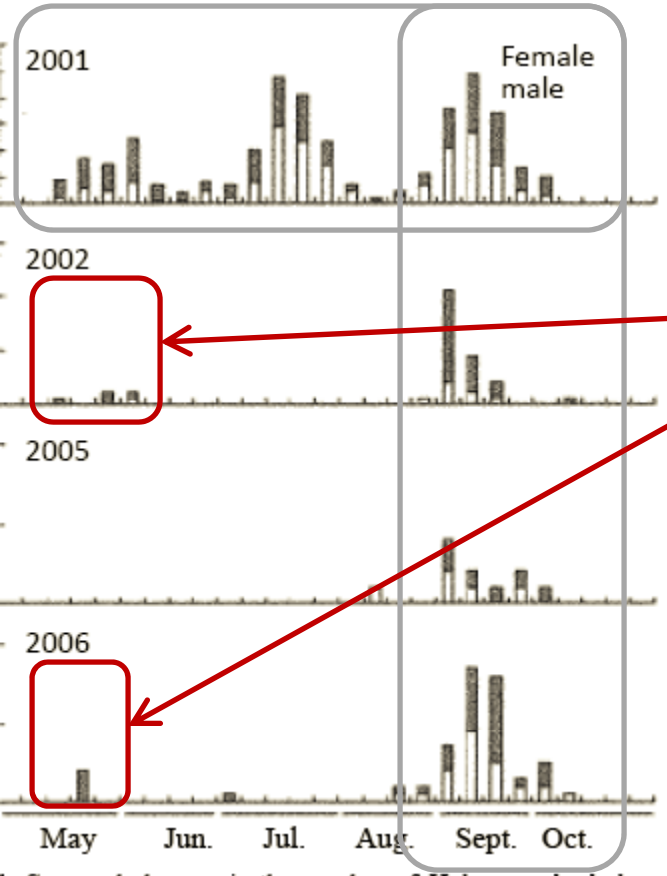
Asian native
responsive to MDT

... or, during outbreak years (axis is 60 vs. 10 to 30 in subsequent years)

Halyomorpha halys
Brown marmorated stink bug



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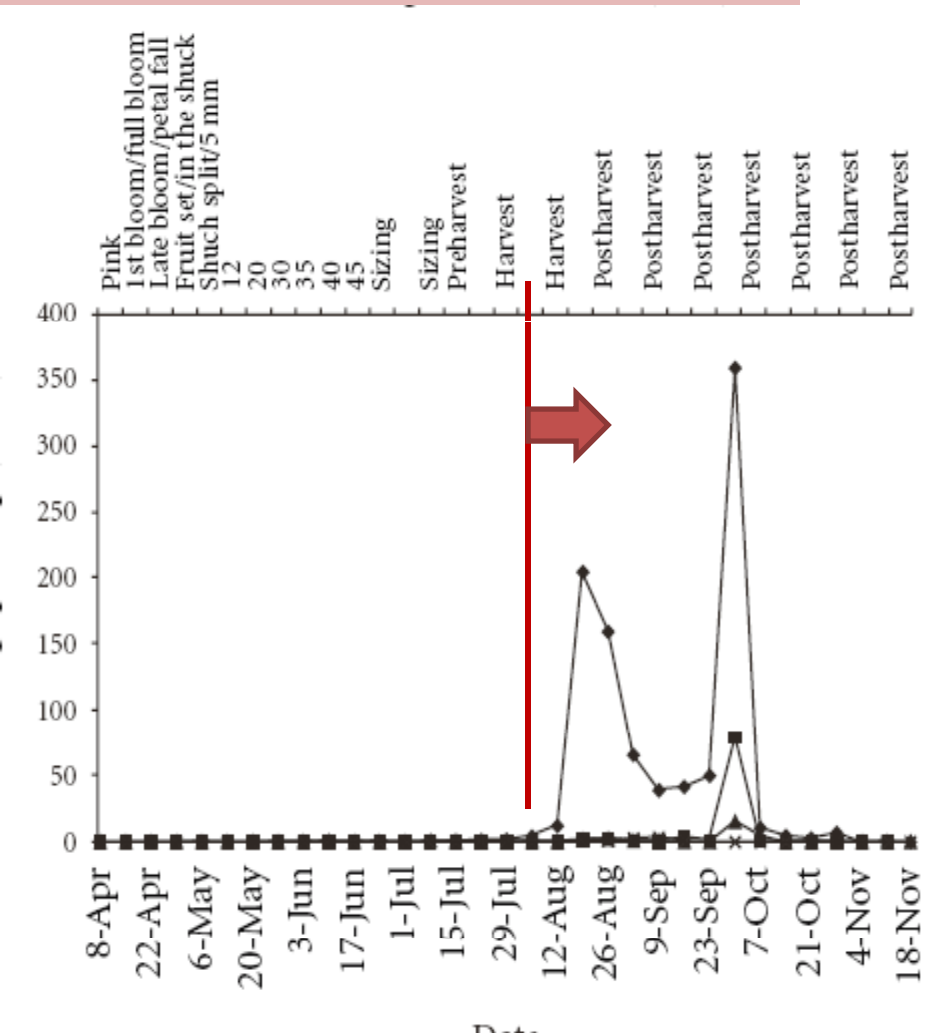
Asian native
responsive to MDT

... and occasionally in the early season

tures using black pyramid
s baited with MDT (50mg)
A & MD apple orchards, 2011



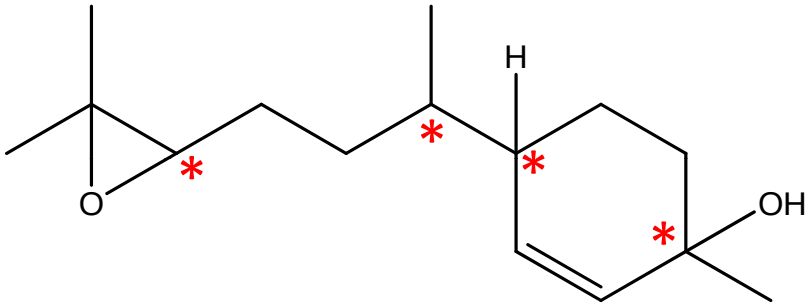
Halyomorpha halys
Brown marmorated stink bug

Asian native
responsive to MDT

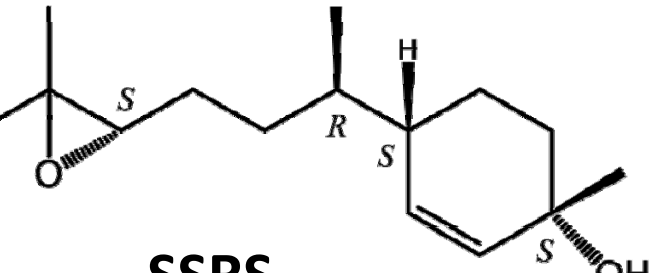
but usually only
after harvest
of apple crop,
in late season

Halyomorpha halys
Brown marmorated stink bug

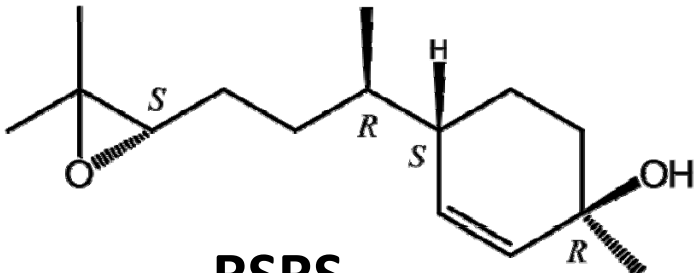
scovery & availability of BMSB pheromone
in quantities useful for field bioassays by early 2012



10,11-epoxy-1-bisabolen-3-ol
total 16 stereoisomers



SSRS



RSRS

Halyomorpha halys
Brown marmorated stink bug

ith... **knowledge of seasonally-limited attraction of MDT**
d... **discovery & availability of BMSB pheromone**
... **an isomer mixture which we knew had comparable attractiveness to pure isomers ...**

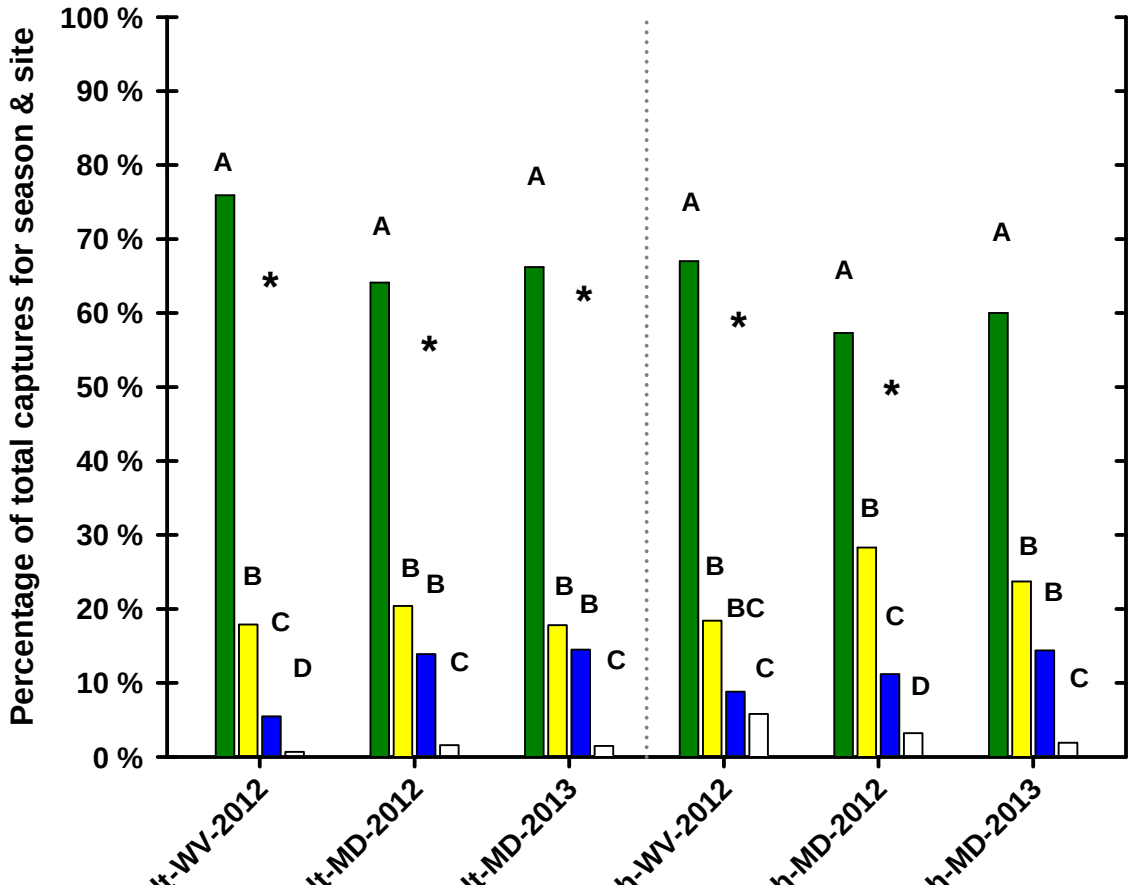
e set up a simple factorial experiment:

- **BMSB pheromone (mixed isomers with ~2mg of SSRS)**
- **MDT (66mg)**
- **Both**
- **Neither**

black pyramid traps, MD 2012-13 and WV 2012, RCB layout, season-long)

e of pheromone together with MDT produces synergistic attraction ...

Halyomorpha halys
Brown marmorated stink bug



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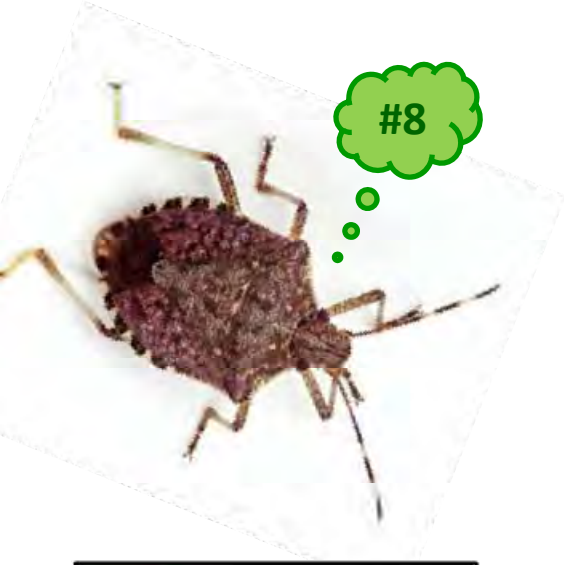

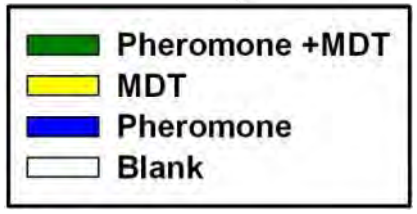

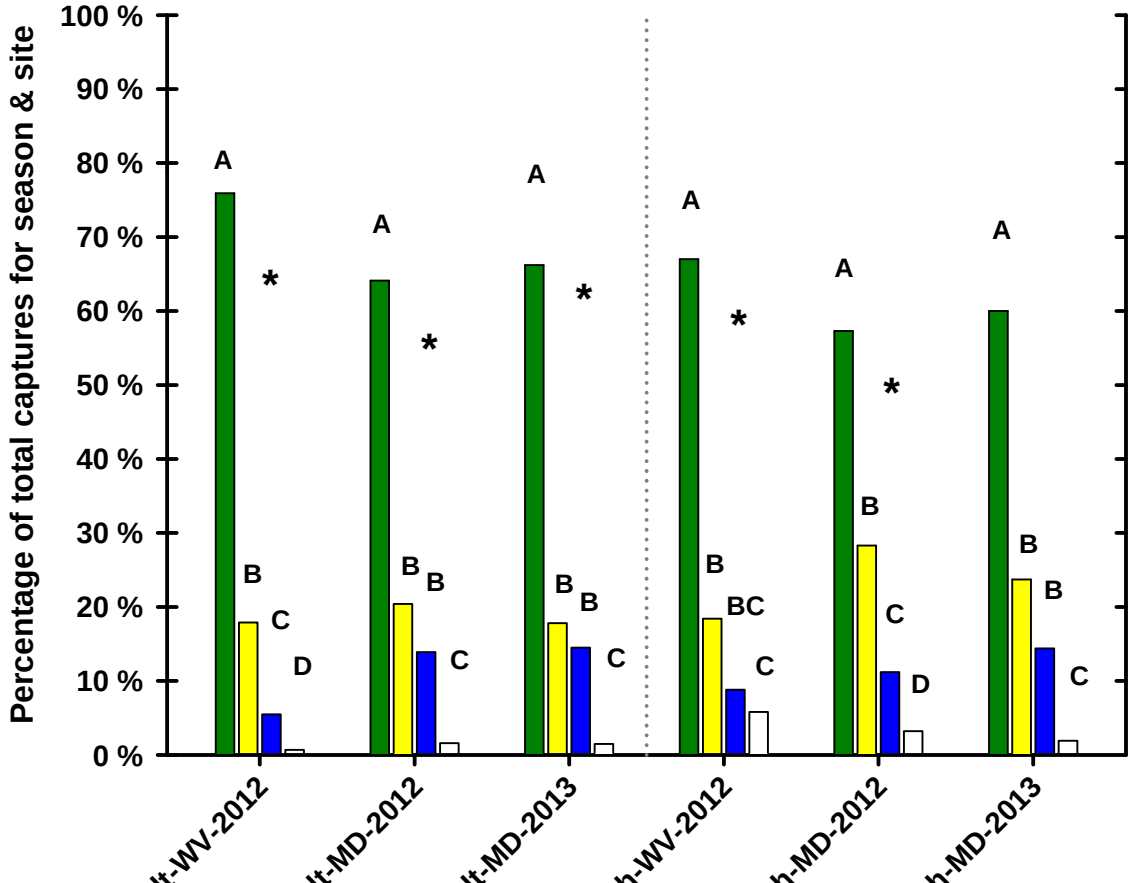

mprovement in captures (season-long totals)
and Synergism (greater-than-additive) effect
from use of combined pheromone plus MDT lures

	Arden WV 2012			Beltsville MD 2012			Beltsville MD 2013		
ure	adult season total			adult season total			adult season total		
ombined	4231	ratio	95% c.i.	3783	ratio	95% c.i.	1821	ratio	95% c.i.
MDT	999	4.24	(3.95, 4.54)	1203	3.14	(2.95, 3.36)	510	3.57	(3.24, 3.95)
heromone	304	13.93	(12.39, 15.69)	822	4.60	(4.27, 4.97)	383	4.75	(4.26, 5.32)
ynergism		3.25	(3.05, 3.46)		1.87	(1.77, 1.97)		2.04	(1.88, 2.21)

compared to MDT alone

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compared to pheromone alone

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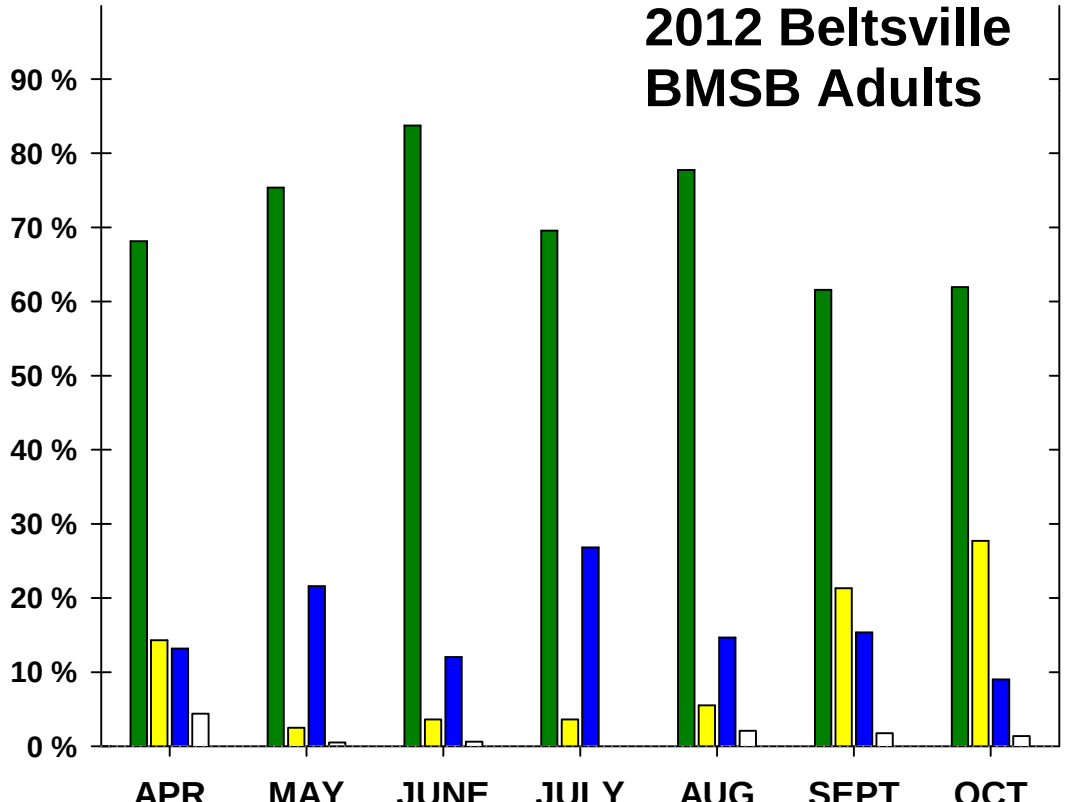
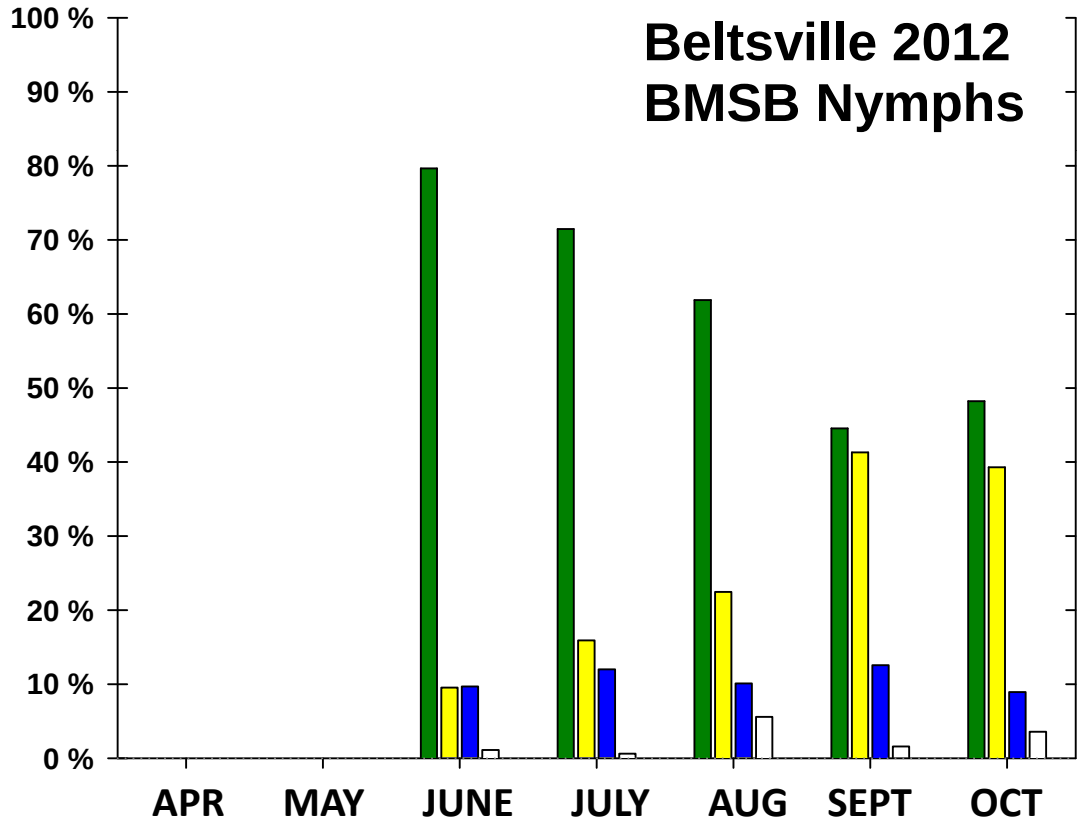
mbined lure is superior over the entire season for adults

Halyomorpha halys
Brown marmorated stink bug



Halyomorpha halys
Brown marmorated stink bug

and also provides superior season-long attraction in nymphs



son-long performance of combined lure
mple: Beltsville 2013 adult BMSB

. halys		========== Lure treatments ==========													
, Maryland		Unbaited control			Pheromone (BMSB2)			MDT (MDT2)			Combined MDT2+BMSB2				
DATES	capture for 4 traps / trtmt	adults captured (% of total)			adults captured (% of total)			adults captured (% of total)			adults captured (% of total)				
ril	13-day total	0	0.0%		2	14.3%		0	0.0%		12	85.7%			
10 May	15-day total	0	0.0%	b	3	33.3%	b	0	0.0%	b	6	66.7%	a	*	
ay	13-day total	0	0.0%	c	12	17.9%	b	7	10.4%	c	48	71.6%	a		
June	15-day total	0	0.0%	d	27	21.4%	b	9	7.1%	c	90	71.4%	a	*	
e	14-day total	0	0.0%	b	26	45.6%	a	3	5.3%	b	28	49.1%	a		
- 5 July	14-day total	0	0.0%	c	18	12.5%	b	6	4.2%	bc	120	83.3%	a	*	
y	14-day total	0	0.0%	b	13	40.6%	b	0	0.0%	b	19	59.4%	a	*	
2 Aug	14-day total	2	0.9%	c	36	16.3%	b	6	2.7%	c	177	80.1%	a	*	
g	14-day total	2	4.0%	b	8	16.0%	b	1	2.0%	b	39	78.0%	a	*	
g	14-day total	3	0.9%	b	42	12.9%	b	37	11.4%	b	243	74.8%	a	*	
3Sept	14-day total	6	0.9%	c	90	13.7%	b	153	23.3%	b	408	62.1%	a		
pt	13-day total	23	0.0%	c	73	10.4%	bc	206	29.2%	b	403	57.2%	a		
3 Oct	12-day total	4	1.2%	c	28	8.4%	b	79	23.6%	b	224	66.9%	a	*	
	16-day total	1	7.7%		5	38.5%		3	23.1%		4	30.8%			
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son-long performance of combined lure
mple: Beltsville 2013 adult BMSB

. halys

, Maryland

DATES	capture for 4 traps / trtmt	Unbaited control adults captured (% of total)			Pheromone (BMSB2) adults captured (% of total)			MDT (MDT2) adults captured (% of total)			Combined MDT2+BMSB2 adults captured (% of total)			
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son-long performance of combined lure
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son-long performance of combined lure
mple: Beltsville 2013 nymphal BMSB

H. halys		========== Lure treatments ==========												
. Maryland		Unbaited control			Pheromone (BMSB2)			MDT (MDT2)			Combined MDT2+BMSB2			
DATES	capture for 4 traps / trtmt	nymphs captured (% of total)			nymphs captured (% of total)			nymphs captured (% of total)			nymphs captured (% of total)			
ril	13-day total	0			0			0			0			
10 May	15-day total	0			0			0			0			
ay	13-day total	0			0			0			0			
June	15-day total	0			0			0			0			
e	14-day total	1	33.3%		1	33.3%		1	33.3%		0	0.0%		
5 July	14-day total	5	0.3%	c	97	5.5%	bc	531	29.9%	b	1143	64.4%	a	
y	14-day total	1	0.4%	c	113	45.0%	ab	28	11.2%	bc	109	43.4%	a	
2 Aug	14-day total	21	3.0%	b	177	25.4%	ab	92	13.2%	ab	408	58.5%	a	
g	14-day total	39	8.6%	b	114	25.1%	a	135	29.7%	ab	166	36.6%	a	
g	14-day total	28	1.9%	c	156	10.3%	bc	296	19.6%	b	1030	68.2%	a	*
Sept	14-day total	4	1.1%	c	72	19.7%	b	111	30.4%	b	178	48.8%	a	
ot	13-day total	0	0.0%	b	3	14.4%	ab	12	28.6%	ab	27	64.3%	a	
Oct	12-day total	1	5.3%		10	52.6%		6	31.6%		2	10.5%		
	16-day total	0			0			0			0			
24 Oct	TOTAL	100	2.0%	c	743	14.5%	b	1212	23.7%	b	3063	59.8%	a	

son-long performance of combined lure
mple: Beltsville 2013 nymphal BMSB

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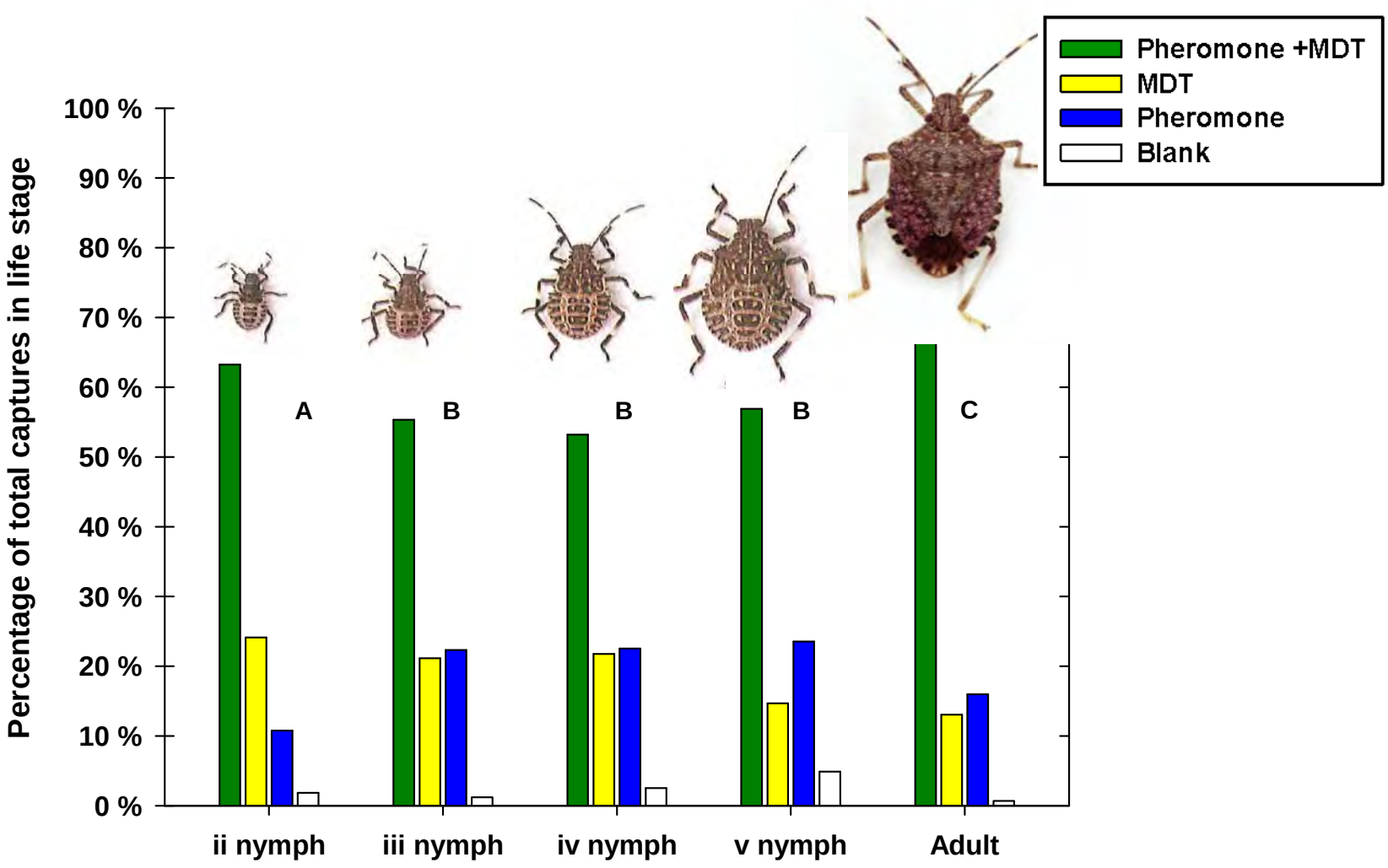
5 July	14-day total	5	0.3%	c	97	5.5%	bc	531	29.9%	b	1143	64.4%	a	
y	14-day total	1	0.4%	c	113	45.0%	ab	28	11.2%	bc	109	43.4%	a	
2 Aug	14-day total	21	3.0%	b	177	25.4%	ab	92	13.2%	ab	408	58.5%	a	
g	14-day total	39	8.6%	b	114	25.1%	a	135	29.7%	ab	166	36.6%	a	
g	14-day total	28	1.9%	c	156	10.3%	bc	296	19.6%	b	1030	68.2%	a	*
Sept	14-day total	4	1.1%	c	72	19.7%	b	111	30.4%	b	178	48.8%	a	
pt	13-day total	0	0.0%	b	3	14.4%	ab	12	28.6%	ab	27	64.3%	a	
Oct	12-day total	1	5.3%		10	52.6%		6	31.6%		2	10.5%		
	16-day total	0			0			0			0			
24 Oct	TOTAL	100	2.0%	c	743	14.5%	b	1212	23.7%	b	3063	59.8%	a	

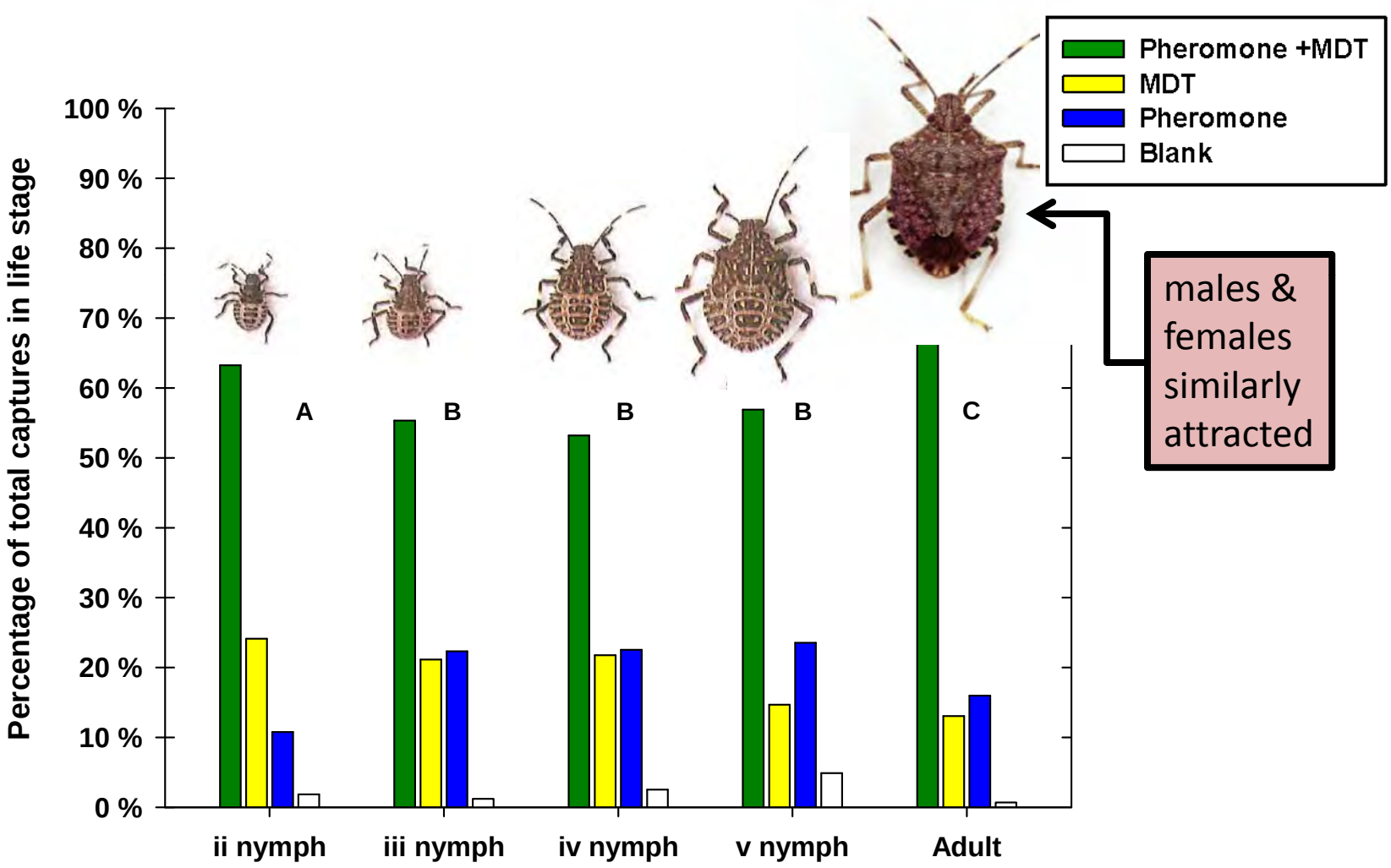
Amongst nymphal stages and adults, season-long differences are small

dataset: Beltsville 2013

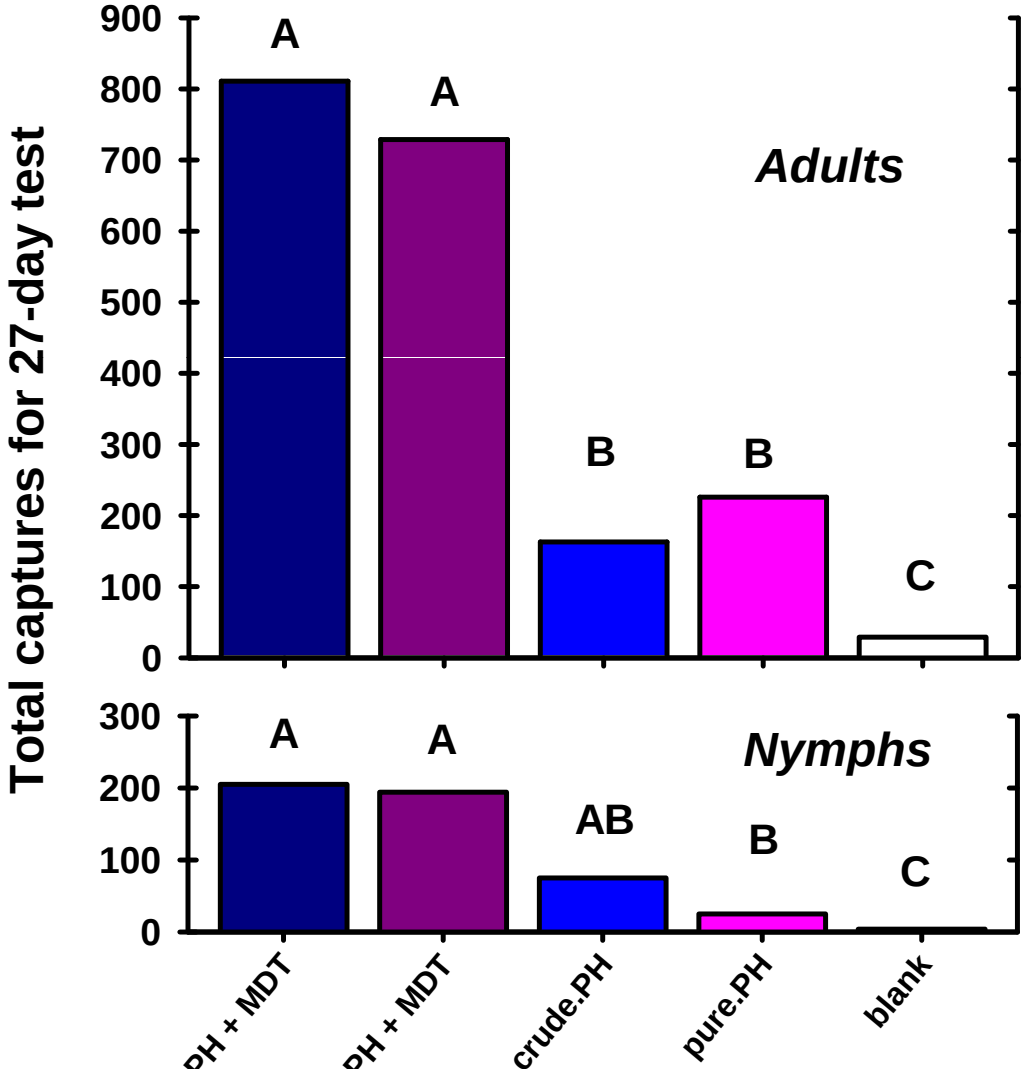


Amongst nymphal stages and adults, season-long differences are small

dataset: Beltsville 2013



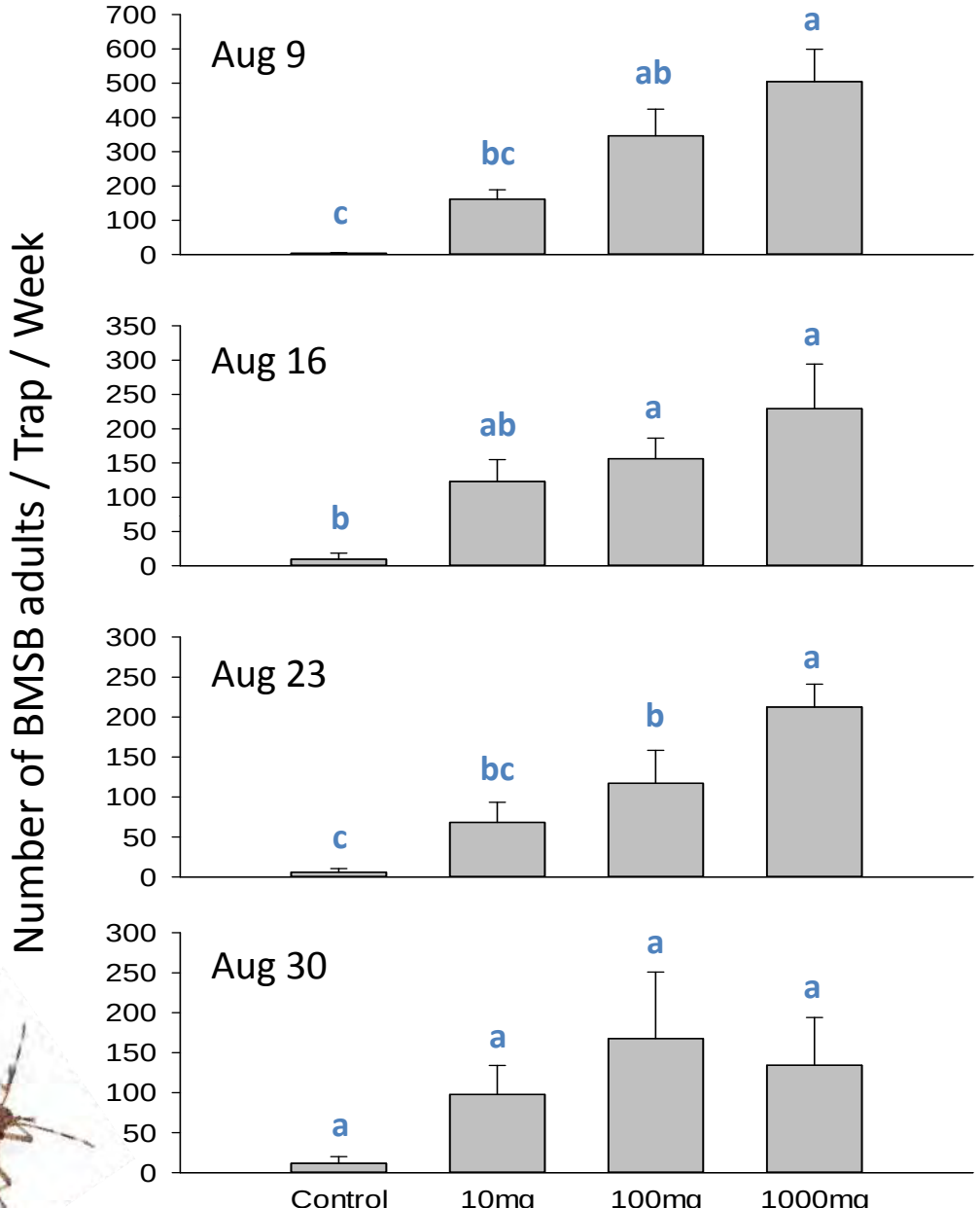
mparison of captures for crude (#20) pheromone mixture rsus pure isomers (SSRS + RSRS) with and without 66mg MDT



al..

alys captures in pyramid ps with mixed-isomer eromone lures of 0, 10, 100, and 1000mg (!), with 66mg MDT

st 2013, soybean, West Virginia



tion on near-natural
stone monument

Halyomorpha halys
Brown marmorated stink bug

distinct overwintering
sites & behavior

attraction to outdoor lighting at a
brick bank building

urgantia histrionica
arlequin bug

&

Halyomorpha halys
Brown marmorated stink bug

ggregation pheromone for HQ bug "murgantiol"
(Zahn et al. 2008)

tractive also to BMSB, as shown in preceding talk

ch species has pheromone with two stereoisomers;
both have as most abundant, (3*S*,6*S*,7*R*,10*S*)-10,11-
epoxy-1-bisabolen-3-ol

t ... there are some KEY distinctions ...

urgantia histrionica
arlequin bug

&

Halyomorpha halys
Brown marmorated stink bug

Revolution
#9...#9...#9

Key distinctions:

2nd isomer is SSRR	**≠**	**2nd isomer is RSRS**
plant specialist	**≠**	**extreme generalist**
orth American native	**≠**	**Asian native**
ot responsive to MDT	**≠**	**responsive to MDT**
distinct overwintering sites & behavior	**≠**	**distinct overwintering sites & behavior**

urgantia histrionica

arlequin bug

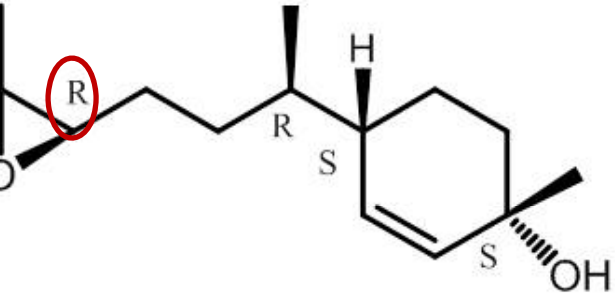
&

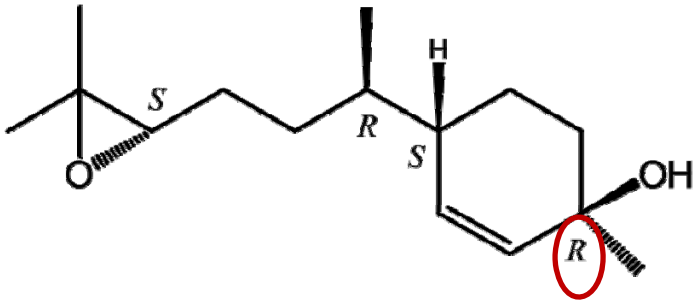
Halyomorpha halys

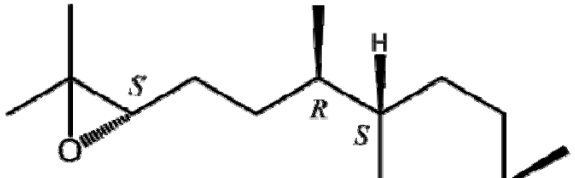
Brown marmorated stink bug

Key distinctions:

2nd isomer is SSRR ≠ 2nd isomer is RSRS



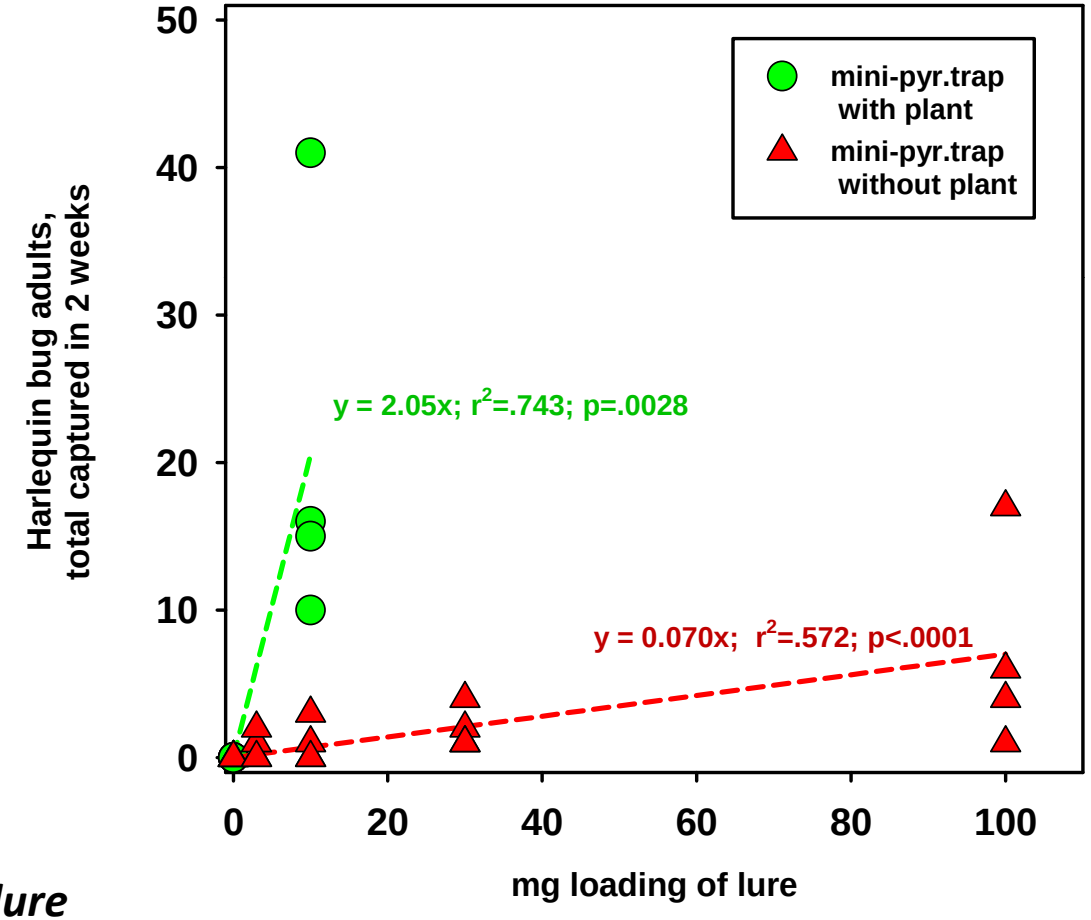




Murgantia histrionica: Harlequin bug

plant specialist (Brassicaceae & Capparaceae)

(Wallingford et al. 2012)



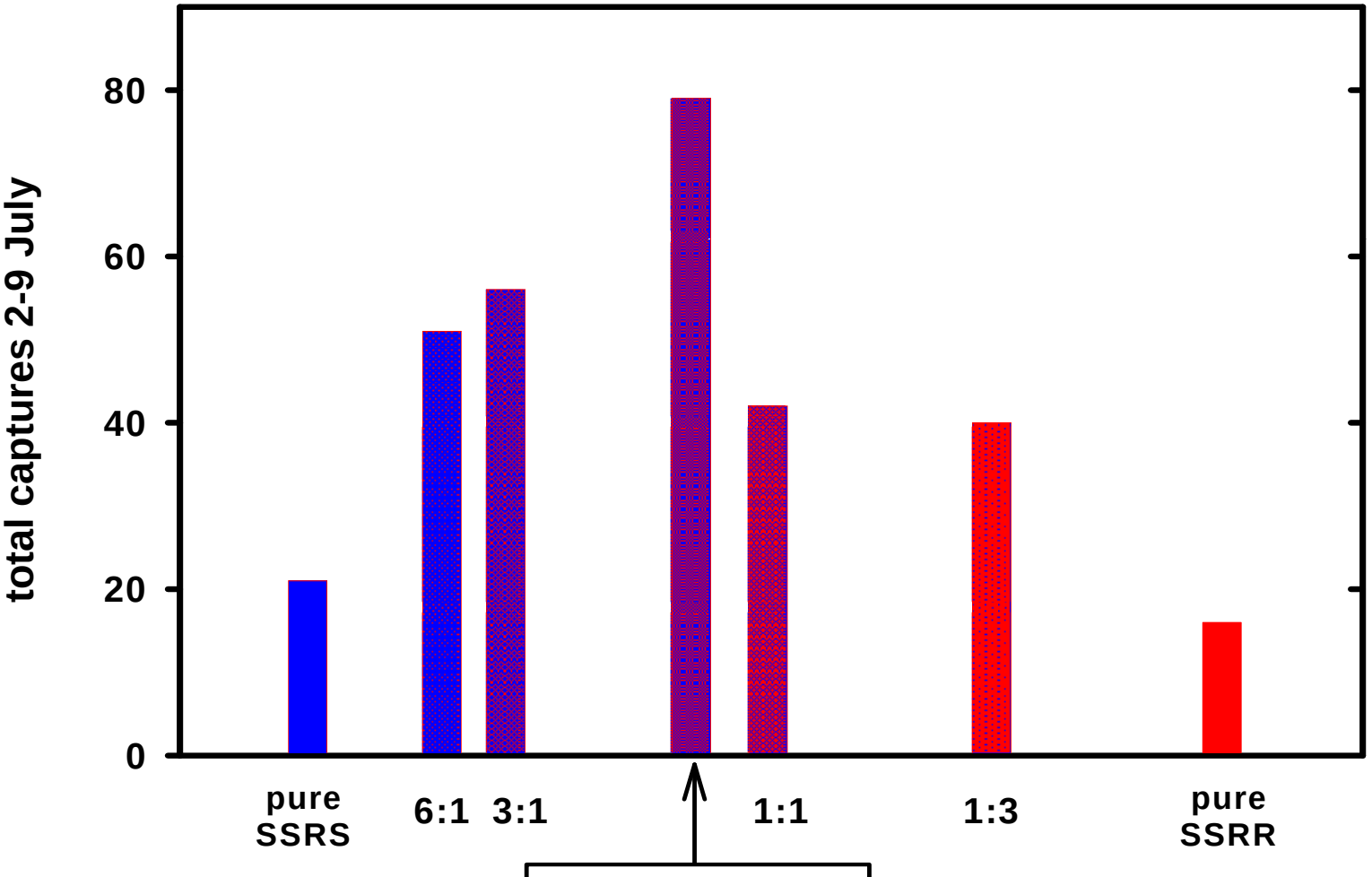
ong response to mixed-isomer lure

pecially in combination with host plant

(0, 3, 10, 30, or 100mg without plant)

Murgantia histrionica
Harlequin bug

Captures at trap collard plants with 4mg blends with varied isomer ratio
7-way field choice test 2-9 July 2013



hallenges to understanding and application of pentatomid semiochemicals – big picture

Knowledge of biology << knowledge of chemistry

Pheromone may have multiple functions depending on...

Other senses involved: visual and especially short-range substrate-borne vibrational

Species are polyphagous and highly mobile; need to consider wild hosts and entire [agro]ecosystems

Additonal attractants: other species' semiochemicals and also various phytochemicals

Natural enemies respond to pheromones

Making pest suppression work: general challenges with managing trap-cropping or mass trapping

Next steps with BMSB pheromone research

Individual isomers: determine optimal ratios (how much increased dose compensates for off-ratios)

Combined lures: determine optimal doses and ratio of MDT to pheromone

Trap design, including toxin-free models

Making pest suppression work: implement trap-cropping and/or mass trapping, while protecting natural enemies and other non-targets

Thank you!

We thank Michael Athanas, Anthony DiMeglio, and Matthew Klein (Maryland) and John Cullum, Sean Wiles and Torri Hancock (West Virginia) for pheromone trap field collection and sorting through the MANY bugs and experiments. Partial support for this study was from USDA, National Institute of Food and Agriculture, Specialty Crop Research Initiative grant #2011-51181-30937.

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