2.2.1 Evaluate efficacy of registered and developmental insecticides against BMSB

Chris Bergh, Galen Dively, Greg Krawczyk,
Tom Kuhar, Tracy Leskey and Joanne Whalen

Funding

USDA United States Department of Agriculture

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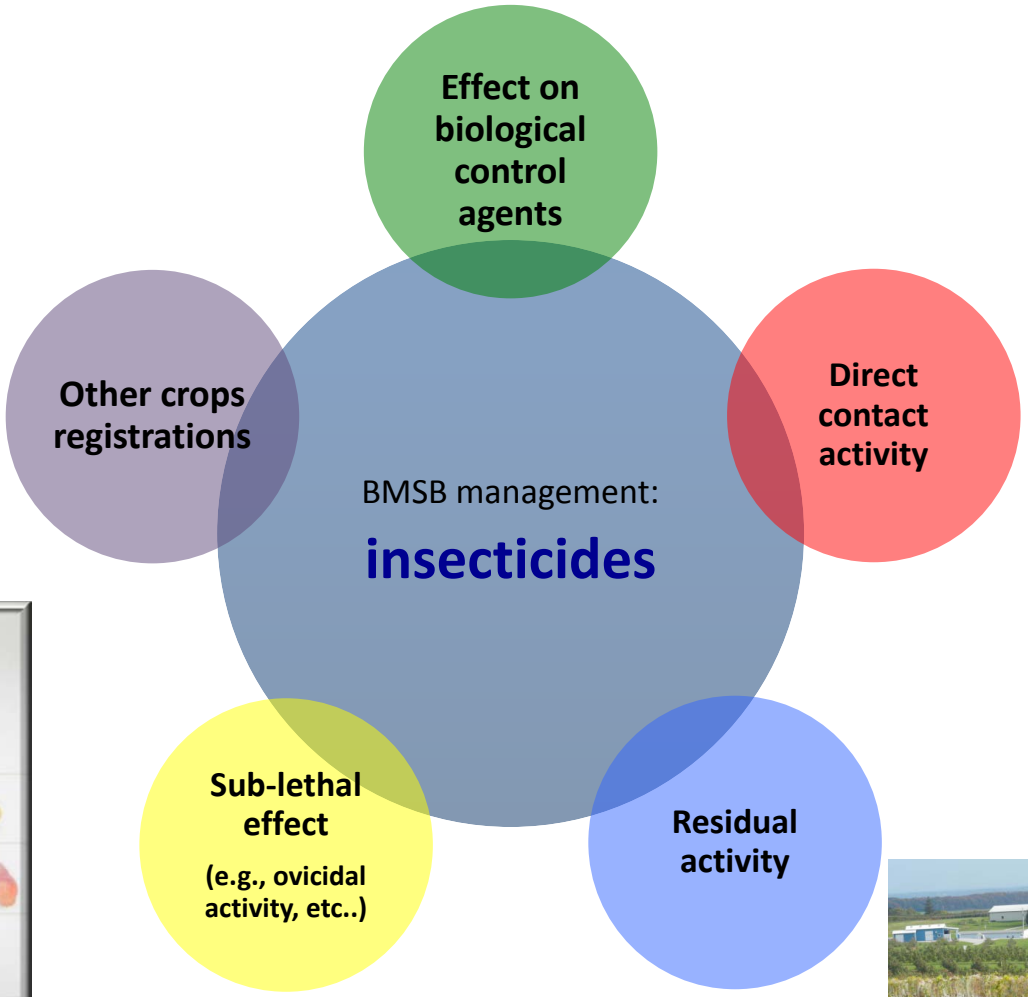
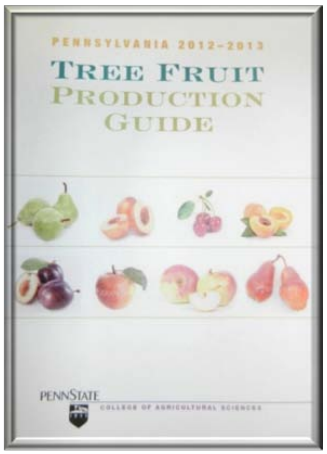
Collaborating Institutions

University of Delaware · ARS · Penn State · Rutgers · Northeastern IPM Center · Washington State University · Cornell University · Virginia Tech · OSU Oregon State University · University of Maryland · NC State University

Stop BMSB.org

Short term solution - insecticides





Management of BMSB – pesticide evaluations

Adult residual bioassays (USDA) — Winter 2011

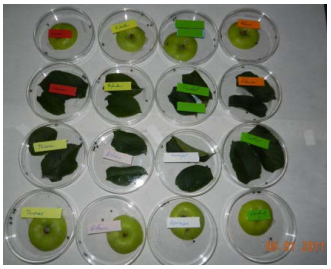
Adult direct contact bioassays (PSU) — Winter/spring 2011

Adult field residual bioassays (USDA) — Summer 2011

Nymphal feeding bioassays (VA Tech) — Winter/spring 2011

Nymphal field residual bioassays (PSU) — Summer/fall 2011

Ovicidal bioassays (PSU) — Summer 2012



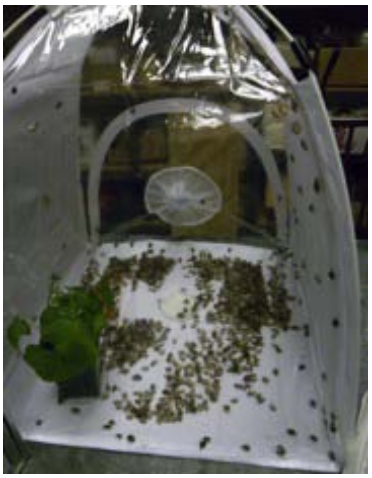
- Tested over 30 insecticides
- Insecticide concentrations based on highest labeled rate & 100 gal / acre water output
- Filter paper + one green bean were:
  - dipped in solution for 5 seconds
  - dried ½ hr under a fume hood
  - placed in a 9-cm Petri dish
- 5 adults or 2nd to 3rd instars per dish
- 4 Petri dishes per treatment for a total of 20 insects per bout
- Mortality at 72 hrs

Green bean dip bioassays in VA

Tom Kuhar and VT team

Direct contact topical bioassays

Brief description of methods

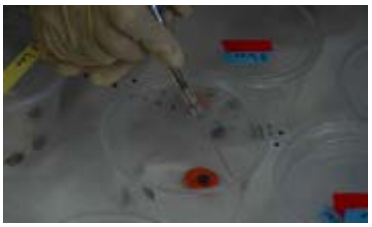


Subject

- BMSB adults from overwintering colony;
- Male and female adults (30 from each gender) tested separately.

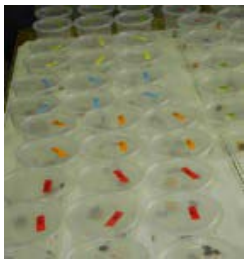
Test

- Commercial grade insecticide solutions at field rate, surfactant added;
- Each individual bug treated dorsally with 2 µl of solution.



Results

- Mortality assessed at 4, 24, 48, 72, 96 and 120 hours after treatment;
- Surviving individuals kept for further observation.



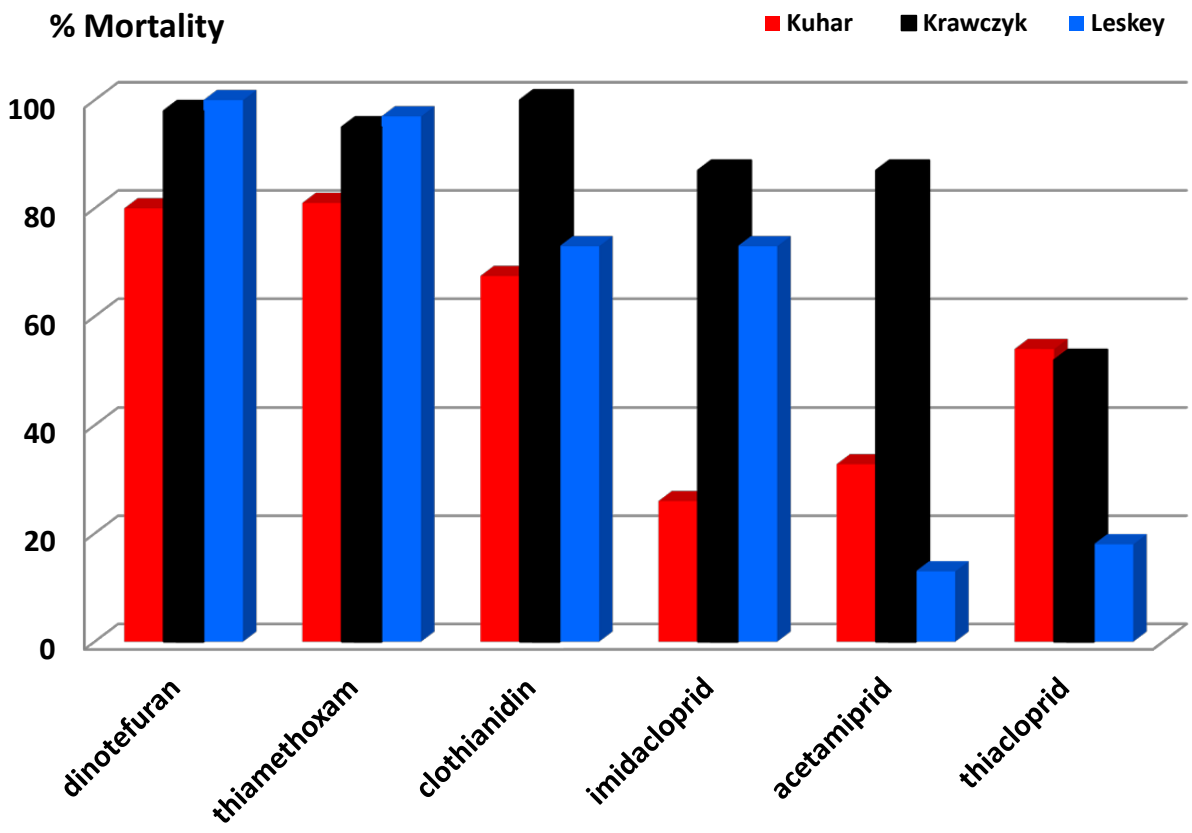
Laboratory assays

Author	Assay approach	Exposure duration
T. Leskey (USDA)	dry residue on glass (contact)	4.5 hours
T. Kuhar (VT)	dipped green beans (feeding/contact)	continuous
G. Krawczyk (PSU)	topical application to thorax (contact)	continuous

- Evaluated response of nymphs and/or adults
- Field-collected overwintering populations and lab colonies
- All authors evaluated response after 3 days
- Two authors also assessed response at up to 5 or 7 days
- Differentiated between dead and moribund bugs

Slide courtesy of Dr. Chris Bergh, VT

Neonicotinoids



Slide courtesy of Dr. Chris Bergh, VT

Relative product ranking: Neonicotinoids

Based on Leskey's Lethality Index	Based on combined data from ≥ 2 studies (# of data sets)
1. Dinotefuran	1. Dinotefuran (3)
2. Thiamethoxam	2. Thiamethoxam (3)
3. Clothianidin	3. Clothianidin (3)
4. Imidacloprid	4. Imidacloprid (3)
5. Acetamiprid	5. Acetamiprid (3)
6. Thiacloprid	6. Thiacloprid (3)

Slide courtesy of Dr. Chris Bergh, VT

Relative product ranking: Pyrethroids

Based on Leskey's Lethality Index	Based on combined data from ≥ 2 studies (# of data sets)
1. Bifenthrin = Brigade	1. Bifenthrin (3) = Bifenture
2. Permethrin = Permethrin 3.2	2. Cyfluthrin* (2) = Baythroid 2E
3. Fenpropathrin = Danitol	3. Permethrin (3) = Permethrin/Pounce
4. ß-cyfluthrin = Baythroid XL	4. Fenpropathrin (3)
5. γ-cyhalothrin = Declare	5. ß-cyfluthrin (3)
6. ʎ-cyhalothrin = Warrior CS	6. ʎ-cyhalothrin (3) = Warrior II**
7. ʒ-cypermethrin = Mustang Max	7. ʒ-cypermethrin (3)
8. Cyfluthrin = Tombstone	8. Esfenvalerate (3)
9. Esfenvalerate = Asana	Etofenprox (Trebon) ranked very highly, based on 1 data set

* Ranking of cyfluthrin based on response at 72 hours
Leskey's data showed significant recovery after 72 hours

** In Kuhar study, Warrior II much stronger than Lambda-Cy

Slide courtesy of Dr. Chris Bergh, VT

Relative product ranking: Carbamates

Based on Leskey's Lethality Index	Based on combined data from ≥ 2 studies (# of data sets)
1. Lannate = Lannate SP	1. Lannate SP (2)
2. Oxamyl = Vydate L	2. Lannate LV (2)
3. Carbaryl = Sevin XLR Plus	3. Oxamyl (3)
	4. Carbaryl (3) = Sevin XLR Plus

Slide courtesy of Dr. Chris Bergh, VT

Relative product ranking: Organochlorine and OPs

Based on Leskey's Lethality Index	Based on combined data from ≥ 2 studies (# of data sets)
1. Malathion = Malathion 5EC	1. Endosulfan (2) = Thionex EC & WP
2. Endosulfan = Thiodan EC	2. Acephate (2) = Acephate 97UP
3. Acephate = Orthene SP	3. Azinphosmethyl (3)
4. Azinphosmethyl = Guthion 50W	4. Phosmet (2)
5. Diazinon = Diazinon AG500	5. Diazinon (2)
6. Phosmet = Imidan 70W	

* Only OPs labeled for use in the post-bloom in apples and/or peaches are presented

Slide courtesy of Dr. Chris Bergh, VT

Field insecticide trials

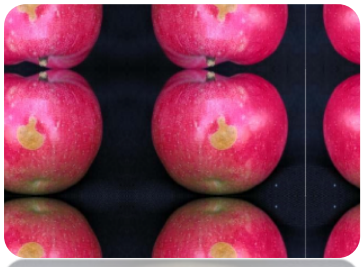
Dr. Chris Bergh, VT

- 1.3 A block of 27-yr-old ‘Law Rome’ on M.111
- Back-to-back applications, 3 June – 20 Sept
- Single-tree plots, replicated 4 times
- Complete sprays (100 gpa) at 10-d intervals
- In-season and harvest evaluations of direct & 2^0 pests

Internal worms

BMSB

Plum curculio



Products evaluated

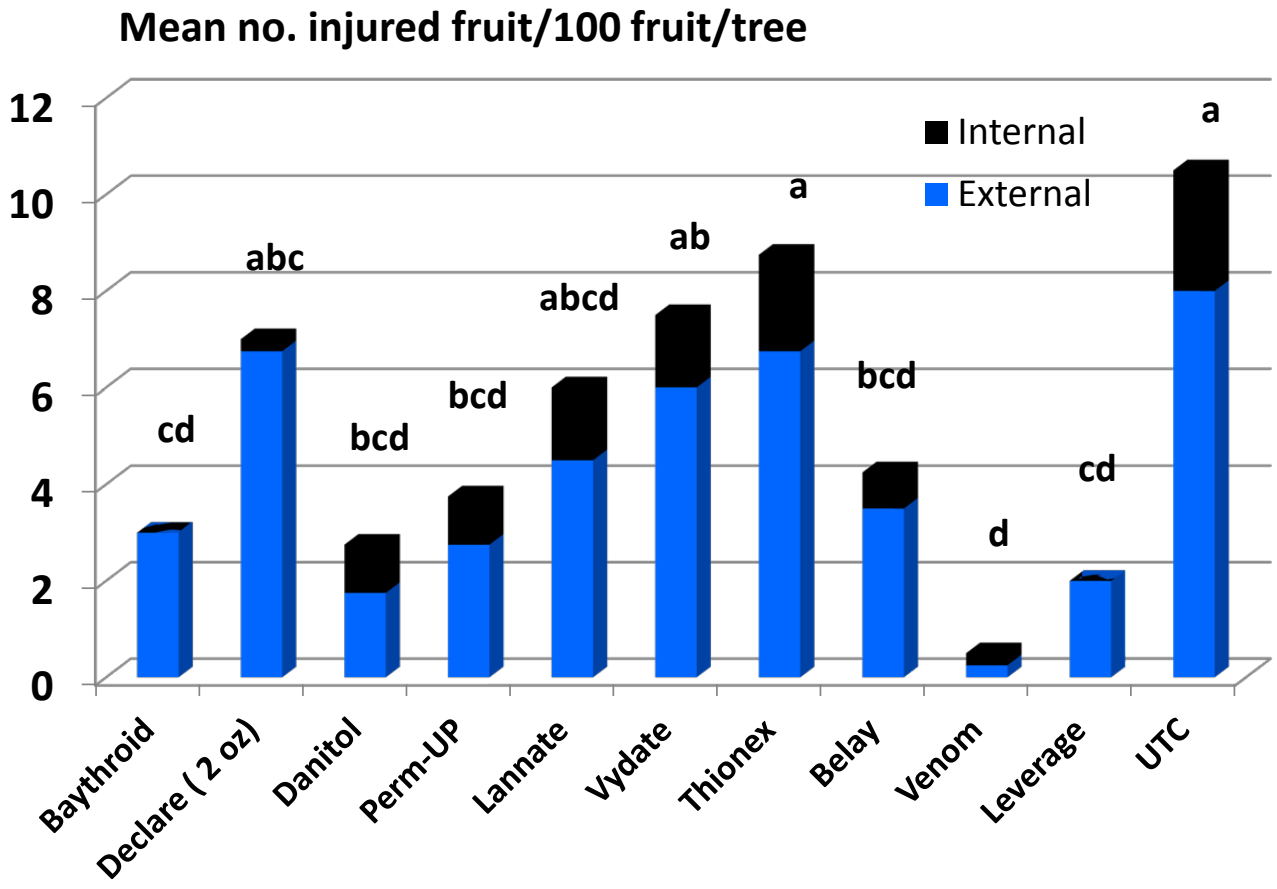
Chris Bergh, VT

Class	A.I.	Trade name	Rate/A
Pyrethroid	beta-cyfluthrin	Baythroid XL	2.8 fl oz
	fenpropathrin	Danitol	16 fl oz
	gamma-cyhalothrin	Declare	1 & 2 fl oz
	permethrin	Perm-UP	12 fl oz
Carbamate	methomyl	Lannate	12 oz
	oxamyl	Vydate	3 pt
Organochlorine	endosulfan	Thionex (EC)	1.67 qt*
Neonicotinoid	clothianidin	Belay	6 fl oz
	dinotefuran	Venom	6.75 oz
Neonicotinoid + Pyethroid	imidacloprid + beta-cyfluthrin	Leverage 360	2.8 fl oz

Altacor (3.0 oz/A) and Delegate (5.2 oz/A) + Envidor (18 fl oz/A) were applied to the entire block to minimize fruit loss to internal worms & reduce mites on 17 June & 29 July, respectively

BMSB injury at harvest

Chris Bergh, VT



BMSB Management Programs - 2012 season

Bayer program:
Belt @ 5 oz + Admire Pro @ 2.8 oz (2x during CM timing) *plus*
Leverage @ 2.8 oz (1 x)

DuPont program:
Altacor @3 oz + Lannate LV @2 pt (2x during CM timing) *plus*
Lannate LV @ 2pt (2 x)

Syngenta program:
Voliam Xpress @ 9 oz (2x during CM timing) *plus*
Endigo @ 5.0 oz (2x)

United Phosphorus program:
Assail @ 8 oz + Intrepid (3 x during CM timing) *plus*
Bifenture 2EC @ 10 oz (Section 18 restriction)

Grower standard

Greg Krawczyk, 2012

Methods

Each insecticide program applied at ≈5 acre block, grower standard block size varied;

All insecticide applications conducted by a grower, at a grower timing;

Treatments applied either as complete or ARM applications;

Pheromone traps for CM, OFM, OBLR, TABM and STLM placed in each block, for entire season;

BMSB trap data collected from late July;

Visual fruit evaluation data collected at weekly/biweekly intervals
(3 x 10 trees x 100 fruit per evaluation/block)

Additional data collected on mites and mite predators, spirea/ green aphid colonies, wooly apple aphid, scale insects
(mites @ 3 x 10 trees x 50 leaves; other visual 3 x 10 trees x 5 min/tree)

Seasonal fruit evaluations in various insecticide programs: GROWER C

Date	Bayer		DuPont		Syngenta		United P.		Standard	
	LR's	SB	LR's	SB	LR's	SB	LR's	SB	LR's	SB
June 08	0.37ab	0.07ab	N/A	N/A	0.23b	0.13ab	0.53ab	0.03b	0.63a	0.23a
June 14	0.57b	0.10a	0.97ab	0.20a	0.53b	0.07a	0.80ab	0.10a	1.20a	0.30a
June 21	0.00a	0.83ab	0.07a	1.20ab	0.03a	0.77b	0.00a	0.93ab	0.03a	1.30a
June 29	0.07ab	0.13ab	0.10ab	0.10b	0.03b	0.10b	0.00b	0.07b	0.17a	0.33a
July 12	0.03a	0.10a	0.00a	0.03a	0.03a	0.10a	0.03a	0.00a	0.10a	0.10a
July 19	0.00a	0.40b	0.00a	0.03b	0.03a	0.27b	0.00a	0.33b	0.03a	0.98a
Aug 13	0.00a	0.17b	0.00a	0.63a	0.00a	0.30ab	0.00a	0.27ab	0.03a	0.33ab

Means within the same row for the same pest followed by the same letter(s) are not significantly different (ANOVA, LSD test, $P \leq 0.05$)

Seasonal fruit evaluations in various insecticide programs: GROWER C

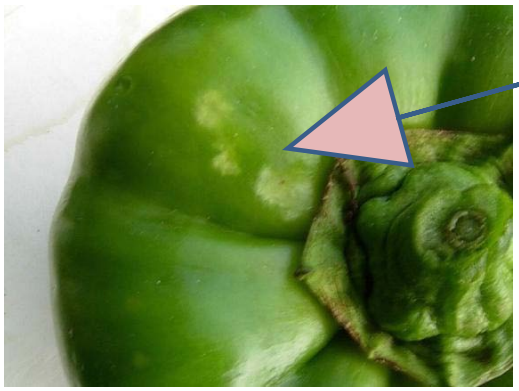
Date	Bayer		DuPont		Syngenta		United P.		Standard	
	CM	OFM	CM	OFM	CM	OFM	CM	OFM	CM	OFM
June 08	0.00a	0.00a	N/A	N/A	0.00a	0.00a	0.03a	0.03a	0.00a	0.00a
June 14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
July 12	0.00	0.00a	0.00	0.03a	0.00	0.00a	0.00	0.00a	0.00	0.00a
July 19	0.00a	0.00	0.03a	0.00	0.00a	0.00	0.00a	0.00	0.00a	0.00
Aug 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Means within the same row for the same pest followed by the same letter(s) are not significantly different (ANOVA, LSD test, $P \leq 0.05$)

Insecticide field efficacy trials on peppers in VA, 2011 & 2012

Tom Kuhar, VT

- Bell peppers ('Aristotle') on plastic mulch at Virginia Tech Kentland Research Farm (Blacksburg, VA)
- Tested over 50 different insecticide treatments
- RCBD small-plot experiments (4 reps)
- Plot = one row (20 ft)
- CO_2 backpack sprayer w/ 3-nozzle drop down boom



Performance of insecticides – all tests

Product	Rate oz/Acre	% mortality in bean dip bioassays*		% control in pepper field tests**		Avg. % control from all four experiments
		Nymphs	Adults	2011	2012	
Scorpion 3.24	7.7	76.7	90.0	85.4	67.0	79.8
Permethrin 3.2EC	8	97.5	98.8	60.6	58.4	78.8
Baythroid XL	2.8	92.5	88.2	52.8	67.8	75.3
Endigo ZC	4.5	75.0	98.7	49.2	78.3	75.3
Bifenture 10DF	12.8	100.0	81.9	56.3	60.3	74.6
Belay	4	75.0	67.5	66.7	78.3	71.9
Lannate LV	40	66.7	75.3	79.8	62.2	71.0
Leverage 360	2.8	97.3	74.5	49.9	60.2	70.5
Hero EC	10.3	91.7	50.0	72.8	66.6	70.3
Brigadier	9.85	76.7	70.0	69.9	62.8	69.9
Venom 70	4	100.0	80.0	46.0	52.8	69.7
MustangMAX	4	100.0	35.0	72.8	69.2	69.2
Acephate 97UP	16	100.0	51.8	70.4	52.8	68.7
Trebon	8	100.0	100.0	36.5	34.9	67.9
Vydate L	48	85.0	47.0	79.7	47.1	64.7
Assail 30 G	4	90.0	32.8	70.4	NA	64.4
Warrior II	2.5	100.0	72.8	38.0	42.5	63.3
Danitol	16	93.3	42.5	60.3	55.6	62.9
Actara 50 WG	5.5	66.7	81.0	60.3	42.5	62.6
Lambda-cy	3.84	86.0	32.3	62.0	NA	60.1
Asana XL	9	35.0	27.5	76.4	NA	46.3
Beleaf 50SG	2.8	28.5	17.5	27.2	71.8	36.3

* Mortality refers to the percentage of dead + moribund individuals after 72 hrs of exposure.
** Based on reduction in stink bug injury to pepper fruit from three harvests.

Slide courtesy of Dr. Tom Kuhar, VT

BMSB management in bell peppers – 2012 field trial

Dr. Joanne Whalen,
University of Delaware

Treatment	Rate/Acre	Number BMSB /10 plants				
		July 23	July 26	July 30	August 2	August 6
Sniper 2 EC	6.4 oz	0.00a	0.25a	0.00a	0.50a	1.00ab
Perm-Up 3.2 EC	8 oz	0.00a	0.00a	0.00a	1.00a	0.75ab
Lannate LV	1.5 pt	0.00a	0.25a	0.75a	1.25a	1.00ab
Vydate	2 pt	0.50a	0.00a	0.00a	1.00a	0.50ab
Belay 2.13SC	4 oz	0.00a	0.25a	0.25a	0.00a	0.25ab
Endigo ZC	4.5 oz	0.00a	0.25a	0.25a	1.75a	1.00ab
Actara 25WDG	5.5 oz	0.50a	0.25a	0.00a	1.50a	2.50ab
Venom 70 SG	4 oz	0.00a	0.00a	0.25a	0.50a	0.50ab
Acephate 97	1 lb	0.00a	0.00a	0.50a	0.25a	0.00b
Warrior II	1.92 oz	0.00a	0.00a	0.50a	0.25a	1.00ab
Leverage 360	3.8 oz	0.00a	0.25a	1.25a	0.50a	2.75a
Baythroid XL	2.8 oz	0.25a	0.00a	0.00a	1.00a	1.00ab
Untreated	---	0.00a	0.00a	0.25a	0.00a	0.25a

Applications with CO_2 backpack sprayer @ 46 gpa at 40 psi.

Application dates: Aug 03 and 16 and Sep 06

Weekly BMSB adults and nymphs samples of 10 plants from Jun 05 to Aug 21.

Harvest data: Jul 24, Aug 07 and 20, Sep 10

Treatment	Rate/Acre	Percent Damaged Fruit			
		July 24	Aug 7	Aug 20	Sept 10
Sniper 2 EC	6.4 oz	0.00a	0.28a	3.32a	2.86a
Perm-Up 3.2 EC	8 oz	0.68a	0.28a	3.09a	2.78a
Lannate LV	1.5 pt	0.00a	0.63a	5.21a	5.73a
Vydate	2 pt	0.00a	0.33a	7.48a	4.09a
Belay 2.13SC	4 oz	0.00a	0.37a	3.59a	3.22a
Endigo ZC	4.5 oz	0.00a	0.28a	5.67a	6.02a
Actara 25WDG	5.5 oz	0.00a	1,72a	4.34a	1.63a
Venom 70 SG	4 oz	0.00a	0.00a	0.50a	4.07a
Acephate 97	1 lb	0.00a	0.69a	4.32a	2.03a
Warrior II	1.92 oz	0.83a	0.70a	2.17a	4.72a
Leverage 360	3.8 oz	0.00a	0.00a	6.61a	1.71a
Baythroid XL	2.8 oz	1.09a	0.40a	6.40a	3.70a
Untreated	---	3.13a	0.00a	9.13a	5.90a

BMSB management in sweet corn – 2012 field trial

Dr. Joanne Whalen, University of Delaware

Treatment	Rate/Acre	No. BMSB Adults & Nymphs per 2 minute count Aug 1[1]	Mean % Clean Ears Aug 6[1]	Mean % Damaged Ears Aug 6 [1]
Baythroid XL	2.8 oz	6.75a	36.67a	63.33a
Leverage 360	2.8 oz	5.50a	42.01a	57.99a
Lannate LV	1 pt	11.00a	19.08a	80.92a
Lannate LV	1.5 pt	8.50a	33.44a	66.56a
Sniper 2EC	4 oz	11.25a	35.10a	64.90a
Warrior II	1.92 oz	17.00a	58.97a	41.03a
Besiege	9 oz	3.00a	48.47a	51.53a
Endigo ZC	4.5 oz	6.75	44.67a	55.33a
Untreated	--	11.00a	36.41a	63.59a

Applications with CO_2 backpack sprayer @ 33 gpa at 40 psi.
Injury evaluation at harvest on Aug 06

"Although BMSB could not be found earlier in the field, damage at this late stage occurred quickly. Treatments applied on a schedule basis will be needed in the future to evaluate the effectiveness of materials on BMSB in sweet corn. Data from research trials in 2012 aimed at identifying when BMSB damages sweet corn indicated that damage can occur from silking through harvest maturity. A tiing study will be needed in 2013 to better evaluate the effectiveness of labeled and non-labeled insecticides. "

BMSB management in bell peppers – 2012 field trial

Table 1. Efficacy of different insecticides for suppression of brown marmorated stink bugs and prevention of fruit damage on bell peppers. Beltsville Research and Education Center. 2012.

Treatment	Rate/acre	Number of stink bug adults and nymphs per plot	Percent of stink bug damaged fruit
Leverage 360	3.8 oz	0.00 b	16.0
Baythroid	2.8 oz	0.33 ab	15.9
Vydate	1.5 pts	0.00 b	15.3
Vydate	3 pts	0.25 ab	14.1
Lannate	1.5 pts	0.50 ab	10.9
Lannate + Asana	1.5 pts + 6 oz	0.50 ab	13.4
Warrior II	1.92 oz	0.00 b	18.8
PFR-97 WG	1 lb	1.50 ab	8.4
Endigo ZC	4.5 oz	0.00 b	13.4
Untreated		2.25 a	18.6

Dr. Galen Dively,
University of Maryland

Manual release of BMSB adults and nymphs on Jul 31

Applications: Aug 07 and 21 @ 27 gpa at 40 psi

Re-release o Aug 23, efficacy counts 5 days later

Table 2. Effects on cohorts of brown marmorated stink bugs caged on treated plants at 2 days after application of different insecticides. Beltsville Research and Education Center. 2012.

Treatments	Rate/acre	Percent of stink bugs showing			Percent affected
		Alive	Moribund	Dead	
Leverage 360	3.8 oz	23.9 abc	30.3 a	45.8 abc	76.1 a
Baythroid	2.8 oz	14.4 ab	24.2 ab	61.4 ab	85.6 a
Vydate	1.5 pts	41.9 ab	1.1 bc	55.6 ab	56.7 ab
Vydate	3 pts	20.8 a	1.3 bc	82.3 a	83.6 a
Lannate	1.5 pts	67.0 bcd	2.1 bc	30.9 bcd	33.0 bc
Lannate + Asana	1.5 pts+6 oz	75.5 bcd	3.9 bc	21.9 bcd	25.8 bc
Warrior II	1.92 oz	29.4 abc	19.1 abc	51.5 abc	70.6 a
PFR-97 WG	1 lb	98.8 d	0.0 c	1.2 d	1.2 c
Endigo ZC	4.5 oz	13.8 a	12.3 abc	73.9 a	86.2 a
Untreated		86.8 cd	5.3 bc	7.9 cd	13.2 c

BMSB management in bell peppers – 2012 field trial

Table 1. Release Time 1. Efficacy of insecticides for suppression of brown marmorated stink bugs and prevention of fruit damage on bell peppers. Beltsville Research and Education Center. 2012.

Treatment	Rate/acre	Number of alive stink bugs per 12 plants		Percent damaged fruit
Belay+NIS	4 oz+.25%	1.00	b	10.6
Belay+NIS	6 oz+.25%	0.75	b	12.3
Danitol+ NIS	10.67 oz+ .25%	0.00	b	15.1
Belay+Brigade+NIS	4 oz+2.6 oz+.25%	0.00	b	11.5
Belay+Danitol+NIS	6 oz+10.67 oz+.25%	0.00	b	11.6
Venom+Danitol+NIS	4 oz+10.67 oz+.25%	0.00	b	20.4
Warrior II + NIS	1.92 oz + .25%	0.75	b	18.0
Untreated		6.25	a	15.4

Dr. Galen Dively,
University of Maryland

Manual release of BMSB nymphs (4th and 5th nymphs n=18 per plot) on Jul 31

Applications: Aug 06 and 21 @ 27 gpa at 40 psi

Re-release on Aug 22, (20% and 80 % nymphs) efficacy counts 5 days later

Table 2. Release Time 2. Efficacy of insecticides for suppression of brown marmorated stink bugs and prevention of fruit damage on bell peppers. Beltsville Research and Education Center. 2012.

Treatment	Rate/acre	Number of alive stink bugs per 12 plants		Percent damaged fruit	
Belay+NIS	4 oz+.25%	2.50	b	5.7	b
Belay+NIS	6 oz+.25%	3.75	b	3.0	b
Danitol+ NIS	10.67 oz+ .25%	0.50	b	9.1	ab
Belay+Brigade+NIS	4 oz+2.6 oz+.25%	1.25	b	5.4	b
Belay+Danitol+NIS	6 oz+10.67 oz+.25%	2.67	b	11.5	ab
Venom+Danitol+NIS	4 oz+10.67 oz+.25%	1.00	b	8.2	b
Warrior II + NIS	1.92 oz + .25%	4.25	b	4.5	b
Untreated		24.5	a	31.5	a

Penn State Extension
Management Options for Brown Marmorated Stink Bug in Pennsylvania Fruit Orchards - 2012 Perspective
Impact of Insecticides on the Invasive Halyomorpha halys (Hemiptera: Pentatomidae): Analysis of Insecticide Lethality
Research summary 2011-2012: Efficacy of insecticides on brown marmorated stink bug on vegetables in Virginia
Factors Influencing the Management of BMSB
BMSB biology

Thank you