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Arthropod Pest Management Research on Vegetables in Virginia – 2011

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Foreword

This booklet summarizes more than 50 experiments of arthropod pest management research conducted on vegetable crops in Virginia in 2011. Experiments were primarily conducted at three Virginia Tech research stations: the Eastern Shore Agricultural Research and Extension Center (ESAREC) near Painter, VA, the Hampton Roads Agricultural Research and Extension Center (HRAREC) in Virginia Beach, VA and the Kentland Research Farm near Blacksburg, VA. All plots were maintained according to standard commercial practices. Soil type at the ESAREC is a Bojac Sandy Loam. Soil type at the HRAREC is a tetotum loam (average pH: 5.7). Soil type at the Kentland Research Farm is a shottower loam. Most of the research involves field evaluations of federally-labeled and experimental insecticides. Some of the information presented herein will be published in the journal Arthropod Management Tests: 2012, vol. 37 (Accessed via Entomological Society of America or Plant Management Network). We hope that this information will be of value to those interested in insect pest management on vegetable crops, and we wish to make the information accessible. All information, however, is for informational purposes only. Because most of the data from the studies are based on a single season's environmental conditions, it is requested that the data not be published, reproduced, or otherwise taken out of context without the permission of the authors. The authors neither endorse any of the products in these reports nor discriminate against others. Additionally, some of the products evaluated are not commercially available and/or not labeled for use on the crop(s) in which they were used.

If you have questions concerning the data or interpretation of the results, please feel free to contact me, Tom Kuhar at 540-231-6129; e-mail: tkuhar@vt.edu

ACKNOWLEDGEMENTS

We sincerely thank the following organizations and individuals for their assistance and support of the entomological research presented in this booklet:

Competitive Grants:
USDA-SRIPM, USDA-NERIPM
EPA Region 3-Strategic Ag Initiative Grant
VDACS –Specialty Crops
SSARE Graduate Research Grant
Virginia Agricultural Council
Virginia Irish Potato Board
USDA-ARS Special Potato Grants

Industry Support:
DuPont: Don Ganske
Syngenta: Erin Hitchner & Chris Munstermann
Valent USA: John Cranmer
Nichino America: James Adams
United Phosphorus Inc.: Tony Estes
BASF: Glenn Oliver& Garr Thomas
Bayer CropScience: Matt Mahoney
Gowan: Paul David
FMC: Joe Reed
Dow AgroSciences: Brian Olson
Chemtura: Jay Angle
Marrone Bioinnovations: Tim Johnson
Agritechnologies: Scott Weathington
East Coast Tomatoes: Paul Seltzer
Kuzzen's Tomatoes: Jim Loukx

Research Collaborators:
D. Ames Herbert (Virginia Tech TAREC)
Ron Morse (Virginia Tech)

All of the faculty and staff of the Virginia Tech Eastern Shore AREC with a special thanks to:

Our Summer Entomology Field Research Assistants:
ESAREC/HRAREC: Mary Morse, Jill Rajevich, Hope Birch, and Jordan Miles
Blacksburg/Kentland Farm: Ben Aigner, Logan Lilliston, Lynda Manden, Charlie Aller, Matt Lowery

And the Eastern Shore AREC Farm Manager:
James T. Custis

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CONTROL OF FOLIAR INSECTS IN BROCCOLI

Location: ESAREC, Painter, VA
Variety: Premium Crop
Transplant Date: 22 Aug 2011
Experimental Design: 5 treatments arranged in a RCB design with 4 reps – 3 rows x 50 ft. (3-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates: 9, 16, 23 and 30 Sep

Treatment[A]	Rate / acre	Mean no. lepidopteran larvae* / 5 plants				
		16-Sep	30-Sep	7-Oct	14-Oct	21-Oct
1. Untreated Control		19.3 a	2.5 a	4.0 a	1.5 a	1.0
2. HGW86 10SE + MSO	13.5 fl. oz	0.0 b	0.0 b	0.0 b	0.0 b	0.0
3. HGW86 10SE + MSO	16.9 fl. oz	0.0 b	0.5 b	0.3 b	0.0 b	0.0
4. HGW86 10SE + MSO	20.5 fl. oz	0.3 b	0.0 b	0.0 b	0.0 b	0.0
5. Movento + MSO	5 fl. oz	1.8 b	1.3 ab	0.5 b	1.3 a	0.5
P-Value from anova		0.0001	0.0253	0.002	0.008	ns

*16 Sep: 80% cabbage webworm, 20% beet armyworm; 30 Sep – 21 Oct: 40% cross-striped cabbageworm; 30% imported cabbageworm; 30% cabbage webworm.
[A]All treatments included MSO at 0.25% v/v.

Treatment[A]	Rate / acre	Mean no. green peach aphids / 5 plants					
		16-Sep	22-Sep	30-Sep	7-Oct	14-Oct	21-Oct
1. Untreated Control		4.8 a	647.3 a	138.8	435.0 a	1999.3 a	910.8 a
2. HGW86 10SE + MSO	13.5 fl. oz	0.0 b	0.0 b	2.0	2.5 b	6.0 b	0.8 b
3. HGW86 10SE + MSO	16.9 fl. oz	0.0 b	0.0 b	0.0	1.3 b	3.5 b	0.0 b
4. HGW86 10SE + MSO	20.5 fl. oz	0.0 b	0.0 b	0.3	1.0 b	1.3 b	0.0 b
5. Movento + MSO	5 fl. oz	0.0 b	0.0 b	0.0	0.3 b	4.3 b	0.8 b

P-Value from anova	0.0314	0.0031	ns	0.0157	0.0052	0.0001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).
[A]All treatments included MSO at 0.25% v/v.

Treatment[A]	Rate / acre	Mean no. whiteflies / 5 plants		Yield (in lbs)	Mean no. broccoli heads	Mean no. grade A heads
		16-Sep	22-Sep			
1. Untreated Control		2.0	3.0 bc	15.7 b	45.8	35.3
2. HGW86 10SE + MSO	13.5 fl. oz	2.3	6.0 a	20.3 ab	49.5	42.5
3. HGW86 10SE + MSO	16.9 fl. oz	2.0	2.3 c	20.2 ab	45.0	40.8
4. HGW86 10SE + MSO	20.5 fl. oz	3.3	3.8 abc	23.3 a	51.3	46.8
5. Movento + MSO	5 fl. oz	4.3	5.5 ab	16.0 b	44.0	35.5
P-Value from anova		ns	0.0336	0.0329	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).
[A]All treatments included MSO at 0.25% v/v.

CONTROL OF GREEEN PEACH APHIDS IN BROCCOLI

Location: HRAREC, Virginia Beach, VA
Variety: Arcadia
Transplant Date: 8 Sep 2011
Experimental Design: 9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. with unplanted guard rows (3-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates: 13 Oct

Treatment[A]	Rate / acre	Gallons per Acre	Mean no. green peach aphids / 5 plants		Mean no. lepidopteran larvae / 5 plants (20 Oct)
			20-Oct (7 DAT)	26-Oct (13 DAT)	
1. Untreated Control			106.0 a	64.8 a	1.0
2. Tolfenpyrad EC + NIS	17 fl. oz	23	31.3 b	2.3 b	0.0
3. Tolfenpyrad EC + NIS	17 fl. oz	34	1.5 b	1.3 b	0.3
4. Tolfenpyrad EC + NIS	17 fl. oz	51	4.5 b	2.0 b	0.0
5. Tolfenpyrad EC + NIS	21 fl. oz	23	10.0 b	0.0 b	0.0
6. Tolfenpyrad EC + NIS	21 fl. oz	34	4.0 b	3.0 b	0.3
7. Tolfenpyrad EC + NIS	21 fl. oz	51	1.8 b	0.0 b	0.8
8. Pyrifluquinazon + NIS	3.2 fl. oz	34	4.0 b	1.0 b	0.0
9. Assail 30SG + NIS	4 oz	34	0.0 b	0.5 b	0.0
P-Value from anova			0.0004	0.0020	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).
[A]All treatments included NIS at 0.5% v/v.

CONTROL OF STRIPED CUCUMBER BEETLES IN CANTALOUPES

Location: Kentland Research Farm, Blacksburg, VA
Variety: Athena
Transplant Date: 9 Jun 2011
Experimental Design: 6 treatments (see below) arranged in a RCB design with 4 replicates - 1 row x 20 ft. (6 ft. row centers); no guard rows
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates: 7 and 19 Jul

Treatment	Rate / acre	Mean no. dead cucumber beetles 7-Jul	Mean no. dead cucumber beetles 25-Jul	Mean no. dead squash bugs	Mean no. live cucumber beetles 7-Jul	Mean no. live cucumber beetles 25-Jul	Yield (mean no. fruit / plot)
1. Untreated control		0.3 b	0.0	0.0 c	8.8 a	2.0 a	11.0 c
2. Belay 2.13SC	4 fl. oz	32.0 a	12.5	1.8 a	0.0 b	0.0 b	12.3 bc
3. Venom 70SG	4 oz	28.5 a	9.0	0.3 bc	0.0 b	0.8 ab	15.3 ab
4. Venom 70SG + Exponent	4 oz + 5 fl. oz	45.8 a	4.5	1.3 ab	0.5 b	0.3 b	18.0 a
5. Trebon (etofenprox 280 g/l)	8 fl. oz	4.8 b	0.8	0.3 bc	0.3 b	1.0 ab	13.0 bc
6. Trebon + Exponent	8 fl. oz + 5 fl. oz	2.3 b	1.5	0.3 bc	0.3 b	0.5 b	14.0 bc
P-Value from Anova		0.0001	ns	0.0462	0.002	0.0499	0.0212

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF LEPIDOPTERAN LARVAE IN COLLARDS

Location: HRAREC, Virginia Beach, VA
Variety: Vates
Plant Date: 15 Apr 2011
Experimental Design: 9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. with unplanted guard rows (3-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates: 18 May and 1 Jun.

Treatment [A]	Rate / acre	Mean no. diamondback moth larvae 25 May (7 DAT) per 5 plants	Mean no. diamondback moth larvae 8 Jun (7 DAT2) per 5 plants	Mean no. diamondback moth larvae 11 Jun (10 DAT2) per 15 leaves	Mean total no. of lepidopteran larvae 25 May (7 DAT) per 5 plants	Mean total no. of lepidopteran larvae 8 Jun (7 DAT2) per 5 plants	Mean total no. of lepidopteran larvae 11 Jun (10 DAT2) per 15 leaves	% marketable leaves
1. Untreated Control		6.0 a	1.5	10.5	13.0 a	1.5	10.8	15.0 b
2. Dipel ES + Li-700	1 lb	0.3 b	1.3	6.0	0.8 b	1.5	6.3	35.0 b
3. Dipel ES + Permethrin + Li-700	1lb + 4 fl. oz	1.3 b	0.5	4.8	1.5 b	0.5	4.8	67.5 a
4. Dipel ES + Permethrin + Li-700	1 lb + 2 fl. oz	0.3 b	0.0	3.3	0.3 b	0.0	3.3	70.0 a

5. Permethrin + Li-700	4 fl. oz	1.3 b	1.0	2.3	1.3 b	1.0	2.3	72.5 a
6. Permethrin + Li-700	2 fl. oz	0.5 b	1.3	3.3	0.8 b	1.3	4.3	70.0 a
7. Vetica + Li-700	17 fl. oz	0.0 b	0.0	2.5	0.0 b	0.0	2.5	80.0 a
8. Radiant + Li-700	8 fl. oz	0.5 b	0.3	3.8	0.5 b	0.3	4.3	72.5 a
9. Synapse 24WG + Li-700	2 oz	0.3 b	0.5	0.5	0.3 b	0.5	0.5	80.0 a
P-Value from anova		0.027	ns	ns	0.0111	ns	ns	0.0002

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).
[A]All treatments included Li-700 at 0.25% v/v.

CONTROL OF FLEA BEETLES IN COLLARDS AND MUSTARD

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Collards: 'Champion' and Mustard: 'Southern Giant Curled'
Plant Date:	10 May 2011
Experimental Design:	5 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. with unplanted guard rows (3-ft row centers)
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates:	4 Jun

		Mean no. flea beetles* / 5 plants			
		Collards		Mustard	
Treatment[A]	**Rate / acre**	**7-Jun (3 DAT)**	**10-Jun (6 DAT)**	**7-Jun (3 DAT)**	**10-Jun (6 DAT)**
1. Untreated Control		7.3 a	1.0 b	10.8 a	3.0 ab
2. Belay + MSO	3 fl. oz + 0.25% v/v	1.3 b	0.5 b	3.8 bc	5.0 a
3. Belay + MSO	6 fl. oz + 0.25% v/v	0.3 b	0.0 b	0.8 c	0.8 bc
4. Voliam Flexi + MSO	6 fl. oz + 0.25% v/v	1.3 b	0.3 b	1.3 c	1.8 bc
5. Coragen + MSO	5 fl. oz + 0.25% v/v	3.3 b	3.0 a	7.3 ab	1.3 bc
P-Value from anova		0.0166	ns	0.0008	0.0178

* *Phyllotreta striolata* and *Phyllotreta cruciferae*
All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).
[A]All treatments included MSO at 0.25% v/v.

CONTROL OF GREEN PEACH APHIDS IN COLLARDS

Location:	ESAREC, Painter, VA
Variety:	'Vates'
Plant Date:	12 Sep 2011
Experimental Design:	8 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. with unplanted guard rows (3-ft row centers)
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.

Treatment Dates: 20 Oct.

Treatment[A]	Rate / acre	Mean no. green peach aphids / 30 leaves (4 DAT)
1.Untreated Control		41.8 ab
2. Coragen + MSO	5 fl. oz	64.0 a
3. Voliam Flexi + NIS	6 oz	0.8 d
4. Belay + MSO	3 fl.oz	2.3 d
5. Belay + MSO	6 fl. oz	1.3 d
6. M-Pede	2% v/v	35.8 bc
7. M-Pede + Scorpion 35SL	2% v/v + 7 fl. oz	13.8 cd
8. Venom	4 oz	16.0 cd
P-Value from Anova		0.0001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).
[A]All treatments included MSO at 0.25% v/v, except trt. 3, which included NIS at 0.25%.

CONTROL OF TWO-SPOTTED SPIDER MITES IN EGGPLANTS

Location: ESAREC, Painter, VA **(Greenhouse Experiment)**
Variety: Black Beauty
Transplant Date: 29 Apr 2011
Experimental Design: 5 treatments replicated 4 times. Eggplants were 11-week old transplants in 4 inch pots placed in one separate tray for each treatment. Pots were placed in containers filled with water to prevent overhead irrigation.
Treatment Method: All foliar treatments were applied with a household hand sprayer containing 500 ml of water and insecticide amount based on a 30 GPA rate. Each individual plant was sprayed to the point of run-off (approximately 3 pumps).
Treatment Dates: 29 Apr 2011

		Mean no. two-spotted spider mites				% stippling damage (18 DAT)
		2 May (3 DAT)		5 May (5 DAT)		
Treatment*	Rate / acre	Eggs	Adults	Eggs	Adults	
1. Untreated control		1.0	3.8 a	1.4	3.2 a	84.0 a
2. GWN-1708	20 fl. oz	7.4	0.0 b	0.0	0.0 b	16.0 b
3. GWN-1708	25 fl. oz	5.0	1.6 ab	0.0	0.0 b	29.5 b
4. GWN-1708	30 fl. oz	0.8	0.4 b	0.0	0.0 b	13.0 b
5. Oberon 2SC	8.5 fl. oz	8.8	0.0 b	0.0	0.0 b	22.5 b
P-Value from Anova		ns	0.0539	ns	0.0001	0.0003

*** All treatments also received 0.25% v/v wet-cit**

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF TWO-SPOTTED SPIDER MITES IN EGGPLANTS

Location:	HRAREC, Virginia Beach, VA
Variety:	Black Beauty
Transplant Date:	11 May 2011
Experimental Design:	5 treatments. No replication. This trial planted on 11 May designed for another experiment experienced some spider mite pressure. Visibly affected plots were used to conduct screening of the efficacy of GWN-1708 - 1 row x 20 ft (6-ft row centers), no guard rows – 12 inch plant spacing
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates:	30 Jun

		Number of two-spotted spider mites per 3cm² (7 Jul – 7 DAT)			Number of two-spotted spider mites per 3cm² (15 Jul – 15 DAT)	
Treatment*	**Rate / acre**	**Eggs**	**Nymphs**	**Adults**	**Eggs**	**Adults**
1. Untreated control		56	141	29	6	72
2. GWN-1708	20 fl. oz	19	63	12	0	0
3. GWN-1708	25 fl. oz	19	0	0	0	2
4. GWN-1708	30 fl. oz	10	2	2	0	0
5. Oberon 2SC	8.5 fl. oz	0	0	0	0	0

*** All treatments also received 0.25% v/v wet-cit**

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR INSECTS IN BELL PEPPERS

Location:	HRAREC, Virginia Beach, VA
Variety:	Paladin
Transplant Date:	12 May 2011
Experimental Design:	8 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows, – 12 inch plant spacing
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 38 GPA.
Treatment Dates:	1, 8 and 15 Aug.

Treatment	Rate / acre	% lepidopteran damage			% stink bug damage	
		8-Aug	15-Aug	25-Aug	8-Aug	25-Aug
1. Untreated Control		5.0	10.8 a	2.5 b	5.0	2.5
2. Vydate L	16 fl. oz	6.0	5.0 b	6.3 ab	4.0	1.3
3. Vydate L	24 fl. oz	2.0	0.0 c	2.5 b	8.0	1.3
4. Vydate L	48 fl. oz	5.0	6.0 ab	13.8 a	6.0	1.3
5. Lannate LV	16 fl. oz	0.0	0.0 c	0.0 b	4.0	7.5

6. Lannate LV	24 fl. oz	1.0	4.7 b	0.0 b	6.0	0.0
7. Lannate LV	36 fl. oz	0.0	0.0 c	2.5 b	5.0	0.0
8. Asana XL	9 fl. oz	3.0	0.0 c	0.0 b	6.0	0.0
P-Value from anova		ns	0.0001	0.0519	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF APHIDS IN BELL PEPPERS – SPRAY VOLUME

Location: Kentland Research Farm, Blacksburg, VA
Variety: Aristotle
Transplant Date: 7 Jun 2011
Experimental Design: 9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows, – 12 inch plant spacing
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering various spray volumes (GPA) (see table).
Treatment Dates: 9 Sep

Treatment	Rate / acre	Gallons Per Acre	Mean no. green peach aphids / 20 leaves	
			12-Sep	16-Sep
1. Untreated Control			1621.8 a	1087.5 a
2. Tolfenpyrad EC + NIS	17 fl. oz	23	139.0 abc	224.8 ab
3. Tolfenpyrad EC + NIS	17 fl. oz	34	45.8 c	137.3 ab
4. Tolfenpyrad EC + NIS	17 fl. oz	51	696.3 ab	356.5 ab
5. Tolfenpyrad EC + NIS	21 fl. oz	23	37.3 c	70.5 abc
6. Tolfenpyrad EC + NIS	21 fl. oz	34	87.8 abc	78.5 ab
7. Tolfenpyrad EC + NIS	21 fl. oz	51	43.5 abc	168.8 ab
8. Pyrifluquinazon + NIS	3.2 fl. oz	34	67.5 bc	63.3 bc
9. Assail 30SG + NIS	4 oz	34	7.5 c	9.3 c
P-Value from ANOVA			0.0500	0.0381

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).
[A]All treatments included NIS at 0.5% v/v.

CONTROL OF BROWN MARMORATED STINK BUGS IN BELL PEPPERS 1

Location: Kentland Research Farm, Blacksburg, VA
Variety: Aristotle
Transplant Date: 7 Jun 2011
Experimental 12 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row

Design:	centers), no guard rows, – 12 inch plant spacing
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates:	1, 6, 15 and 24 Aug

Treatment	Rate / acre	% lepidopteran damage			% stink bug damage			% sticky peppers	Mean no. green peach aphids / 20 leaves
		9-Aug	19-Aug	1-Sep	9-Aug	19-Aug	1-Sep		
1. Untreated Control		12.5	3.8	7.5	31.3 a	26.3	21.3	0.0	6.0
2. Belay 2.13SC	4 fl. oz	6.3	1.3	8.8	10.0 bc	3.8	12.5	0.0	0.5
3. Belay 2.13SC + Danitol 2.4SC	3 fl. oz + 10.67 fl. oz	5.0	1.3	15.0	16.3 bc	1.3	5.0	0.0	6.3
4. Danitol 2.4SC	10.67 fl. oz	7.5	3.8	5.0	10.0 bc	10.0	11.3	11.3	120.0
5. Danitol 2.4SC	16 fl. oz	10.0	6.3	2.5	16.3 bc	21.3	13.8	15.0	58.5
6. Venom 70SG	4 oz	1.3	2.5	7.5	17.5 abc	13.8	11.3	0.0	2.5
7. Venom 70SG + Exponent (PBO)	4 oz + 5 fl. oz	7.5	3.8	11.3	12.5 bc	13.8	16.3	0.0	0.0
8. Trebon 280 g/l	8 fl. oz	8.8	3.8	12.5	21.3 ab	11.3	17.5	7.5	100.0
9. Trebon 280 g/l + Exponent (PBO)	8 fl. oz + 5 fl. oz	2.5	2.5	2.5	7.5 c	16.3	18.8	3.8	925.8
10. Endigo ZC	5.5 fl. oz	3.8	2.5	3.8	17.5 abc	8.8	13.8	1.3	1.3
11. Warrior II	1.92 fl. oz	3.8	5.0	12.5	31.3 a	11.3	6.3	13.8	498.5
12. Actara 25WG	5.5 oz	5.0	3.8	8.8	12.5 bc	7.5	11.3	0.0	2.5
P-Value from anova		ns	ns	ns	0.0112	ns	ns	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF BROWN MARMORATED STINK BUGS IN BELL PEPPERS 2

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Aristotle
Transplant Date:	7 Jun 2011
Experimental Design:	13 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows, – 12 inch plant spacing
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates:	1, 6, 15 and 24 Aug

Treatment	Rate / acre	% lepidopteran damage			% stink bug damage			% sticky peppers from aphid honey dew (1-Sep)	Mean no. green peach aphids / 20 leaves (9-Sep)
		9-Aug	19-Aug	1-Sep	9-Aug	19-Aug	1-Sep		
1. Untreated Control		3.8	8.8 ab	11.3	40.0	15.0 a	32.5	0.0 c	2.8 c
2. Hero	6.4 fl. oz	5.0	1.3 c	2.5	17.5	2.5 bcd	10.0	41.3 a	1014.0 ab
3. Hero	7.1 fl. oz	3.8	2.5 bc	3.8	21.3	5.0 bcd	11.3	28.8 ab	398.5 bc
4. Hero	8 fl. oz	6.3	0.0 c	11.3	17.5	7.5 a-d	15.0	17.5 abc	1195.0 a
5. Hero	10.3 fl. oz	2.5	3.8 abc	11.3	10.0	3.8 cd	10.0	0.0 c	53.3 c
6. Brigadier 2SC	8 fl. oz	5.0	5.0 abc	7.5	15.0	7.5 abc	3.8	0.0 c	0.3 c
7. Athena	16 fl. oz	3.8	0.0 c	7.5	12.5	5.0 bcd	17.5	3.8 bc	63.3 c
8. Mustang Max	4 fl. oz	1.3	1.3 c	2.5	7.5	8.8 ab	7.5	18.8 abc	155.0 c
9. Mustang Max + Lannate LV	4 fl. oz + 16 fl. oz	2.5	1.3 c	2.5	21.3	1.3 d	7.5	1.3 c	13.0 c
10. Beleaf	2.8 oz	6.3	8.8 a	12.5	23.8	7.5 a-d	16.3	0.0 c	1.0 c
11. F9318	18 fl. oz	7.5	8.8 ab	11.3	16.3	6.3 abc	8.8	0.0 c	40.0 c
12. Baythroid XL	2.8 fl. oz	3.8	6.3 abc	11.3	25.0	6.3 a-d	10.0	5.0 bc	201.8 c
13. Leverage 360	2.8 fl. oz	3.8	5.0 abc	3.8	20.0	8.8 ab	15.0	0.0 c	0.5 c
P-Value from anova		ns	0.0492	ns	ns	0.0592	ns	0.0208	0.018

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF BROWN MARMORATED STINK BUGS IN BELL PEPPERS 3

Location: Kentland Research Farm, Blacksburg, VA
Variety: Aristotle
Transplant Date: 7 Jun 2011
Experimental Design: 12 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows, – 12 inch plant spacing
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates: 1, 6, 15 and 24 Aug

Treatment	% lepidopteran damage			% stink bug damage			% sticky peppers	Mean no. green peach aphids / 20 leaves
	8-Aug	19-Aug	30-Aug	8-Aug	19-Aug	30-Aug		
Untreated Control	5.0	10.0	12.5ab	32.0	26.7	28.8	0.0	10.3abc
Assail 30G	6.0	1.7	13.8ab	8.0	6.7	11.3	0.0	1.5c
Assail 70WP	1.3	6.3	7.5ab	18.8	12.5	18.8	0.0	0.0c
Bifenture 2EC	5.0	1.25a	23.8a	13.8	5.0	12.5	27.5	765.5a

Bifenture 10DF	5.0	0.0	0.0b	13.0	16.7	10.0	0.0	15.3abc
Acephate 97UP	0.0	1.3	6.3ab	7.5	11.3	7.5	0.0	0.0c
Lambda-Cy 1EC	1.3	5.0	7.5ab	12.5	10.0	11.3	10.0	850.8ab
Perm-up 3.2EC	2.5	1.3	5.0ab	8.8	7.5	18.8	11.25	539.0ab
Assail 30G + plus Perm-up 3.2EC	3.8	11.3	5.0ab	15.0	8.8	22.5	0.0	1.3c
Assail 30G + plus Lambda-Cy 1EC	0.0	8.8	13.8ab	10.0	12.5	8.8	0.0	3.8c
Assail 30G + plus Bifenture 2EC	5.0	6.3	5.0ab	7.5	7.5	12.5	0.0	0.3c
Assail 30G + plus Bifenture 10DF	4.0	3.3	13.8ab	8.0	6.7	13.8	0.0	10.0b
Assail 30G + plus Acephate 97UP	0.0	7.5	5.0ab	21.3	13.8	22.5	0.0	0.0c
P-value from ANOVA	ns	ns	0.03	ns	ns	ns	ns	<.0001

All data were analyzed using analysis of variance procedures. Means were separated using Tukey's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF BROWN MARMORATED STINK BUGS IN BELL PEPPERS 4

Location: Kentland Research Farm, Blacksburg, VA
Variety: Aristotle
Transplant Date: 7 Jun 2011
Experimental Design: 8 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows, – 12 inch plant spacing
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates: 1, 6, 15 and 24 Aug

Treatment	Rate / acre	% lepidopteran damage			% stink bug damage		
		9-Aug	19-Aug	1-Sep	9-Aug	19-Aug	1-Sep
1. Untreated Control		1.3	8.8	11.3 b	28.8 a	17.5	65.0 a
2. Vydate L	16 fl. oz	13.8	12.5	25.0 a	3.8 b	11.3	5.0 b
3. Vydate L	24 fl. oz	8.8	6.3	16.3 ab	13.8 b	5.0	7.5 b
4. Vydate L	48 fl. oz	5.0	10.0	11.3 b	13.8 b	3.8	5.0 b
5. Lannate LV	16 fl. oz	2.5	3.8	5.0 b	12.5 b	8.8	18.8 b
6. Lannate LV	24 fl. oz	6.3	3.8	16.3 ab	12.5 b	6.3	3.8 b
7. Lannate LV	36 fl. oz	2.5	5.0	5.0 b	7.5 b	2.5	12.5 b
8. Asana XL	9 fl. oz	2.5	2.5	8.8 b	7.5 b	7.5	11.3 b
P-Value from anova		ns	ns	0.0488	0.0396	ns	0.0001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF BROWN MARMORATED STINK BUGS IN BELL PEPPERS 5

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Aristotle
Transplant Date:	7 Jun 2011
Experimental Design:	6 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows, – 12 inch plant spacing
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates:	1, 6, 15 and 24 Aug

Treatment	Rate / acre	% lepidopteran damage			% stink bug damage		
		9-Aug	19-Aug	1-Sep	9-Aug	19-Aug	1-Sep
1. Untreated Control		1.3	8.8	11.3	28.8 a	17.5 a	65.0 a
2. Scorpion 35SL + wet-cit	5 fl. oz + 0.25% v/v	6.3	1.3	16.3	13.8 b	6.3 b	8.8 b
3. Scorpion 35SL + wet-cit	7 fl. oz + 0.25% v/v	2.5	2.5	16.3	3.8 b	5.0 b	7.5 b
4. Scorpion 35SL + wet-cit	9 fl. oz + 0.25% v/v	1.3	6.3	13.8	5.0 b	2.5 b	16.3 b
5. Scorpion 35SL (soil application)	10.5 fl. oz	8.8	6.3	6.3	8.8 b	3.8 b	18.8 b
6. Admire Pro (soil application)	10.5 fl. oz	1.3	6.3	6.3	17.5 ab	2.5 b	10.0 b
P-Value from anova		ns	ns	ns	0.0152	0.0552	0.0005

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF FOLIAR INSECTS IN BELL PEPPERS

Location:	ESAREC, Painter, VA
Variety:	Revolution
Transplant Date:	19 Jul 2011
Experimental Design:	5 treatments arranged in a RCB design with 4 reps – 4 rows x 20 ft. (6-ft row centers), no guard rows, on plastic mulch
Treatment Method:	All drip irrigation treatments were applied at flowering with the use of chemilizers. Each insecticide amount was diluted in 100 ml of water, poured into the chemilizer feeding tube and flushed with an additional 300 ml of water.
Treatment Dates:	18 and 29 Aug

Treatment	Rate / acre	% lepidopteran damage				Mean no. whiteflies / 40 leaves		Total Yield (in lbs)
		14-Sep	26-Sep	4-Oct	11-Oct	7-Sep	28-Sep	
1. Untreated Control		16.3 a	31.3 a	10.0 a	19.0 a	3.5	2.5	79.9
2. HGW86 20SC	5.1 fl. oz	10.6 a	11.3 b	6.9 ab	5.5 b	5.0	1.8	86.7

3. HGW86 20SC	6.75 fl. oz	13.8 a	8.8 b	10.0 a	11.0 ab	2.8	0.5	116.6
4. HGW86 20SC	10.20 fl. oz	5.0 b	9.4 b	3.8 b	4.0 bc	3.0	0.5	81.1
5. Durivo	10 fl. oz	10.0 ab	5.0 b	3.8 b	0.0 c	1.0	0.3	92.0
P-Value from anova		0.0420	0.0134	0.0232	0.0031	ns	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF GREEN PEACH APHIDS IN BELL

Location: ESAREC, Painter, VA
Variety: Revolution
Transplant Date: 28 Jul 2011
Experimental Design: 5 treatments arranged in a RCB design with 4 reps – 4 rows x 50 ft. (3-ft row centers), no guard rows, – 12 inch plant spacing
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA
Treatment Dates: 24 Aug, 16, 29 Sep and 6 Oct

PEPPERS

		Mean no. green peach aphids				% lepidopteran damage at harvest		Mean total weight (in lbs)
Treatment	**Rate / acre**	**29-Sep per 20 plants**	**6-Oct per 10 plants**	**13-Oct per 10 plants**	**20-Oct per 10 leaves**	**14-Oct**	**20-Oct**	
1. Untreated Control		8.0	5.8 a	228.0 a	141.0 a	4.4	2.5	49.2
2. HGW86 10SE + MSO	13.5 fl. oz + 0.25% v/v	0.3	0.0 b	29.8 b	20.0 b	1.9	2.5	53.8
3. HGW86 10SE + MSO	16.9 fl. oz + 0.25% v/v	1.0	1.5 b	43.8 b	10.3 b	7.5	4.2	59.3
4. HGW86 10SE + MSO	20.5 fl. oz + 0.25% v/v	0.0	0.8 b	15.0 b	8.5 b	4.4	8.3	60.5
5. Movento + MSO	5 fl. oz + 0.25% v/v	2.3	0.0 b	0.0 b	0.3 b	6.9	5.0	39.7
P-Value from Anova		ns	0.0038	0.0053	0.0001	ns	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR INSECTS IN POTATOES

Location: ESAREC, Painter, VA
Variety: Superior
Plant Date: 30 Mar 2011
Experimental 11 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-

Design:	ft row centers), no guard rows
Treatment Method:	All foliar treatments were applied in 1600 ml of water at 38 GPA using a 4-nozzle boom equipped with 110003VS spray tips spaced 20" apart spraying 2 rows and powered by a CO_2 backpack sprayer at 40psi.
Treatment Dates:	18, 25 May, 3 Jun
Harvest:	13 Jul

		Mean no. Colorado potato beetles / 10 stems									% defoliation	
		23 May (5 DAT)		25 May (7 DAT)		30 May (5 DAT2)		1 Jun (7 DAT2)		14 Jun (11 DAT3)		
Treatment	Rate / acre	small larvae	large larvae	small larvae	large larvae	small larvae	large larvae	small larvae	large larvae	Adults	9-Jun	23-Jun
1. Untreated Control		59.2 a	89.2 a	88.0 a	167.2 a	29.2 a	89.2 a	2.0	39.0 a	7.2 bc	93.8 a	100.0 a
2. Endigo 2.06ZC	4 fl. oz	2.0 b	1.2 b	0.0 b	1.2 b	0.0 b	0.0 b	1.0	0.0 b	15.2 bc	2.5 c	35.0 cd
3. Endigo ZCX 2.71ZC	4 fl. oz	0.0 b	0.0 b	1.2 b	0.0 b	0.0 b	0.0 b	0.0	0.0 b	8.0 bc	2.5 c	15.0 d
4. Warrior II	1.92 fl. oz	1.2 b	0.0 b	6.0 b	5.2 b	10.0 b	8.0 b	2.0	1.0 b	30.0 ab	10.0 b	75.0 b
5. Actara 25WG	3 oz	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0	0.0 b	8.0 bc	3.8 bc	35.0 cd
6. Leverage 360	2.8 fl. oz	0.0 b	7.2 b	3.2 b	6.0 b	0.0 b	0.0 b	2.0	0.0 b	12.0 bc	2.5 c	35.0 cd
7. Blackhawk	3.3 fl. oz	0.0 b	0.0 b	8.0 b	3.2 b	5.2 b	1.2 b	0.0	3.0 b	44.0 a	3.8 bc	74.0 b
8. HGW86 10OD	3.37 fl. oz	0.0 b	0.0 b	11.2 b	1.2 b	0.0 b	0.0 b	0.0	0.0 b	4.0 c	0.0 c	25.0 d
9. HGW86 10OD	6.75 fl. oz	0.0 b	0.0 b	0.0 b	2.0 b	0.0 b	0.0 b	0.0	0.0 b	5.2 c	2.5 c	26.0 d
10. HGW86 10OD	10.1 fl. oz	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0	0.0 b	3.2 c	3.8 bc	17.5.0 d
11. Provado	3.8 fl. oz	0.0 b	0.0 b	3.2 b	4.8 b	0.0 b	4.0 b	0.0	0.0 b	15.2 bc	2.5 c	52.5 c
P-Value from anova		0.0001	0.0181	0.0001	0.0001	0.0062	0.0001	ns	0.0001	0.0470	0.0001	0.0001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different ($P>0.05$).

		Mean no. potato leafhoppers			Total Yield
Treatment	Rate / acre	1-Jun	10-Jun	14-Jun	(in lbs)
1. Untreated Control		1.3 b	1.3	0.3	14.8 d
2. Endigo 2.06ZC	4 fl. oz	0.0 b	0.0	0.0	46.2 bc
3. Endigo ZCX 2.71ZC	4 fl. oz	0.3 b	0.5	0.0	57.8 a
4. Warrior II	1.92 fl. oz	0.8 b	0.0	0.0	38.5 c
5. Actara 25WG	3 oz	0.0 b	0.0	0.3	41.9 bc
6. Leverage 360	2.8 fl. oz	0.0 b	0.0	0.3	50.1 ab
7. Blackhawk	3.3 fl. oz	0.8 b	0.0	0.0	37.6 c
8. HGW86 10OD	3.37 fl. oz	4.8 a	3.3	0.5	44.0 bc
9. HGW86 10OD	6.75 fl. oz	0.3 b	0.8	0.0	46.1 bc
10. HGW86 10OD	10.1 fl. oz	0.0 b	1.3	0.5	46.4 abc
11. Provado	3.8 fl. oz	0.0 b	0.0	0.0	36.7 c
P-Value from anova		0.0022	ns	ns	0.0001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different ($P>0.05$).

CONTROL OF FOLIAR INSECTS IN POTATOES

Location:	ESAREC, Painter, VA
Variety:	Superior
Plant Date:	12 Apr 2011

Experimental Design:	6 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All in-furrow treatments were applied in 900 ml of water at 19.8 GPA using a single nozzle boom equipped with an 8003 even flat spray tip powered by a CO2 backpack sprayer at 30psi. Furrows were cut using a commercial potato planter without the coulters on. Immediately after the treatments were applied over top of seed-pieces, the seed was covered
Treatment Dates:	12 Apr
Harvest:	14 Jul
Laboratory Assays:	On 16 May (34 DAP), 5 adults were placed in a large Petri dish with an excised leaf from the plots. Mortality was assessed at 24, 48 and 72 h. % feeding was also assessed at 72 h. On 2 Jun (51 DAP), the experiment was replicated using 10 small larvae. Mortality was assessed at 24 h

			Mean no. Colorado potato beetles / 10 stems										
			12-May	16-May		23-May			1-Jun		14-Jun	% defoliation	
Treatment	**Rate / acre**	**Stand count**	**adults**	**Sm larvae**	**lg larvae**	**smlarvae**	**lg larvae**	**adults**	**Sm larvae**	**lg larvae**	**adults**	**9-Jun**	**23-Jun**
1. Untreated Control		25	4.0	6.5	28.0 a	28.0 a	6.0	1.0	9.0	10.0 a	25.0	23.8 a	68.8 a
2. A16901 (in-furrow)	6.5 oz	22.5	0.0	0.0	0.0 b	0.0 b	0.0	0.0	0.0	0.0 b	5.0	0.0 b	5.0 b
3. A16901 (in-furrow)	10 oz	23	2.0	0.0	0.0 b	0.0 b	0.0	1.0	1.0	0.0 b	1.0	0.0 b	0.0 b
4. Platinum 75SG (in-furrow)	1.68 oz	25	5.0	0.0	0.0 b	1.0 b	1.0	2.0	0.0	0.0 b	2.0	0.0 b	5.0 b
5. Platinum 75SG (in-furrow)	2.66 oz	22	5.0	0.0	0.0 b	0.0 b	2.0	0.0	0.0	0.0 b	0.0	0.0 b	1.3 b
6. Admire Pro (in-furrow)	8.7 fl. oz	24.3	2.0	0.0	0.0 b	0.0 b	0.0	0.0	0.0	0.0 b	2.0	0.0 b	2.5 b
P-Value from anova		ns	ns	ns	0.001	0.004	ns	ns	ns	0.001	ns	0.0002	0.001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

		Mean no. potato leafhopper nymphs / 10 compound leaves		Harvest data	
Treatment	**Rate / acre**	**1-Jun**	**14-Jun**	**Mean total yield (in lbs)**	**% wireworm damage**
1. Untreated Control		2	1.0	13.8 c	3.5
2. A16901 (in-furrow)	6.5 oz	0	0.3	54.3 a	2.5
3. A16901 (in-furrow)	10 oz	0	0.0	47.9 a	2.5
4. Platinum 75SG (in-furrow)	1.68 oz	0	0.3	29.3 bc	4.5

5. Platinum 75SG (in-furrow)	2.66 oz	0	0.0	40.9 ab	1.0
6. Admire Pro (in-furrow)	8.7 fl. oz	0	1.3	48.9 a	3.0
P-Value from anova		ns	ns	0.0027	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

- **Summary of excised leaf assay 1 – CPB adults (16 May), ESAREC, Painter, VA, 2011**

		% dead and down adult Colorado potato beetles			% feeding at 72 h
Treatment	Rate / acre	24 h	48 h	72 h	
1. Untreated Control		0.0 c	10.0 b	10.0 b	43.8 a
2. A16901 (in-furrow)	6.5 oz	45.0 ab	55.0 ab	65.0 a	2.5 b
3. A16901 (in-furrow)	10 oz	60.0 ab	70.0 a	80.0 a	3.3 b
4. Platinum 75SG (in-furrow)	1.68 oz	25.0 bc	60.0 a	65.0 a	3.3 b
5. Platinum 75SG (in-furrow)	2.66 oz	60.0 ab	65.0 a	70.0 a	15.0 b
6. Admire Pro (in-furrow)	8.7 fl. oz	75.0 a	95.0 a	95.0 a	6.5 b
P-Value from anova		0.0318	0.0255	0.004	0.0031

- **Summary of excised leaf assay 2 – CPB small larvae (2 Jun), ESAREC, Painter, VA, 2011**

Treatment	Rate / acre	% dead and down Colorado potato beetles small larvae (24 h)
1. Untreated Control		32.5 b
2. A16901 (in-furrow)	6.5 oz	80.0 a
3. A16901 (in-furrow)	10 oz	97.5 a
4. Platinum 75SG (in-furrow)	1.68 oz	100.0 a
5. Platinum 75SG (in-furrow)	2.66 oz	100.0 a
6. Admire Pro (in-furrow)	8.7 fl. oz	90.0 a
P-Value from anova		0.0187

CONTROL OF FOLIAR INSECTS IN POTATOES WITH TOLFENPYRAD

Location:	ESAREC, Painter, VA
Variety:	Superior
Plant Date:	13 Apr 2011
Experimental Design:	4 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All foliar treatments were applied in 1600 ml of water at 38 GPA using a 4-nozzle boom equipped with 110003VS spray tips spaced 20” apart spraying 2 rows and powered by a CO_2 backpack sprayer at 40psi.
Treatment Dates:	20 and 27 May
Harvest:	13 Jul

		Mean no. Colorado potato beetles / 10 stems					
		26-May		2-Jun		10-Jun	
Treatment	**Rate / acre**	**Small larvae**	**Large larvae**	**Small larvae**	**Large larvae**	**Small larvae**	**Large larvae**
1. Untreated Check		27.00 a	44.00 a	14.00 a	17.00 a	1.00	1.00
2. Tolfenpyrad	14 fl. oz	2.00 b	3.00 b	0.00 b	0.00 b	0.00	2.00
3. Tolfenpyrad	17 fl. oz	0.00 b	13.00 ab	0.00 b	0.00 b	0.00	6.00
4. Tolfenpyrad	21 fl. oz	0.00 b	0.00 b	0.00 b	2.00 b	0.00	0.00
P-Value from Anova		0.022	0.041	0.002	0.014	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

Treatment	**Rate / acre**	**% defoliation 10-Jun**	**Mean no. potato leafhopper nymphs / 10 compound leaves**	**Yield (in lbs)**
1. Untreated Check		23.75 a	3.5	26.48
2. Tolfenpyrad	14 fl. oz	1.25 b	1.25	40.7
3. Tolfenpyrad	17 fl. oz	0.0 b	0.5	36.73
4. Tolfenpyrad	21 fl. oz	0.0 b	0.75	23.29
P-Value from Anova		0.0007	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR AND SOIL INSECTS IN POTATOES

Location:	ESAREC, Painter, VA
Variety:	Superior
Plant Date:	14 Apr 2011
Experimental Design:	8 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All in-furrow treatments were applied in 900 ml of water at 19.8 GPA using a single nozzle boom equipped with an 8003 even flat spray tip powered by a CO2 backpack sprayer at 30psi. Furrows were cut using a commercial potato planter without the coulters on. Immediately after the treatments were applied over top of seed-pieces, the seed was covered. Post-emergence banded treatments were applied at drag-off using the same methods as described above.
Treatment Dates:	In-furrow: 14 Apr Post-emergence: 25 Apr
Harvest:	14 Jul

Mean no.	% defoliation	Mean no.PLH

			CPB / 10 stems				nymphs / 10 leaves			
Treatment	Rate / acre	Stand 32 DAP	16-May (32 DAP)	13-Jun (60 DAP)	55 DAP	69 DAP	1-Jun (48 DAP)	13-Jun (60 DAP)	% tubers with wireworm damage	Mean total yield (in lbs)
1. Untreated Control		22.8	3.0	4.5	57.5 a	96.3 a	2.5 a	0.3	6.5	23.8 c
2. Brigadier (in-furrow) + Admire Pro (in-furrow) + Brigadier (post-emergence)	16 + 3.48 + 6.4 fl. oz	23	1.0	8.0	2.5 c	17.5 b	0.5 b	1.5	4.5	71.9 ab
3. Brigadier (in-furrow) + Admire Pro (in-furrow)	16 + 5.22 fl. oz	22.3	1.0	8.0	1.3 c	21.3 b	0.3 b	0.3	2.0	53.3 b
4. Brigadier (in-furrow) + Admire Pro (in-furrow) + Brigadier (post-emergence)	12 + 3.48 +12 fl. oz	23.3	1.0	4.0	2.5 c	13.8 b	0.3 b	0.8	3.5	79.8 a
5. Brigadier (in-furrow) + Admire Pro (post-emergence) + Brigadier (post-emergence)	12 + 3.48 + 12 fl. oz	22	2.0	6.5	1.3 c	26.3 b	0.3 b	0.3	4.5	62.0 ab
6. Brigadier (in-furrow)	25.5 fl. oz	23.5	0.0	6.3	1.3 c	21.3 b	0.0 b	1.0	3.5	55.1 ab
7. Capture LFR (in-furrow) + Admire Pro (in-furrow)	25.5 + 3.5 fl. oz	23.3	2.0	9.0	2.5 c	33.8 b	0.0 b	0.8	6.5	65.1 ab
8. Capture LFR (in-furrow) + Capture LFR (post-emergence) + Admire Pro (post-emergence)	12 + 12 + 3.5 fl. oz	24.8	2.0	9.0	30.0 b	82.5 a	0.3 b	1.3	3.0	46.5 bc
P-Value from anova		ns	ns	ns	0.0001	0.0001	0.0103	ns	ns	0.0079

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR AND SOIL INSECTS IN POTATOES

Location:	ESAREC, Painter, VA
Variety:	Superior
Plant Date:	14 Apr 2011
Experimental Design:	6 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers), no guard rows

Treatment Method:	All in-furrow treatments were applied in 900 ml of water at 19.8 GPA using a single nozzle boom equipped with an 8003 even flat spray tip powered by a CO2 backpack sprayer at 30psi. Furrows were cut using a commercial potato planter without the coulters on. Immediately after the treatments were applied over top of seed-pieces, the seed was covered. Seed-piece pesticide treatments were applied on 13 Apr using a standard cement mixer to tumble 50 lbs of seed, while the chemicals were applied directly to the seed with a hand-pump spray bottle containing 100 ml water. Seed pieces were left to dry.
Treatment Dates:	14 Apr
Harvest	23 Jun (one row by hand); 14 Jul (one row mechanical)

			Mean no. Colorado potato beetles / 10 stems 20 May (36 DAP)		% defoliation		Mean no. potato leafhopper nymphs (1 Jun)
Treatment	**Rate**	**Stand**	**small larvae**	**adults**	**9 Jun (56 DAP)**	**23 Jun (70 DAP)**	
1. Untreated Control		23.8 a	85.0 a	8.0	96.3 a	100.0 a	6.0
2. HGW86 20SC (seed treatment)	2.25 mg AI / seed	19.0 c	22.0 b	4.0	93.8 ab	100.0 a	3.5
3. HGW86 20SC (seed treatment)	3.4 mg AI / seed	21.0 abc	4.0 b	4.0	77.5 b	100.0 a	3.0
4. HGW86 20SC (seed treatment)	4.5 mg AI / seed	19.8 bc	3.0 b	6.0	86.3 ab	100.0 a	6.3
5. HGW86 20SC (in-furrow)	13.5 fl. oz / acre	24.5 a	6.0 b	5.0	13.8 c	32.5 b	3.0
6. Regent 4SC (in-furrow)	3.2 fl. oz / acre	23.3 ab	44.0 ab	3.0	91.3 ab	100.0 a	2.8
P-Value from anova		0.0297	0.0434	ns	0.0001	0.0001	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

Treatment	**Rate**	**Total Yield (lbs)**	**% wireworm damage 23 Jun**	**% wireworm damage 14 Jul**	**Total % wireworm damage**
1. Untreated Control		23.1 c	12.0	18.0	15.0
2. HGW86 20SC (seed treatment)	2.25 mg AI / seed	26.0 bc	10.0	6.5	8.3
3. HGW86 20SC (seed treatment)	3.4 mg AI / seed	28.0 bc	15.5	11.5	13.5
4. HGW86 20SC (seed treatment)	4.5 mg AI / seed	25.9 bc	13.5	6.0	9.8
5. HGW86 20SC (in-furrow)	13.5 fl. oz / acre	51.5 a	10.0	8.5	9.3
6. Regent 4SC (in-furrow)	3.2 fl. oz / acre	32.2 b	6.5	5.0	5.8
P-Value from anova		0.0001	ns	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF WIREWORMS IN POTATOES

Location:	HRAREC, Virginia Beach, VA
Variety:	Superior
Plant Date:	28 Apr 2011
Experimental Design:	3 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All in-furrow treatments were applied in 900 ml of water at 19.8 GPA on 28 Apr using a single nozzle boom equipped with an 8003 even flat spray tip powered by a CO2 backpack sprayer at 30psi. Furrows were cut using a tiller-furrower. Immediately after the treatments were applied over top of seed-pieces, the seed was covered.
Treatment Dates:	28 Apr 2011
Harvest:	19 May (tubers dug)

Treatment	Rate / acre	Mean no. wireworm holes	% wireworm damaged tubers
1. Untreated Control		16.8 a	66.7 a
2. HGW86 20SC	13.5 fl. oz	11.0 ab	43.3 ab
3. Brigadier	25.5 fl. oz	4.5 b	25.0 b
P-Value from anova		0.0244	0.0001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR AND SOIL INSECTS IN POTATOES

Location:	Southwest Virginia 4-H Center, Abingdon, VA
Variety:	Kennebec
Plant Date:	6 May 2011
Experimental Design:	8 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All in-furrow treatments were applied in 900 ml of water at 19.8 GPA using a single nozzle boom equipped with an 8003 even flat spray tip powered by a CO2 backpack sprayer at 30psi. Furrows were cut using a commercial potato planter without the coulters on. Immediately after the treatments were applied over top of seed-pieces, the seed was covered. Post-emergence banded treatments were applied at drag-off using the same methods as described above.
Treatment Dates:	In-furrow: 6 May Post-emergence: 30 May
Harvest:	2 Sep

Treatment	Rate / acre	% of potato leaves severely injured by flea beetles 31 May	% wireworm damage

1. Untreated Control		86.0 a	41.0 a
2. Brigadier (in-furrow) + Admire Pro (in-furrow) + Brigadier (post-emergence)	16 + 3.48 + 6.4 fl. oz	0.0 b	20.0 bcd
3. Brigadier (in-furrow) + Admire Pro (in-furrow)	16 + 5.22 fl. oz	16.0 b	29.0 ab
4. Brigadier (in-furrow) + Admire Pro (in-furrow) + Brigadier (post-emergence)	12 + 3.48 +12 fl. oz	0.0 b	11.5 d
5. Brigadier (in-furrow) + Admire Pro (post-emergence) + Brigadier (post-emergence)	12 + 3.48 + 12 fl. oz	10.0 b	24.0 bc
6. Brigadier (in-furrow)	25.5 fl. oz	20.0 b	20.0 bcd
7. Capture LFR (in-furrow) + Admire Pro (in-furrow)	25.5 + 3.5 fl. oz	0.0 b	16.0 cd
8. Capture LFR (in-furrow) + Capture LFR (post-emergence) + Admire Pro (post-emergence)	12 + 12 + 3.5 fl. oz	66.0 a	18.0 bcd
P-Value from anova		0.0001	0.0022

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

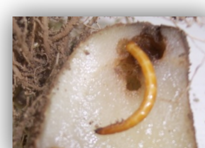
CONTROL OF FOLIAR AND SOIL INSECTS IN POTATOES

Location:	Southwest Virginia 4-H Center, Abingdon, VA
Variety:	Kennebec
Plant Date:	6 May 2011
Experimental Design:	6 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All in-furrow treatments were applied in 900 ml of water at 19.8 GPA using a single nozzle boom equipped with an 8003 even flat spray tip powered by a CO2 backpack sprayer at 30psi. Furrows were cut using a commercial potato planter without the coulters on. Immediately after the treatments were applied over top of seed-pieces, the seed was covered
Treatment Dates:	6 May 2011
Harvest:	2 Sep

Treatment	Rate / acre	Mean % of leaves with significant flea beetle injury 31 May (25 DAT)	% wireworm damage
1. Untreated Control		4.5 a	37.0 b
2. Regent 4SC	3.2 fl. oz	3.5 a	15.5 a
3. A16901	6.5 oz	0.0 b	45.5 b
4. A16901	10 oz	0.5 b	39.5 b
5. Platinum 75SG	1.68 fl. oz	0.0 b	36.5 b
6. Platinum 75SG	2.66 fl. oz	1.3 b	29.5 b
P-Value from anova		0.0016	0.0111

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR AND SOIL INSECTS IN POTATOES



Location:	Southwest Virginia 4-H Center, Abingdon, VA
Variety:	Kennebec
Plant Date:	6 May 2011
Experimental Design:	6 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All in-furrow treatments were applied in 900 ml of water at 19.8 GPA using a single nozzle boom equipped with an 8003 even flat spray tip powered by a CO2 backpack sprayer at 30psi. Furrows were cut using a commercial potato planter without the coulters on. Immediately after the treatments were applied, the seed was covered Seed-piece pesticide treatments were applied directly to the seed with a hand-pump spray bottle containing 100 ml water/25 lb seed
Treatment Dates:	6 May 2011 (in-furrow and seed treatments)
Harvest:	2 Sep

Treatment	Rate	% of potato leaves severely injured by flea beetles 31 May	% tubers damaged by wireworm
1. Untreated Control		90.0 a	37.0 a
2. HGW86 20SC (seed treatment)	2.25 mg AI / seed	10.0 b	42.5 a
3. HGW86 20SC (seed treatment)	3.4 mg AI / seed	26.0 b	43.0 a
4. HGW86 20SC (seed treatment)	4.5 mg AI / seed	6.0 b	40.5 a
5. HGW86 20SC (in-furrow)	13.5 fl. oz / acre	6.0 b	29.5 ab
6. Regent 4SC (in-furrow)	3.2 fl. oz / acre	3.5 a	15.5 b
P-Value from anova		0.0002	0.0274

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF FOLIAR INSECTS IN SNAP BEANS

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Bronco
Plant Date:	10 Jun 2011
Experimental Design:	10 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
Treatment Dates:	27Jul
Bagged Assay:	On 1 Aug (5 DAT), 5 brown marmorated stink bug nymphs were placed in a mesh bag. 2 bags were secured to a bean plant in each treated row following treatments. On 4 Aug (72 hr), the bags were removed and the number of dead and down nymphs was evaluated.

		Mean no. Mexican bean beetles / 10 plants				Mean no. PLH nymphs / 10 plants		Damage to pods at harvest (5 Aug)		
		29 Jul (2 DAT)		1 Aug (5 DAT)		29 Jul (2 DAT)	1 Aug (5 DAT)	% stink bug injury	% beetle scarring injury	total % damaged pods
Treatment	Rate / acre	Larvae	Egg masses	Larvae	Egg masses	PLH nymp	PLH nymp			

						hs	hs			
1. Untreated Control		12.5 a	1.5 a	20.3 a	1.3 a	4.8a	3.0a	6.8 a	5.8 a	12.5a
2. Brigadier	5.5 fl. oz	4.5 ab	0.5 ab	0.3 b	0.0 a	0.0b	0.0b	2.3 ab	3.0 ab	5.25ab
3. Mustang Max	4.0 fl. oz	1.0 b	0.5 ab	0.0 b	0.3 a	0.5b	0.0b	3.0 ab	1.8 bc	4.75ab
4. Hero	6.4 fl. oz	4.0 ab	0.0 b	0.3 b	0.3 a	0.0b	0.0b	0.0 b	2.3 ab	2.75b
5. Hero	7.1 fl. oz	2.0 b	0.3 ab	0.0 b	0.8 a	0.0b	0.0b	2.5 ab	0.0 c	2.5b
6. Hero	8.0 fl. oz	6.5 ab	1.0 ab	0.3 b	0.0 a	0.0b	0.0b	1.0 b	1.8 abc	2.75b

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

- **Summary of bagged-stink bug bioassay**

Treatment	Rate	% brown marmorated stink bug mortality (72 hrs)
1. Untreated Control		2.5 b
2. Brigadier	5.5 fl. oz	45.0 a
3. Mustang Max	4.0 fl. oz	35.0 a
4. Hero	6.4 fl. oz	47.5 a
5. Hero	7.1 fl. oz	55.0 a
6. Hero	8.0 fl. oz	52.5 a

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR INSECTS IN SNAP BEANS

Location: ESAREC, Painter, VA
Variety: Bronco
Plant Date: 10 Aug 2011
Experimental Design: 10 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.
All soil treatments were applied as a drench with a watering can containing 15 pints of water for each plot row.
Treatment Dates: foliar: 16, 23 and 30 Sep
Soil: 9 Sep

Treatment	Rate / acre	% lepidopteran damaged pods	% "crooked" pods	Total Yield (in lbs)
1. Untreated Control		4.5 ab	6.3	15.7
2. HGW86 20SC (foliar)	13.5 fl. oz	0.0 c	12.0	17.0
3. HGW86 20SC (foliar)	16.9 fl. oz	1.0 bc	11.5	17.1
4. HGW86 20SC (foliar)	20.5 fl. oz	0.0 c	4.8	16.4
5. Admire Pro (soil-applied)	10.5 fl.oz	7.0 a	8.0	15.0

6. Durivo (soil-applied)	13 fl. oz	0.0 c	10.8	18.3
7. A16901 + MSO (foliar)	7 oz + 0.1% v/v	0.0 c	4.3	15.4
8. A 16901 (soil-applied)	14 oz	0.0 c	13.0	15.6
9. Venom 20SG (foliar)	4 oz	4.5 a	8.0	16.6
10. Voliam Xpress + MSO (foliar)	9 fl. oz + 0.1% v/v	0.0 c	8.5	18.4
P-Value from Anova		0.0004	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR INSECTS IN SOYBEANS

Location: ESAREC, Painter, VA
Variety: NK 46-06
Plant Date: 27 Jul 2011
Experimental Design: 10 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers), no guard rows
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 65 GPA.
Treatment Dates: 16, 26 Sep and 3 Oct

Treatment	Rate / acre	Mean no. lepidopteran larvae* / 3-ft beat sheet			Mean no. stink bugs / 3-ft beatsheet	
		22-Sep	3-Oct	11-Oct	22-Sep	11-Oct
1. Untreated Control		7.3	0.5	0.0	0.0	0.3
2. Endigo ZCX	3.5 fl. oz	1.8	0.0	0.0	0.0	0.5
3. Baythroid XL + Exponent	2.8 fl. oz + 4 fl. oz	0.5	0.3	0.0	0.0	0.0
4. Baythroid XL + Evergreen	2.8 fl. oz + 4 fl. oz	0.3	0.0	0.0	0.0	0.0
5. Baythroid XL	2.8 fl. oz	0.3	0.0	0.0	0.0	0.0
6. Dipel ES	16 fl. oz	0.0	0.3	0.3	0.0	0.0
7. Dipel ES + Brigade	16 fl. oz + 6.4 fl. oz	0.3	0.5	0.0	0.3	0.0
8. Dipel ES + Brigade	16 fl. oz + 4.22 fl. oz	0.8	0.0	0.3	0.3	0.0
9. Brigade	6.4 fl. oz	0.5	0.3	0.0	0.0	0.0
10. Brigade	4.22 fl. oz	0.0	0.3	0.0	0.0	0.0
11. Leverage 360	2.8 fl. oz	0.3	0.3	0.0	0.0	0.0
P-Value from anova		ns	ns	ns	ns	ns

***** > 90% beet armyworm

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR INSECTS IN SUMMER SQUASH

Location: HRAREC, Virginia Beach, VA
Variety: Spineless Perfection (zucchini)
Transplant Date: 15 Jun 2010

Experimental Design:	9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40psi delivering 34 GPA
Treatment Dates:	14, 21 and 27 Jul

		Mean no. squash bugs / 5 plants										
		Egg masses			Nymphs			Adults				
Treatment	Rate / acre	21-Jul	27-Jul	3-Aug	21-Jul	27-Jul	3-Aug	21-Jul	27-Jul	3-Aug	Mean no. squash vine borer damaged plants	Mean total no. of fruit per plot
1. Untreated Control		9.0	10.3 bc	10.5	5.0	18.0	43.5	1.8	3.5 bc	0.8	1.8	78.0
2. HGW86 10SE + MSO	10.1 fl. oz + 0.25% v/v	7.0	14.0 ab	9.8	3.8	10.5	48.3	0.5	2.0 bc	1.5	2.3	78.8
3. HGW86 10SE + MSO	13.5 fl. oz +j 0.25% v/v	8.8	18.0 ab	7.8	7.5	12.8	8.0	0.3	7.0 a	1.8	2.0	75.5
4. HGW86 10SE + MSO	16.9 fl. oz + 0.25% v/v	6.8	10.3 bc	10.0	2.5	14.0	36.5	0.5	2.0 bc	0.3	1.8	70.5
5. HGW86 10SE + MSO	20.5 fl. oz + 0.25% v/v	6.8	21.3 a	7.5	6.5	20.0	38.3	1.0	3.5 bc	2.5	1.3	79.5
6. Asana XL + MSO	8 fl. oz + 0.25% v/v	6.5	3.8 c	5.5	0.0	2.8	0.0	0.5	0.8 c	0.5	0.8	82.5
7. Coragen + MSO	3.5 fl. oz + 0.25% v/v	10.5	21.8 a	11.3	0.0	29.3	35.5	0.5	4.5 ab	1.0	1.5	79.8
8. Coragen + MSO	5 fl. oz + 0.25% v/v	5.0	14.5 ab	14.3	9.0	3.3	30.8	0.8	3.0 bc	0.8	1.0	72.5
9. Warrior II	1.92 fl. oz + 0.25% v/v	4.3	10.8 bc	0.8	0.0	1.5	0.0	0.3	1.8 bc	0.0	1.0	73.3
P-Value from anova		ns	0.0149	ns	ns	ns	ns	ns	0.0455	ns	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF FOLIAR INSECTS IN SUMMER SQUASH

Location:	ESAREC, Painter, VA
Variety:	Gentry (yellow squash)
Transplant Date:	28 Jul 2010
Experimental Design:	9 treatments arranged in a RCB design with 4 reps on plastic mulch – 1 row x 20 ft. (6-ft row centers), no guard rows
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40psi delivering 34 GPA
Treatment Dates:	23, 30 Aug and 7 Sep

		Mean no. melon aphids / 10 leaves				Mean no. striped cucumber beetles / 5 plants			Mean no. healthy plants (not squash vine borer damaged)
Treatment[A]	Rate	30-	6-Sep	13-Sep	22-Sep	30-	6-Sep	13-Sep	

	/ acre	Aug				Aug			
1. Untreated Control		145.8 b	179.3 bc	135.0 b	40.0 ab	7.5	5.8	7.0	6.8
2. HGW86 10SE + MSO	10.1 fl. oz	15.5 cd	19.8 c	2.0 b	2.5 b	8.5	5.0	3.5	7.0
3. HGW86 10SE + MSO	13.5 fl. oz	15.3 cd	3.8 c	7.8 b	5.0 b	7.0	4.3	3.3	9.3
4. HGW86 10SE + MSO	16.9 fl. oz	4.0 d	6.3 c	1.5 b	2.5 b	4.0	2.0	3.0	10.5
5. HGW86 10SE + MSO	20.5 fl. oz	5.0 d	5.5 c	6.3 b	0.0 b	5.3	6.0	6.8	13.3
6. Asana XL + MSO	8 fl. oz	102.5 bc	516.0 ab	291.3 b	32.3 ab	5.3	3.3	2.3	12.8
7. Coragen + MSO	3.5 fl. oz	13.3 cd	133.3 c	60.0 b	54.5 a	6.3	5.8	3.8	14.3
8. Coragen + MSO	5 fl. oz	10.3 cd	28.0 c	84.3 b	36.3 ab	6.0	3.0	5.0	7.5
9. Warrior II	1.92 fl. oz	254.5 a	813.0 a	2911.3 a	76.3 a	4.5	5.3	1.3	11.5
P-Value from anova		0.0001	0.0004	0.0001	0.0216	ns	ns	ns	0.0686

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).
[A]All treatments included MSO at 0.25% v/v, except trt. 9 Warrior II.

CONTROL OF FOLIAR INSECTS IN SWEET CORN

Location: Kentland Research Farm, Blacksburg, VA
Variety: Merit
Plant Date: 10 Jun 2011
Experimental Design: 6 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method: All treatments were applied at 38 GPA using a 1-nozzle boom equipped with D3 tips and 45 cores and powered by a CO2 backpack sprayer delivering at 40 psi.
Treatment Dates: 2, 5, 8, 12, and 16 Aug (only 5 sprays were applied because the corn matured very quickly)
Methods: On 8 Aug (1 DAT) and 18 Aug (2 DAT), one gallon paint strainer bags were fastened with a rubber band around 2 ears of corn in each plot with 5 brown marmorated stink bug adults in each (10 total insects for each plot). Bug mortality was assessed on 11 Aug and 22 Aug for each separate experiment. The number of dead and down brown marmorated stink bugs was recorded
Harvest: 22 Aug

Treatment	Rate / acre (in fl oz)	% dead and down stink bugs 11 Aug (3 DAT3)	% dead and down stink bugs 22 Aug (2 DAT5)
1. Untreated Control		5.0 d	5.0 d

2. Hero fb Hero fb Hero fb Mustang Max + Lannate LV fb Hero + Lannate LV fb Mustang Max + Lannate LV fb Mustang Max + Lannate	6.4 fb 6.4 fb 6.4 fb 4 + 16 fb 6.4 + 16	97.5 a	90.0 a
3. Hero fb Hero fb Mustang Max fb Mustang Max + Lannate LV fb Mustang Max + Lannate LV fb Hero + Lannate LV fb Hero + Lannate LV	6.4 fb 6.4 fb 4 fb 4 + 16 fb 4 + 16	87.5 ab	85.0 ab
4. Hero fb Hero fb Mustang Max fb Mustang Max fb Mustang Max fb Hero fb Hero	6.4 fb 6.4 fb 4 fb 4 fb 4	75.0 bc	50.0 c
5. Hero fb Hero fb Hero fb Mustang Max fb Hero fb Mustang Max fb Mustang Max	6.4 fb 6.4 fb 6.4 fb 4 fb 6.4	95.0 ab	92.5 a
6. Voliam Xpress (x 5 apps)	8	52.5 c	72.5 bc
P-Value from anova		0.0001	0.0001

Treatment	Rate/ acre (in fl oz)	% husk damage	% brown marmorated stink bug damage	% lepidopteran damage
1. Untreated Control		39.3	28.3	37.7 a
2. Hero fb Hero fb Hero fb Mustang Max + Lannate LV fb Hero + Lannate LV fb Mustang Max + Lannate LV fb Mustang Max + Lannate	6.4 fb 6.4 fb 6.4 fb 4 + 16 fb 6.4 + 16	27.3	9.0	0.0 c
3. Hero fb Hero fb Mustang Max fb Mustang Max + Lannate LV fb Mustang Max + Lannate LV fb Hero + Lannate LV fb Hero + Lannate LV	6.4 fb 6.4 fb 4 fb 4 + 16 fb 4 + 16	36.0	19.3	3.5 bc
4. Hero fb Hero fb Mustang Max fb Mustang Max fb Mustang Max fb Hero fb Hero	6.4 fb 6.4 fb 4 fb 4 fb 4	37.2	28.5	5.2 b
5. Hero fb Hero fb Hero fb Mustang Max fb Hero fb Mustang Max fb Mustang Max	6.4 fb 6.4 fb 6.4 fb 4 fb 6.4	45.5	23.3	3.2 bc
6. Voliam Xpress (x 5 apps)	8	26.7	20.6	1.3 bc
P-Value from anova		ns	ns	0.0000

CONTROL OF FOLIAR INSECTS IN SWEET CORN

Location:	HRAREC, Virginia Beach, VA
Variety:	Silver King
Plant Date:	16 Jun 2011
Experimental Design:	10 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method:	All treatments were applied at 38 GPA using a 1-nozzle boom equipped with D3 tips and 45 cores and powered by a CO2 backpack sprayer delivering at 40 psi.
Treatment Dates:	beginning at 60% tasselling: 25, 27, 29 Jul, 1, 3, 5, 8 Aug
Harvest:	10 Aug

Treatment	Rate / acre (in fl. oz)	% lepidopteran damaged ears

1. Untreated Control		90.0 a
2. Hero fb Hero fb Hero fb Mustang Max + Lannate LV fb Hero + Lannate LV fb Mustang Max + Lannate LV fb Mustang Max + Lannate	6.4 fb 6.4 fb 6.4 fb 4 + 16 fb 6.4 + 16 fb 4 + 16 fb 4 + 16	8.0 b
3. Hero fb Hero fb Mustang Max fb Mustang Max + Lannate LV fb Mustang Max + Lannate LV fb Hero + Lannate LV fb Hero + Lannate LV	6.4 fb 6.4 fb 4 fb 4 + 16 fb 4 + 16 fb 6.4 + 16 fb 6.4 + 16	8.0 b
4. Hero fb Hero fb Mustang Max fb Mustang Max fb Mustang Max fb Hero fb Hero	6.4 fb 6.4 fb 4 fb 4 fb 4 fb 6.4 fb 6.4	5.0 b
5. Hero fb Hero fb Hero fb Mustang Max fb Hero fb Mustang Max fb Mustang Max	6.4 fb 6.4 fb 6.4 fb 4 fb 6.4 fb 4 fb 4	3.0 b
6. Baythroid XL	2.8	4.0 b
7. Leverage 360	2.8	7.0 b
8. Belt + NIS fb Baythroid XL	3 + 0.25% v/v fb 2.8	15.0 b
9. Voliam Xpress	8	2.0 bc
10. Warrior II	1.92	8.0 b
P-Value from anova		0.0000

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FALL ARMYWORM IN SWEET CORN

Location: ESAREC, Painter, VA
Variety: Symmetry
Plant Date: 29 Jul 2011
Experimental Design: 10 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers), no guard rows
Treatment Method: All foliar treatments were applied with a 1-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates: 29 Aug

Treatment	Rate / acre	% fall armyworm damaged plants	Mean no. fall armyworms / 10 plants
1. Untreated Control		97.5 a	16.8 a
2. Hero	6.4 fl. oz	30.0 bc	3.5 bc
3. Hero + Lannate LV	6.4 fl. oz + 16 fl. oz	15.0 c	0.0 c
4. Mustang Max	4 fl. oz	30.0 bc	2.5 bc
5. Mustang Max + Lannate LV	4 fl. oz + 16 fl. oz	0.0 c	0.0 c
6. Baythroid XL	2.8 fl. oz	60.0 b	5.0 b
7. Leverage 360	2.8 fl. oz	45.0 bc	4.3 bc
8. Belt + NIS	3 fl. oz + 0.25% v/v	15.0 def	0.3 c
9. Voliam Xpress	8 fl. oz	2.5 ef	0.0 c
10. Warrior II	1.92 fl. oz	30.0 cde	2.5 bc
11. Coragen	5 fl. oz	7.5 def	0.3 c
P-Value from anova		0.0001	0.0001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR INSECTS IN SPRING TOMATOES

Location: HRAREC, Virginia Beach, VA
Variety: Florida 47
Transplant Date: 5 May 2011
Experimental Design: 5 treatments arranged in a RCB design with 4 reps – 4 rows x 20 ft. (6-ft row centers), no guard rows
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with D3 tips and 45 cores powered by a CO_2 backpack sprayer at 40 psi delivering 38 GPA.
Treatment Dates: 19 May (all treatments), 6 (all treatments), 13 (all treatments) and 22 Jun (all except Movento)

		Mean no. potato aphids					Mean no. flea beetles / 20 plants	Mean no. thrips (vaccum filtration)		
Treatment[A]	Rate / acre	13-Jun (15 leaves)	20-Jun (15 leaves)	28-Jun (15 leaves)	7-Jul (20 leaves)	14-Jul (20 leaves)		Adults 22 Jun (10 blossoms)	Larvae 22 Jun (10 blossoms	Adults + larvae 16 Jun
1. Untreated Control		15.0 a	43.0	119.8 a	46.0 a	21.3	1.8	3.5	58.8	143.8
2. HGW86 10SE + MSO	13.5 fl. oz	0.3 b	1.3	0.8 b	8.3 b	8.8	0.3	6.8	52.3	93.3
3. HGW86 10SE + MSO	16.9 fl. oz	0.3 b	0.0	0.0 b	0.3 b	0.0	0.0	12.8	60.0	108.3
4. HGW86 10SE + MSO	20.5 fl. oz	0.0 b	0.0	1.0 b	7.3 b	3.0	0.0	6.5	65.5	90.5
5. Movento + Scanner	4 fl. oz	0.0 b	0.0	0.0 b	2.4 b	15.3	0.0	3.8	55.0	89.0
P-Value from anova		0.0009	ns	0.0001	0.0059	ns	ns	ns	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).
[A]All treatments included MSO at 0.25% v/v, except trt. 5 Movento, which included Scanner at 0.25% v/v.

Treatment[A]	Rate / acre	Mean no. TSWV affected plants	Yield (in lbs)	% lepidopteran damage fruit	% stink bug damaged fruit	% thrips damaged fruit
1. Untreated Control		2.0	76.4	6.7	11.7	25.0
2. HGW86 10SE + MSO	13.5 fl. oz + 0.25% v/v	4.8	57.9	5.8	10.0	23.3
3. HGW86 10SE + MSO	16.9 fl. oz + 0.25% v/v	5.0	68.1	0.0	5.8	10.0
4. HGW86 10SE + MSO	20.5 fl. oz + 0.25% v/v	4.5	42.3	5.8	13.3	25.8
5. Movento + Scanner	4 fl. oz + 0.25% v/v	6.8	46.2	5.8	10.0	11.7
P-Value from anova		ns	ns	ns	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).
[A]All treatments included MSO at 0.25% v/v, except trt. 5 Movento, which included Scanner at 0.25% v/v.

CONTROL OF THRIPS IN SPRING TOMATOES

Location:	ESAREC, Painter, VA
Variety:	HBN 602
Transplant Date:	3 Jun 2011
Experimental Design:	3 treatments arranged in a RCB design with 4 reps – 5 rows x 50 ft. (6-ft row centers), no guard rows
Treatment Method:	All soil treatments were applied with a one nozzle boom with no spray tip directed at the base of each plant. The boom was powered by a CO2 backpack sprayer at 40 psi delivering 125 ml of water per plant.
Treatment Dates:	6 Jun (76°F soil temperature)

		Mean no. thrips*								
Treatment	**Rate (in fl oz/ acre)**	**10 Jun (per 40 leaves)**	**16 Jun (per 40 leaves)**		**24 Jun (per 20 leaves)**		**5 Jul (per 20 blossoms)**		**11 Jul (per 20 blossoms)**	
		Adults	**Adults**	**Larvae**	**Adults**	**Larvae**	**Adults**	**Larvae**	**Adults**	**Larvae**
1. Untreated Control		10.5 a	7.3	13.5	1.3	5.0	4.0	0.0	9.3	2.8
2. HGW86 20SC	13.5	5.5 b	3.0	4.3	0.8	0.8	4.0	0.0	7.8	4.0
3. Admire Pro	10	1.0 c	3.0	2.3	0.8	1.5	1.8	0.0	5.5	2.8
P-Value from anova		0.0009	ns	ns	ns	ns	ns	ns	ns	ns

* Tobacco thrips (F. fusca) predominant species on leaves; flower thrips (F. tritici) predominant species in blossoms
All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

Treatment	Rate / acre	% lepidopteran damaged fruit	% stink bug damaged fruit	% thrips damaged fruit
1. Untreated Control		5.8	24.5	16.3
2. HGW86 20SC	13.5 fl oz	9.3	43.3	20.5
3. Admire Pro	10 fl oz	14.3	28.5	13.8
P-Value from anova		ns	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF THRIPS IN SPRING TOMATOES

Location:	ESAREC, Painter, VA
Variety:	HBN 602
Transplant Date:	3 Jun 2011
Experimental Design:	11 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40psi

	delivering 34 GPA.
	All soil treatments were applied with a one nozzle boom with no spray tip directed at the base of each plant. The boom was powered by a CO2 backpack sprayer at 40 psi delivering 125 ml of water per plant.
Treatment Dates:	Soil: 24 May
	Foliar: 6, 14, 21, 29 Jun and 5 Jul

		Mean no. thrips[1]								
Treatment	Rate / acre	9 Jun (per 10 leaves)	13 Jun (per 10 leaves)*		16 Jun (per 10 leaves)*		24 Jun (per 10 blossoms)*		8 Jul (per 20 blossoms)*	
		Adults	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae
1. Untreated control		30.3 a	7.3	16.0 a	9.5 bcd	49.3 b	2.0	0.0	8.8 abc	4.8 b
2. M-Pede (2% v/v)		20.3 b	6.8	7.5 bc	11.8 a-d	86.8 a	3.8	2.5	9.0 ab	14.5 a
3. M-Pede (2%) + Scorpion 35SL	7 fl. oz	7.8 cd	3.5	2.5 c	14.3 ab	4.5 c	0.8	0.0	3.0 cd	2.0 b
4. Venom	4 oz	11.0 cd	2.5	4.3 c	9.0 bcd	7.3 c	1.3	0.3	3.8 bcd	2.0 b
5. Endigo 2.06ZC	4.5 fl. oz	5.0 d	7.0	4.0 c	5.8 cd	1.0 c	0.5	1.0	0.5 d	0.5 b
6. Endigo ZCX 2.71	4.5 fl. oz	13.0 bcd	3.3	5.3 c	6.5 bcd	1.0 c	0.3	0.5	1.5 d	0.8 b
7. Actara	5.5 oz	12.8 bcd	5.0	3.0 c	12.5 abc	5.5 c	0.8	0.3	11.3 a	4.5 b
8. Voliam Xpress	9 fl. oz	12.5 bcd	9.3	14.0 ab	4.0 d	7.8 c	2.5	1.0	0.8 d	0.5 b
9. Leverage 360	4 fl. oz	10.3 cd	6.8	6.0 c	10.3 bcd	4.3 c	0.5	0.5	0.5 d	0.0 b
10. HGW86 20SC (at planting)	13.5 fl. oz	14.8 bc	2.8	2.5 c	4.0 d	1.5 c	2.3	2.3	10.0 a	6.0 b
11. Admire Pro (at planting)	10 fl. oz	9.3 cd	8.5	3.5 c	18.5 a	5.3 c	1.5	0.0	5.8 a-d	5.0 b
P-Value from anova		0.0004	ns	0.0138	0.025	0.0001	ns	ns	0.0011	0.015

[1] Tobacco thrips (F. fusca) predominant species on leaves; flower thrips (F. tritici) predominant species in tomato blossoms

*vaccum filtration

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

Treatment	Rate / acre	% lepidopteran damaged fruit	% stink bug damaged fruit	% thrips damaged fruit
1. Untreated control		14.2 ab	58.3 ab	85.8 a
2. M-Pede (2% v/v)		20.0 ab	45.8 bc	65.0 b
3. M-Pede (2%) + Scorpion 35SL	7 fl. oz	25.8 a	8.3 ef	43.3 bcd
4. Venom	4 oz	15.0 ab	6.7 f	30.8 d
5. Endigo 2.06ZC	4.5 fl. oz	9.2 bcd	29.2 cd	36.7 cd
6. Endigo ZCX 2.71	4.5 fl. oz	10.0 ab	21.7 de	33.3 d
7. Actara	5.5 oz	11.7 bc	27.5 cd	42.5 bcd
8. Voliam Xpress	9 fl. oz	3.3 cd	48.3 abc	45.8 bcd
9. Leverage 360	4 fl. oz	0.0 d	15.8 def	22.5 d
10. HGW86 20SC (at planting)	13.5 fl. oz	0.0 d	69.2 a	85.8 a
11. Admire Pro (at planting)	10 fl. oz	10.8 b	45.8 bc	62.5 bc
P-Value from anova		0.0005	0.0001	0.0001

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

CONTROL OF FOLIAR INSECTS IN SPRING TOMATOES

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Patio Hybrid
Transplant Date:	17 Jun 2011

Experimental Design:	7 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40psi delivering 34 GPA
Treatment Dates:	13, 21, 28 Jul
Bagged Assay:	On 25 Jul (4 DAT) and 29 Jul (1 DAT), brown marmorated stink bug nymphs were placed on plants in a mesh 1-gallon paint strainer bag. 2 bags each containing 5 bugs were secured to a tomato plant in each plot row following treatments. Bugs remained on plants in the field for 48 hrs - On 27 Jul and 1 Aug, respectively, the bags were removed and % mortality was assessed as the number of dead and down nymphs.

Treatment	Rate / acre	% lepidopteran damage	% stink bug damage
1. Untreated Control		3.2	19.2
2. Hero	6.4 fl. oz	0.0	3.8
3. Hero	7.1 fl. oz	1.9	9.4
4. Hero	8 fl. oz	3.0	3.8
5. Hero	10.3 fl. oz	0.0	0.0
6. Brigadier 2SC	8 fl. oz	1.3	3.0
7. Athena	16 fl. oz	0.0	3.3
P-Value from ANOVA		ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

- **Summary of bagged stink bug bioassay:**

Treatment	Rate / acre	% mortality of BMSB nymphs caged on plants	
		25 Jul	29 Jul
1. Untreated Control		12.5 d	31.3 b
2. Hero	6.4 fl. oz	20.0 cd	80.0 a
3. Hero	7.1 fl. oz	30.0 bcd	82.5 a
4. Hero	8 fl. oz	40.0 bc	82.5 a
5. Hero	10.3 fl. oz	55.0 b	92.5 a
6. Brigadier 2SC	8 fl. oz	85.0 a	77.5 a
7. Athena	16 fl. oz	30.0 bcd	89.3 a
P-Value from anova		0.0002	0.0049

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF FOLIAR INSECTS IN FALL TOMATOES

Location:	ESAREC, Painter, VA
Variety:	Solar Fire
Transplant Date:	19 Jul 2011
Experimental Design:	5 treatments arranged in a RCB design with 4 reps – 4 rows x 20 ft. (6-ft row centers), no guard rows
Treatment	All drip irrigation treatments were applied at flowering with the use of

Method:	chemilizers. Each insecticide amount was diluted in 100 ml of water, poured into the chemilizer feeding tube and flushed with an additional 300 ml of water.
Treatment Dates:	18 and 29 Aug

Treatment	Rate / acre	% lepidopteran damaged fruit			% stink bug damaged fruit (4 Oct)	Mean no. lepidopteran larvae* / 4 beat sheets (30 Aug)	Mean no. beet armyworm / 2 beat sheets (19 Sep)
		31-Aug	20-Sep	4-Oct			
1. Untreated Control		26.3	25.6 a	33.5 a	8.5	15.8 a	0.5
2. HGW86 20SC	5.1 fl. oz	17.5	21.9 a	22.0 ab	18.0	8.8 ab	0.3
3. HGW86 20SC	6.75 fl. oz	11.4	9.4 b	15.0 b	14.0	6.5 b	0.0
4. HGW86 20SC	10.20 fl. oz	10.0	7.5 b	13.5 b	19.5	2.8 b	0.3
5. Durivo	10 fl. oz	10.0	18.8 ab	13.5 b	18.5	5.3 b	0.3
P-Value from anova		ns	0.0383	0.0138	ns	0.033	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

Treatment	Rate / acre	% lepidopteran damaged fruit			% stink bug damaged fruit (4 Oct)	Total Yield (in lbs)
		31-Aug	20-Sep	4-Oct		
1. Untreated Control		26.3	25.6 a	33.5 a	8.5	41.2 bc
2. HGW86 20SC	5.1 fl. oz	17.5	21.9 a	22.0 ab	18.0	36.0 bc
3. HGW86 20SC	6.75 fl. oz	11.4	9.4 b	15.0 b	14.0	45.9 b
4. HGW86 20SC	10.20 fl. oz	10.0	7.5 b	13.5 b	19.5	31.5 c
5. Durivo	10 fl. oz	10.0	18.8 ab	13.5 b	18.5	66.0 a
P-Value from anova		ns	0.0383	0.0138	ns	0.0014

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF FOLIAR INSECTS IN FALL TOMATOES

Location:	ESAREC, Painter, VA
Variety:	Solar Fire
Transplant Date:	27 Jul 2011
Experimental Design:	11 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40psi delivering 34 GPA
Treatment Dates:	6 (all treatments), 13 (all except Vetica & Radiant), 22 (all treatments) and 30 Sep (all treatments)

Treatment	Rate / acre	Mean no. lepidopteran larvae / 2 beatsheets	% lepidopteran damage	
			28-Sep	4-Oct
1. Untreated Control		1.8	27.5	10.0 abcd
2. M-Pede	2% v/v	1.3	25.0	14.2 abcd
3. M-Pede + Scorpion 35SL	2% v/v + 7 fl. oz	1.3	17.5	17.5 ab
4. Venom	4 oz	1.5	15.0	15.0 abc
5. Endigo 2.06ZC	4.5 fl. oz	0.3	5.0	10.0 bcd
6. Endigo ZCX 2.71	4.5 fl. oz	2.3	12.5	11.7 abcd
7. Actara	5.5 oz	1.5	25.0	23.3 a
8. Voliam Xpress	9 fl. oz	0.0	2.5	5.0 de
9. Leverage 360	4 fl. oz	0.5	12.5	9.2 bcd
10. Vetica + Biosurf (3 applications only)	17 fl. oz + 0.25% v/v	0.3	22.5	1.2 e
11. Radiant + Biosurf (3 applications only)	8 fl. oz + 0.25% v/v	0.3	0.0	5.8 cde
P-Value from anova		ns	ns	0.0039

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

CONTROL OF FLEA BEETLES IN FALL TOMATOES

Location: ESAREC, Painter, VA

Variety: Solar Fire

Transplant Date: 21 Jul 2011 and 15 Sep 2011

Experimental Design: 7 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers), no guard rows

Treatment Method: All soil treatments were applied at planting. One hole was dug for each transplant with a spade. 100 ml of insecticidal solution was poured into the hole. The transplant was set in the soil and the root zone was covered with soil.
All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and 45 cores and powered by a CO_2 backpack sprayer at 40 psi delivering 34 GPA.

Treatment Dates: Soil: 21 Jul 2011 (trial 1); 15 Sep 2011 (trial 2)
Foliar: no foliar (trial 1 destroyed by hurricane); 6 Oct (trial 2)

- **Trial 1:**

Treatment	Rate / acre	Mean no. flea beetles / 10 compound leaves*	% flea beetle damaged leaves*
1. Untreated Control		11.0 ab	67.5
2. A16901 (soil-applied)	14 oz	7.0 ab	60.0
3. Durivo (soil-applied)	13 fl. oz	5.5 b	30.0
4. Venom (foliar)	1.34 oz	n/a	n/a
5. A16901 + MSO (foliar)	7 fl. oz + 0.1% v/v	n/a	n/a
6. Voliam Xpress + MSO (foliar)	9 fl. oz + 0.1% v/v	n/a	n/a
7. Admire Pro (soil-applied)	10.5 fl. oz	27.5 a	60.0
P-Value from Anova		ns	ns

* *Epitrix hirtipennis*

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

- **Trial 2:**

		Mean no. potato aphids / 5 plants	
Treatment	**Rate / acre**	**13-Oct**	**20-Oct**
1. Untreated Control		36.5 a	37.3
2. A16901 (soil-applied)	14 oz	1.5 b	0.0
3. Durivo (soil-applied)	13 fl. oz	0.8 b	2.0
4. Venom (foliar)	1.34 oz	10.5 b	45.0
5. A16901 + MSO (foliar)	7 fl. oz + 0.1% v/v	0.8 b	0.3
6. Voliam Xpress + MSO (foliar)	9 fl. oz + 0.1% v/v	0.0 b	1.0
7. Admire Pro (soil-applied)	10.5 fl. oz	0.3 b	0.8
P-Value from Anova		0.005	ns

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

2011 Survey of Wild and agricultural Host plants of The Brown Marmorated Stink Bug

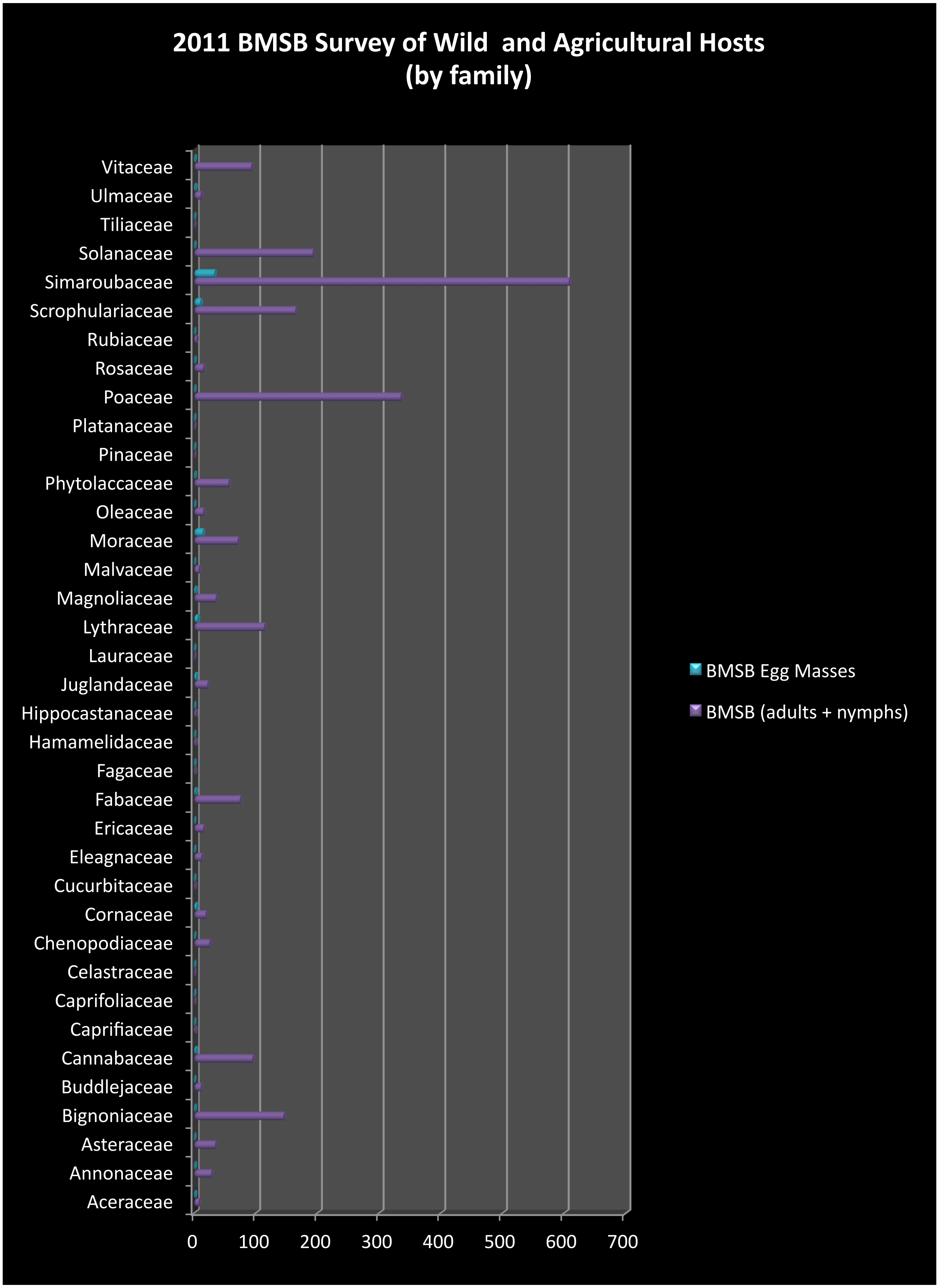
KATHY KAMMINGA – Post-Doctoral Associate

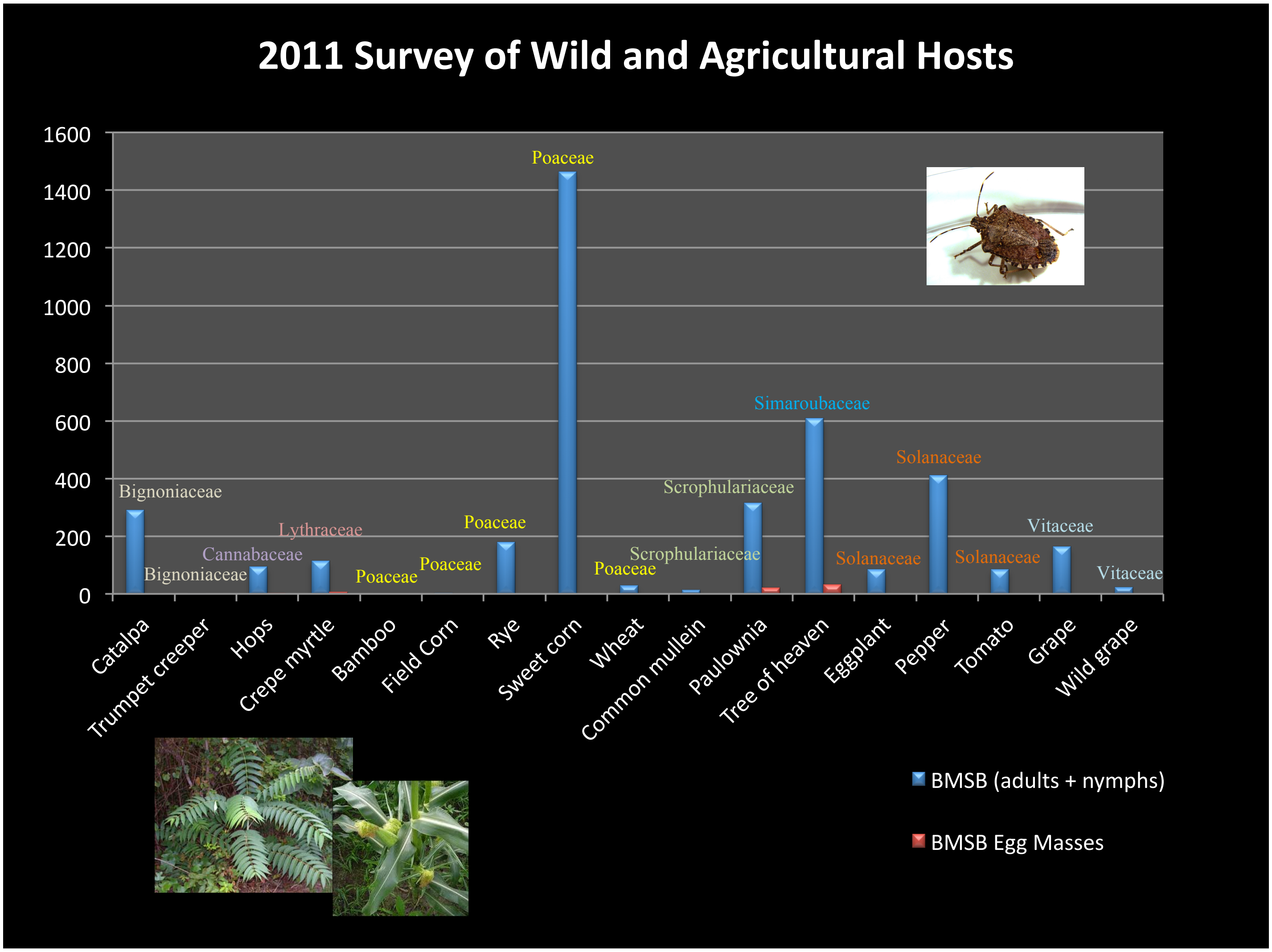
Each count represents one 3-minute survey.

Family	*Common Name*	*Latin name*	*Number of Counts*	*Adults*	*2nd-3rd*	*4ths-5ths*	*Egg Mass*
Phytolaccaceae	American pokeweed	*Phytolacca americana* L.	12	23	10	23	1
Rosaceae	Apples	*Malus domstica* Borkh.	2	0	0	0	0
Oleaceae	Ash	*Fraxinus* spp.	6	2	0	0	0
Eleagnaceae	Autumn Olive	*Elaeagnus umbellata* Thunb.	2	2	2	8	0
Poaceae	Bamboo	*Phyllostachys spp.*	2	0	0	0	0
Caprifoliaceae	Beautybush	*Kolkwitzia amabilis* Graebn.	2	0	0	0	0
Fabaceae	Black locust	*Robinia pseudoacacia* L.	40	5	0	1	4
Juglandaceae	Black Walnut	*Juglans nigra* L.	17	11	24	4	6
Rosaceae	Blackberry	*Rubus* spp.	9	3	8	13	0
Ericaceae	Blueberry	*Vaccinium* spp.	14	8	0	7	0
Aceraceae	Boxelder	*Acer negundo* L.	39	7	2	4	0
Hippocastanaceae	Buckeye	*Aesculus glabra* Willld.	2	2	0	1	0
Asteraceae	Lesser Burdock	*Arctium minus* Bernh.	1	1	0	3	0
Celastraceae	Burningbush	*Euonymus alatus* (Thunb.) Siebold	2	0	0	0	0
Buddlejaceae	Butterflybush	*Buddleja* spp	1	1	0	10	0
Rubiaceae	Button Bush	*Cephalanthus occidentalis* L.	1	2	0	2	0
Bignoniaceae	Catalpa	*Catalpa bignonioides* Walt.	28	220	30	39	2
Rosaceae	Cherry	*Prunus* spp.	36	12	12	50	1
Fagaceae	Chestnut	*Castanae* spp.	5	0	0	0	0
Fagaceae	Chestnut oak	*Quercus prinus* L.	10	2	0	0	1
Fagaceae	Chinese chestnut	*Castanea mollissima* Blume	1	0	0	0	0
Scrophulariaceae	Common mullein	*Verbascum thapsus* L.	6	13	0	0	0
Rosaceae	Common serviceberry	*Amelanchier arborea* (Michx. f.) Fernald	7	0	0	3	3

Lythraceae	Crepe myrtle	*Lagerstroemia* spp.	9	68	0	46	6
Cucurbitaceae	Cucumber	*Cucumis sativus* L.	1	0	0	0	0
Cornaceae	Dogwood	*Cornus* spp.	22	7	1	11	4
Fabaceae	Eastern redbud	*Cercis canadensis* L.	24	22	9	14	4
Solanaceae	Eggplant	*Solanum melongena* L.	2	3	48	33	0
Caprifoliaceae	Elderberry	*Sambucus* spp.	2	0	0	0	0
Ulmaceae	Elm	*Ulmus* spp.	9	2	0	0	1
Poaceae	Field Corn	*Zea mays* L.	4	0	0	4	2
Oleaceae	Forsythia	*Forsythia* spp.	7	3	1	24	0
Vitaceae	Grape	*Vitis vinifera* L.	3	1	69	94	0
Fabaceae	Green bean	*Phaseolus vulgaris* L.	17	15	26	39	0
Ulmaceae	Hackberry	*Celtis* spp.	52	9	4	7	3
Juglandaceae	Hickory	*Carya* spp.	10	4	1	0	1
Caprifiaceae	Honeysuckle	*Lonicera* spp.	2	1	1	0	0
Cannabaceae	Hops	*Humulus* spp.	3	0	43	52	3
Fabaceae	Kudzu	*Pueraria* spp.	13	0	3	1	0
Chenopodiaceae	Lambsquarter	*Chenopodium album* L.	1	0	10	15	0
Tiliaceae	Common linden	*Tilia ×europaea* L. (pro sp.) [cordata × platyphyllos]	1	0	0	0	0
Cucurbitaceae	Cantaloupe	*Cucumis melo* L.	5	1	0	0	0
Fabaceae	Mimosa	*Mimosa* spp.	57	92	109	80	8
Moraceae	Mulberry	*Morus* spp.	30	29	32	10	14
Malvaceae	Okra	*Abelmoschus esculentus* (L.) Moench	2	0	1	7	0
Scrophulariaceae	Paulownia	*Paulownia* spp.	30	53	93	170	21
Annonaceae	Pawpaw	*Asimina* spp.	37	4	17	7	1
Rosaceae	Peach	*Prunus persica* (L.) Batsch	2	0	0	0	0
Solanaceae	Pepper	*Capsicum annuum* var.	36	304	58	48	1
Rosaceae	Raspberries	*Rubus* spp.	2	0	1	1	0
Aceraceae	Red maple	*Acer rubrum* L.	17	2	1	0	3
Poaceae	Rye	*Secale cereale* L.	3	5	74	101	0
Lauraceae	Sassafrass	*Sassafras albidum* (Nutt.) Nees	10	0	0	0	0
Rosaceae	Southern crab apple	*Malus angustifolia* (Aiton) Michx.	1	1	0	1	0
Magnoliaceae	Southern Magnolia	*Magnolia grandiflora* L.	3	13	40	15	4
Fabaceae	Soybean (R7)	Glycine max (L.) Merr.	5	4	2	26	0
Pinaceae	Spruce	*Picea* spp.	5	0	0	0	0
Asteraceae	Sunflower	*Helianthus annus* L.	2	37	10	18	0
Poaceae	Sweet corn	*Zea mays* L.	34	332	157	975	0
Hamamelidaceae	Sweetgum	*Liquidambar styraciflua* L.	1	0	0	1	0

Platanaceae	Sycamore	*Platanus occidentalis* L.	21	0	0	0	0
Solanaceae	Tomato	*Solanum lycopersicum* L.	27	28	8	48	0
Simaroubaceae	Tree of heaven	*Ailanthus altissima* (Mill.) Swingle	109	183	192	233	33
Bignoniaceae	Trumpet creeper	*Campsis radicans* (L.) Seem. ex Bureau	1	1	0	1	0
Magnoliaceae	Tulip poplar	*Liriodendron tulipifera* L.	18	3	0	0	1
Poaceae	Wheat	*Triticum* spp.	4	28	0	0	0
Fagaceae	White Oak	*Quercus alba* L.	8	1	0	2	0
Pinaceae	White Pine	*Pinus strobus* L.	9	0	0	0	0
Vitaceae	Wild grape	*Vitis vinifera* L. ssp. *sylvestris* (C.C. Gmel.) Hegi	32	14	2	6	2
Cucurbitaceae	Winter squash	*Cucurbita maxima* Duchesne	3	0	2	0	0
Hamamelidaceae	Witch-hazel	*Hamamelis* spp.	6	1	0	4	0


2011 BMSB Survey of Wild and Agricultural Hosts
(by family)
Vitaceae
Ulmaceae
Tiliaceae
Solanaceae
Simaroubaceae
Scrophulariaceae
Rubiaceae
Rosaceae
Poaceae
Platanaceae
Pinaceae
Phytolaccaceae
Oleaceae
Moraceae
Malvaceae
Magnoliaceae
Lythraceae
Lauraceae
Juglandaceae
Hippocastanaceae
Hamamelidaceae
Fagaceae
Fabaceae
Ericaceae
Eleagnaceae
Cucurbitaceae
Cornaceae
Chenopodiaceae
Celastraceae
Caprifoliaceae
Caprifiaceae
Cannabaceae
Buddlejaceae
Bignoniaceae
Asteraceae
Annonaceae
Aceraceae
0
100
200
300
400
500
600
700
BMSB Egg Masses
BMSB (adults + nymphs)


2011 Survey of Wild and Agricultural Hosts
1600
1400
1200
1000
800
600
400
200
0
Bignoniaceae
Bignoniaceae
Cannabaceae
Lythraceae
Poaceae
Poaceae
Poaceae
Poaceae
Poaceae
Scrophulariaceae
Scrophulariaceae
Simaroubaceae
Solanaceae
Solanaceae
Solanaceae
Vitaceae
Vitaceae
Catalpa
Trumpet creeper
Hops
Crepe myrtle
Bamboo
Field Corn
Rye
Sweet corn
Wheat
Common mullein
Paulownia
Tree of heaven
Eggplant
Pepper
Tomato
Grape
Wild grape
BMSB (adults + nymphs)
BMSB Egg Masses

Can Native Warm-Season Grasses Increase Sustainability and Production of Forage, Grassland Songbirds and Beneficial Insects

Chris Phillips

This research was in collaboration with Virginia Tech colleagues: Dr. Ben Tracy (Department of Crop & Soil Environmental Sciences), and Dr. Carola Haas (Department of Fisheries & Wildlife Sciences) and was supported by a Virginia Tech CALS Integrated Internal Competitive Grants Program

Problem Statement: Our goal was to document multiple benefits of warm-season grasses and provide information to landowners as to how a planting of warm-season grasses could fit in to their overall farm plan. This is a timely topic of state and national interest, which addresses the CALS key initiative of *Agricultural Productivity and Environmental Sustainability*.

Goals and Objectives: Our overall goal was to build upon a large-scale field experiment with native, warm-season grasses (NWSG) established at Kentland Research Farm to evaluate relationships among plant species composition, diversity, and provision of important ecosystem services including production of biomass (for forage and fuel), grassland birds, and beneficial insects.

Methods:

Botanical composition and biomass were evaluated using six randomly placed quadrats within each treatment plot at Kentland Farm. Plant composition was assessed by estimating the cover of each species within a 0.5-m^2 quadrat. Plant productivity was measured by harvesting plants from one-half of each quadrat, hand-sorting plants to sown species or weeds, then drying and weighing the biomass.

Arthropod populations were sampled monthly from April - September 2011. Arthropods were collected using a standard sweep net (38 cm diameter). In each plot, transects of 25 pendular sweeps were taken. All arthropods were transferred to zip-lock bags, returned to the lab and frozen. Arthropods were later sorted into groups, those known to be important as food for grassland birds (Orthoptera, Lepidoptera, Coleoptera, and Arachnida), and other, counted and placed in a drying oven at 50C for 48hrs. After 48 hours, insect biomass was recorded for each group. Insect biomass was estimated by weighing all arthropods collected in the 50 sweeps per plot.

To assess avian use, a single 100 M line transect was established in each field. Transects were sampled at the same time as insect sampling. Bird species, abundance, distance and direction from the transect line of all birds detected was recorded. Each study site was sampled once per month from May-September.

Results:

<u>Objective 1</u>: Relate insect diversity and biomass to plant biomass in pastures planted to NWSG and CSG.

Because of the labor intensive and time-consuming nature of insect identification, we were only able to collect insect abundance and biomass data. Because the focus of this objective was on important prey items for grassland birds, only those groups known to be important food sources were included in the analysis. Data did not fit a normal distribution; therefore, a t-test was used. Using the values for a two-tailed test, no significant differences were detected in the abundance ($p = 0.20$) or biomass ($p = 0.05$) of these insects groups (Fig. 1) when data were lumped across months. This pattern was also observed when data were compared by month with few exceptions (Figs. 2 & 3).

While the data are not significantly different, trends in insect abundance were observed (Fig 4). The CSG seems to support more lepidopterans and coleopterans in the spring, and there is a slight increase in orthopteran abundance in the WSG in the summer. This numerical trend suggests that different groups of insects use different grass types throughout the year. More research is needed to fully understand these trends.

Because of the focus on insects that birds use for food, a correlation analysis was also performed to look for a relationship between insect abundance and biomass and the number of birds and bird species present. No significant relationships were detected. The diel sampling period used for these studies and the relatively small plot size for bird habitat and feeding range may have impacted these results.

Inference about Beneficial Insects

The insects excluded from the previous analysis included many of the predatory and pollinating arthropods. These two groups were not analyzed individually but when these excluded groups were added to the analysis, significant differences were detected in overall abundance ($p = 0.007$) and biomass ($p = 0.02$) as well as abundance and biomass within several months (Fig 5 & 6). This indicates that these grasses may be harboring larger predator and pollinator populations and communities, and the individuals in these communities are larger.

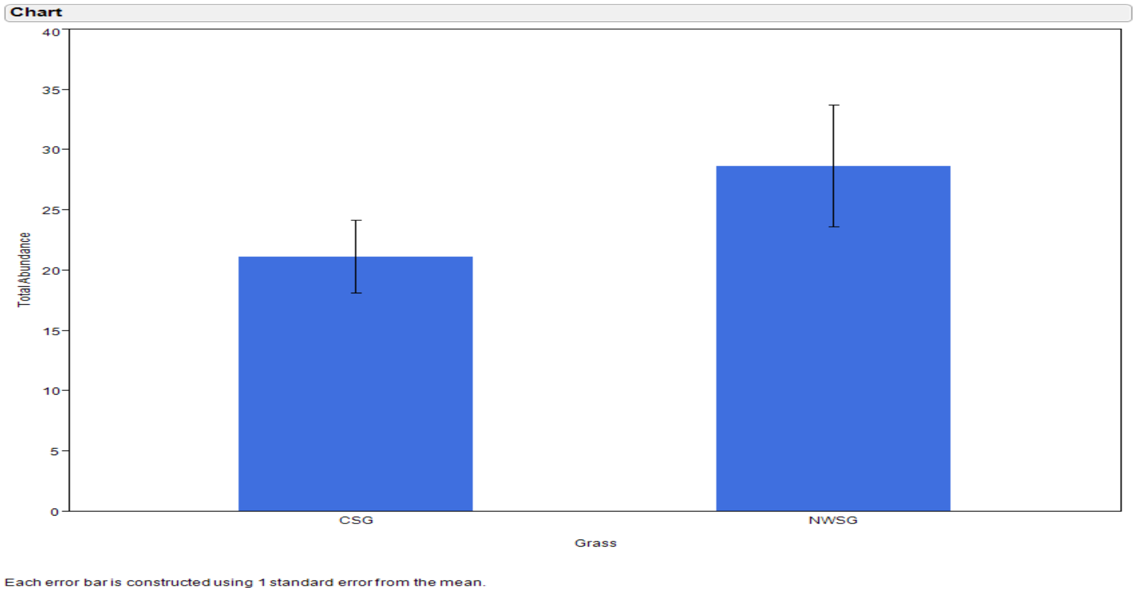
<u>Objective 4:</u> Conduct field sampling of birds and insects in spring 2011 to refine techniques and generate preliminary data.

We trained a field crew in mist-netting and transect sampling techniques. We collected preliminary data on bird populations and insects once per month at replicates at Kentland and on the private land in Craig County.

Bird abundance and species richness

Eastern meadowlarks were the most abundant birds observed on transects, followed by grasshopper sparrows, red-winged blackbirds, and eastern kingbirds. Eastern meadowlarks, grasshopper sparrows, and eastern kingbirds are declining at rates greater between 2 and 5% per year in both the Eastern region overall and in Virginia (trend data from Breeding Bird Survey routes 1966-2009, available online at http://www.mbr-pwrc.usgs.gov/bbs/bbs.html), and they are birds of conservation concern in several eastern states. Data were analyzed using a t-test. Using a two-tailed test no significant differences were detected in bird species richness ($n=16$, $p = 0.77$) or bird abundance ($n=16$, $p = 0.07$) (Fig. 8). This pattern was also observed when data were compared by month (Fig 9). Again, the lack of significant differences may be an artifact of small plot size and low numbers of birds detected.

FIGURES AND TABLES



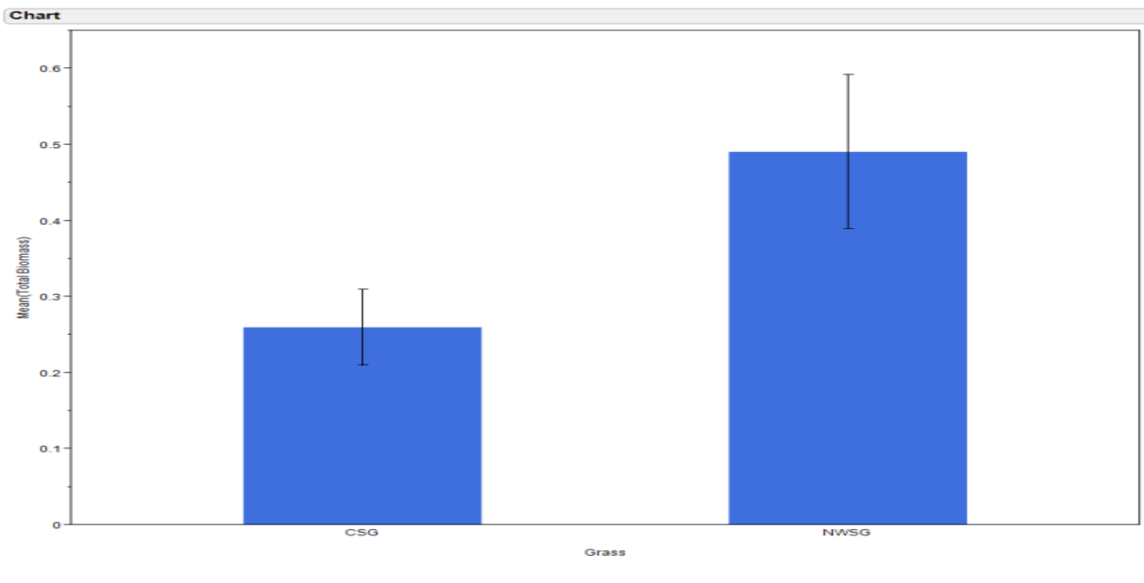


Fig. 1. Overall insect abundance (plot on left) and biomass (plot on right) of insect groups that are known to be important food sources for grassland birds. No significant differences were detected between abundance or biomass in cool-season versus warm-season grass plots.

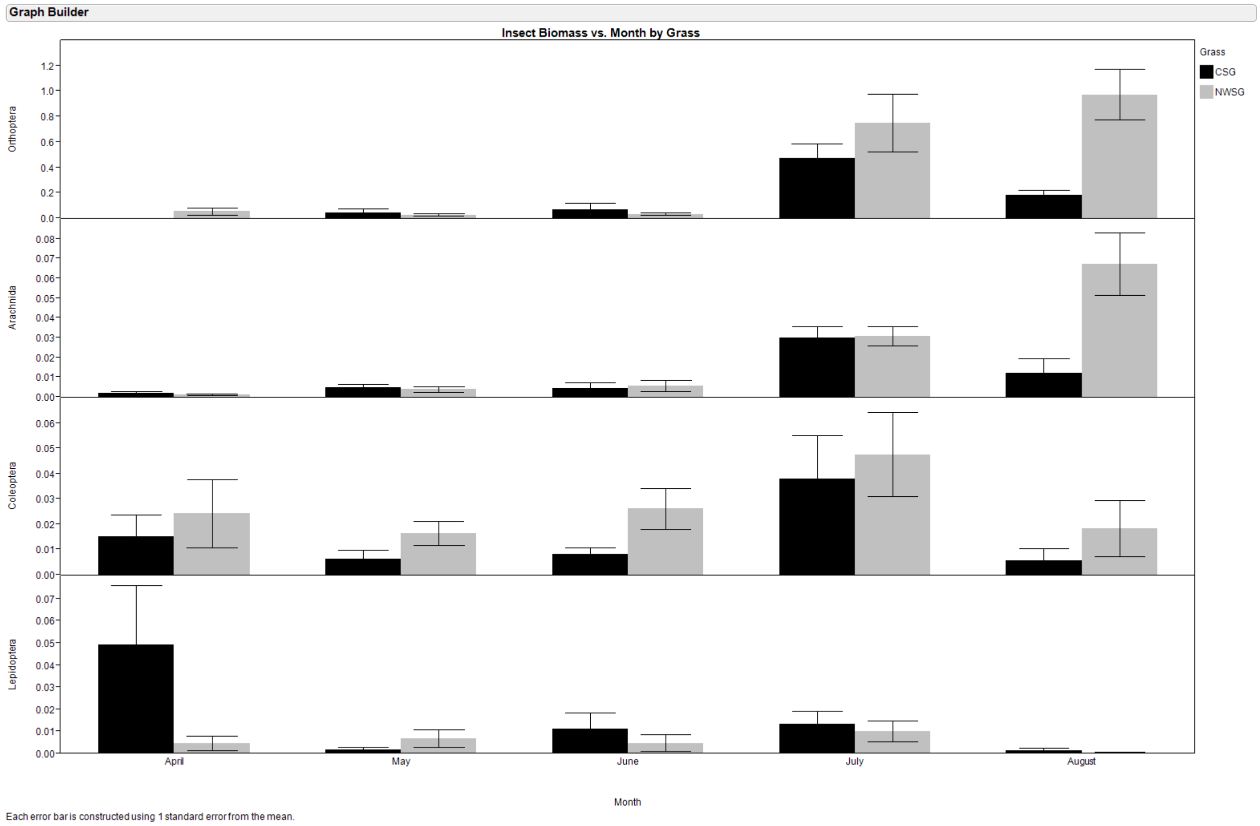


Fig. 2. Insect biomass of insect groups that are known to be important food sources for grassland birds by group and month.

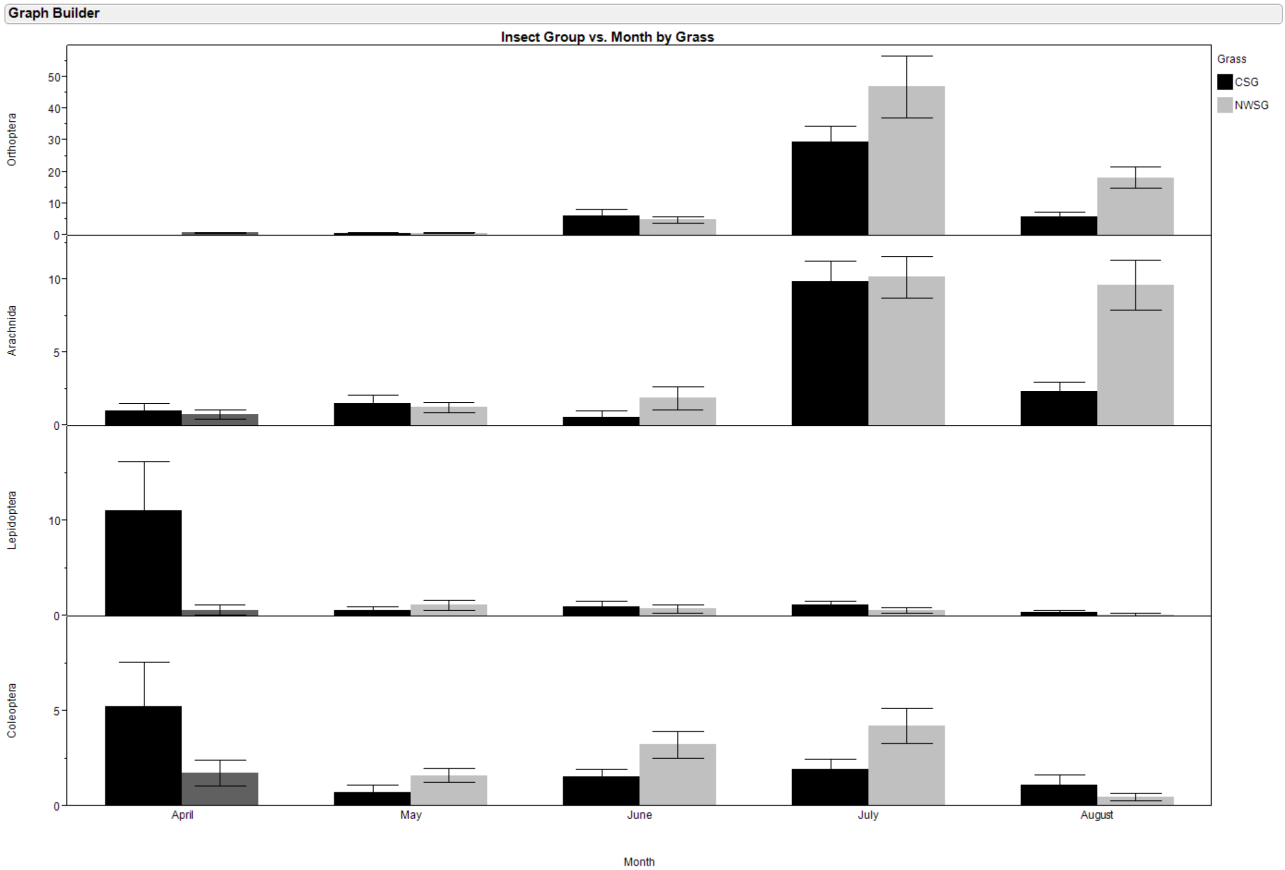


Fig. 3. Insect abundance of insect groups that are known to be important food sources for grassland birds by group and month.

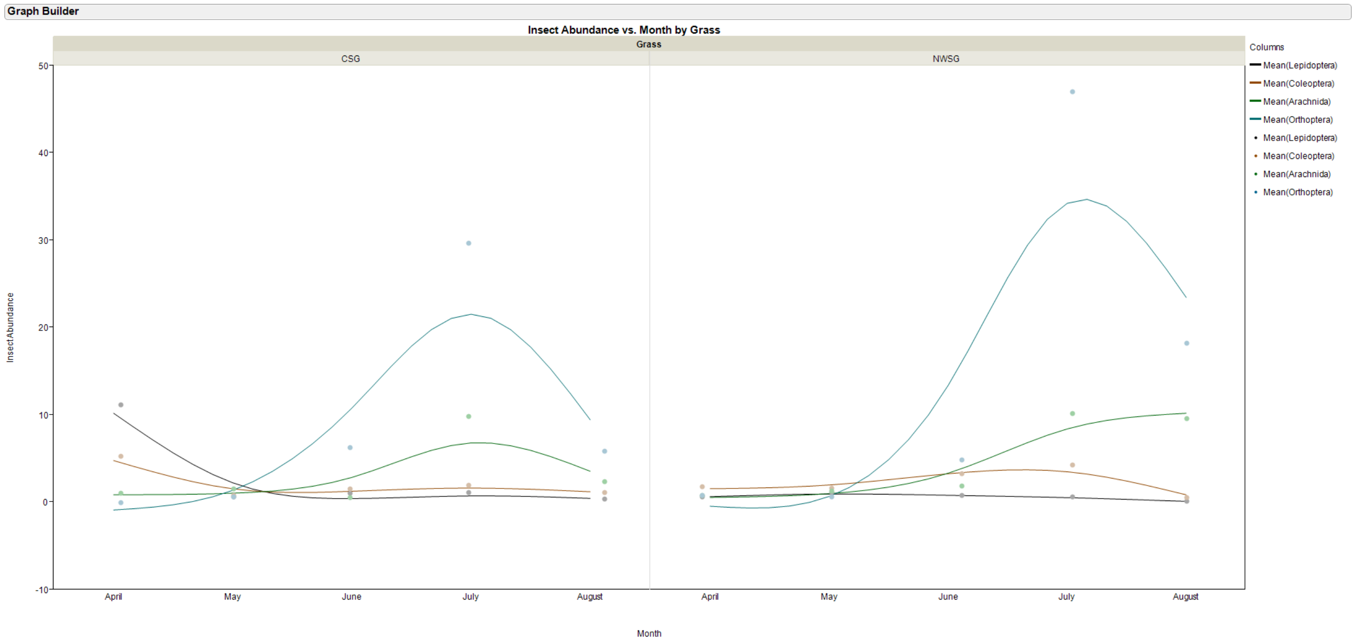


Fig. 4. Trends in insect abundance of insect groups that are known to be important food sources for grassland birds by group and month. .

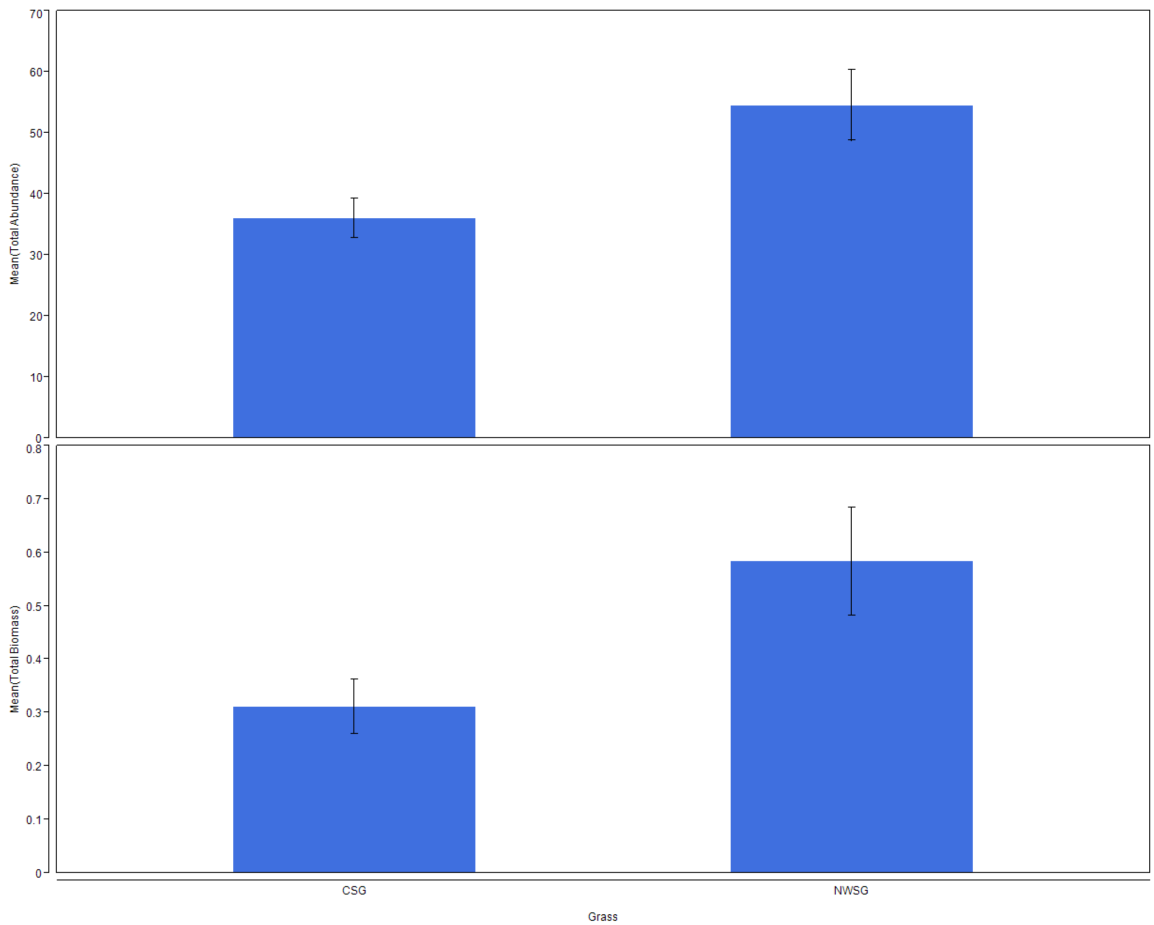


Fig 5. Arthropods abundance and biomass of all groups collected. Significant differences were detected in overall abundance (p =0.007) and biomass (p = 0.02).

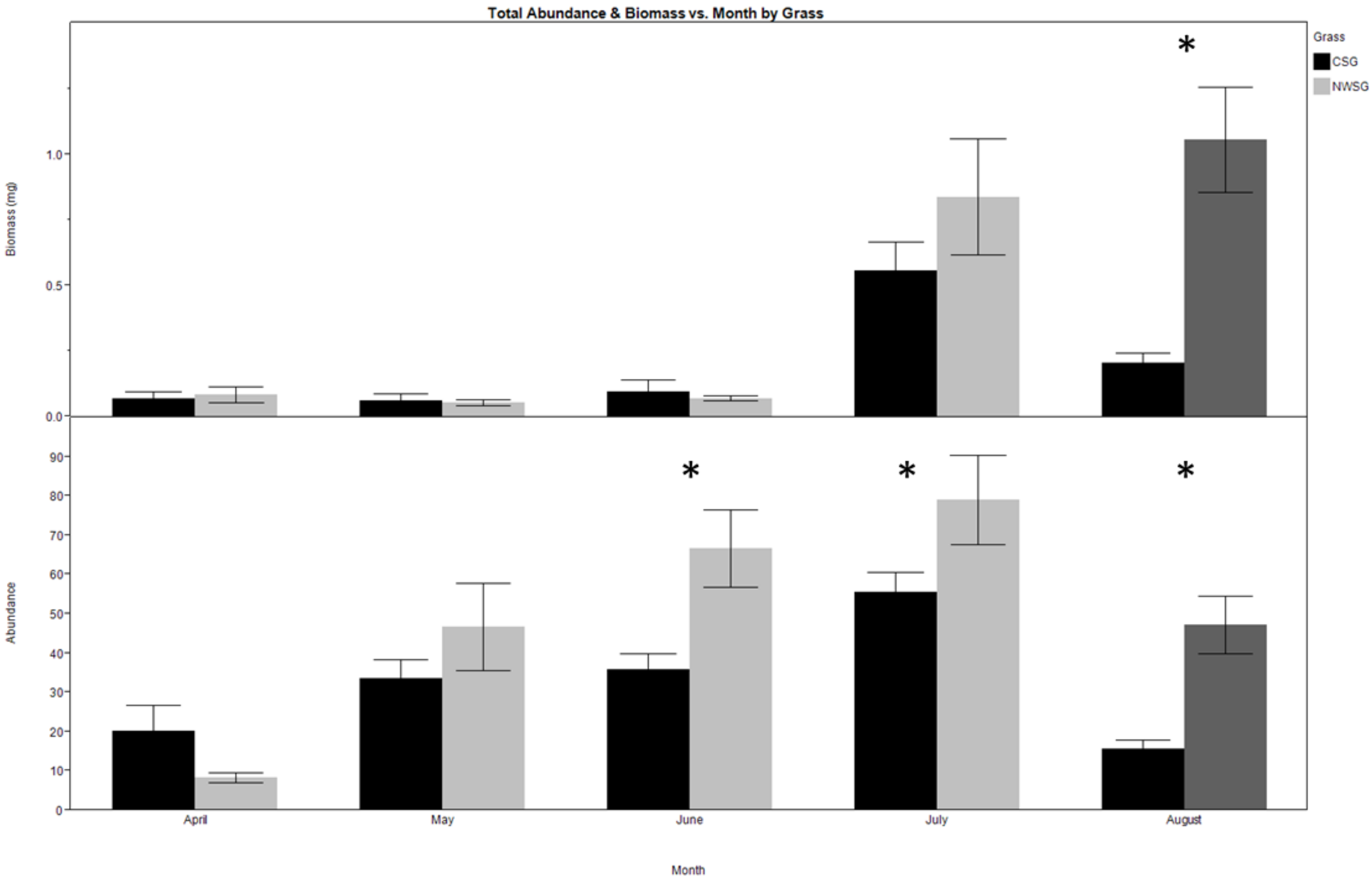


Fig 6. Arthropods abundance and biomass of all groups collected by month.

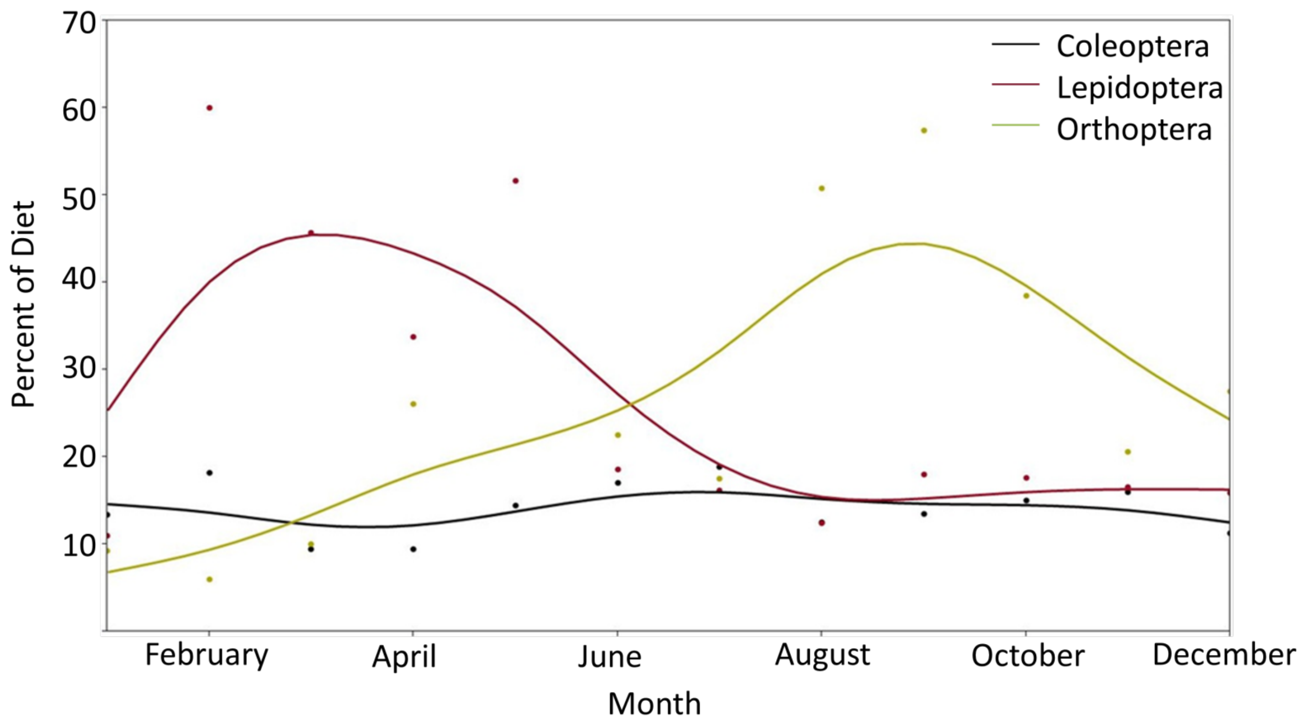


Fig 7. Monthly consumption of insect orders by Eastern Meadowlarks collected in Eastern U.S. between the late 1880s and 1930s (DC, MD, NC, NJ, NY, OH, PA, TN, VA).

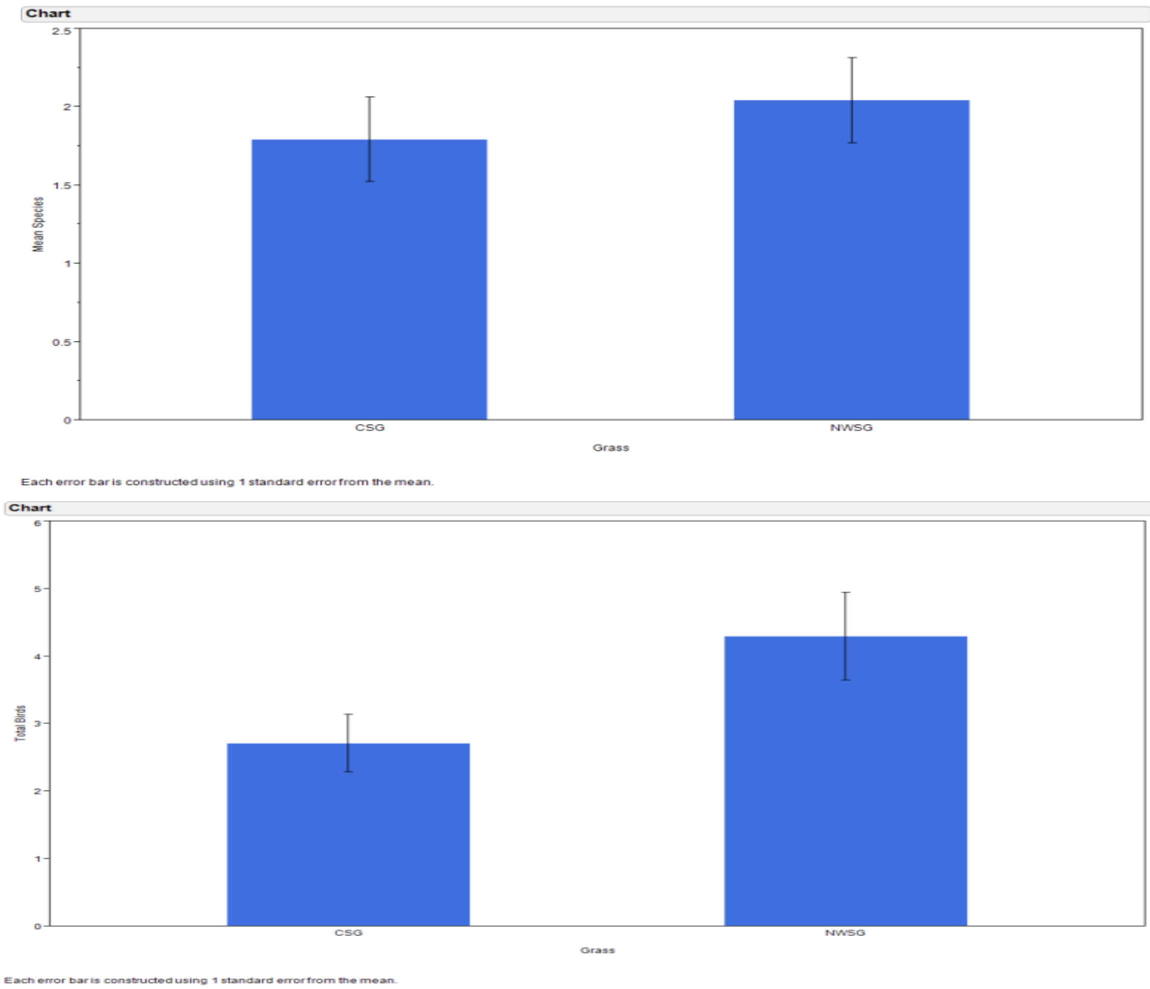


Fig. 8. Total avian species and abundance.

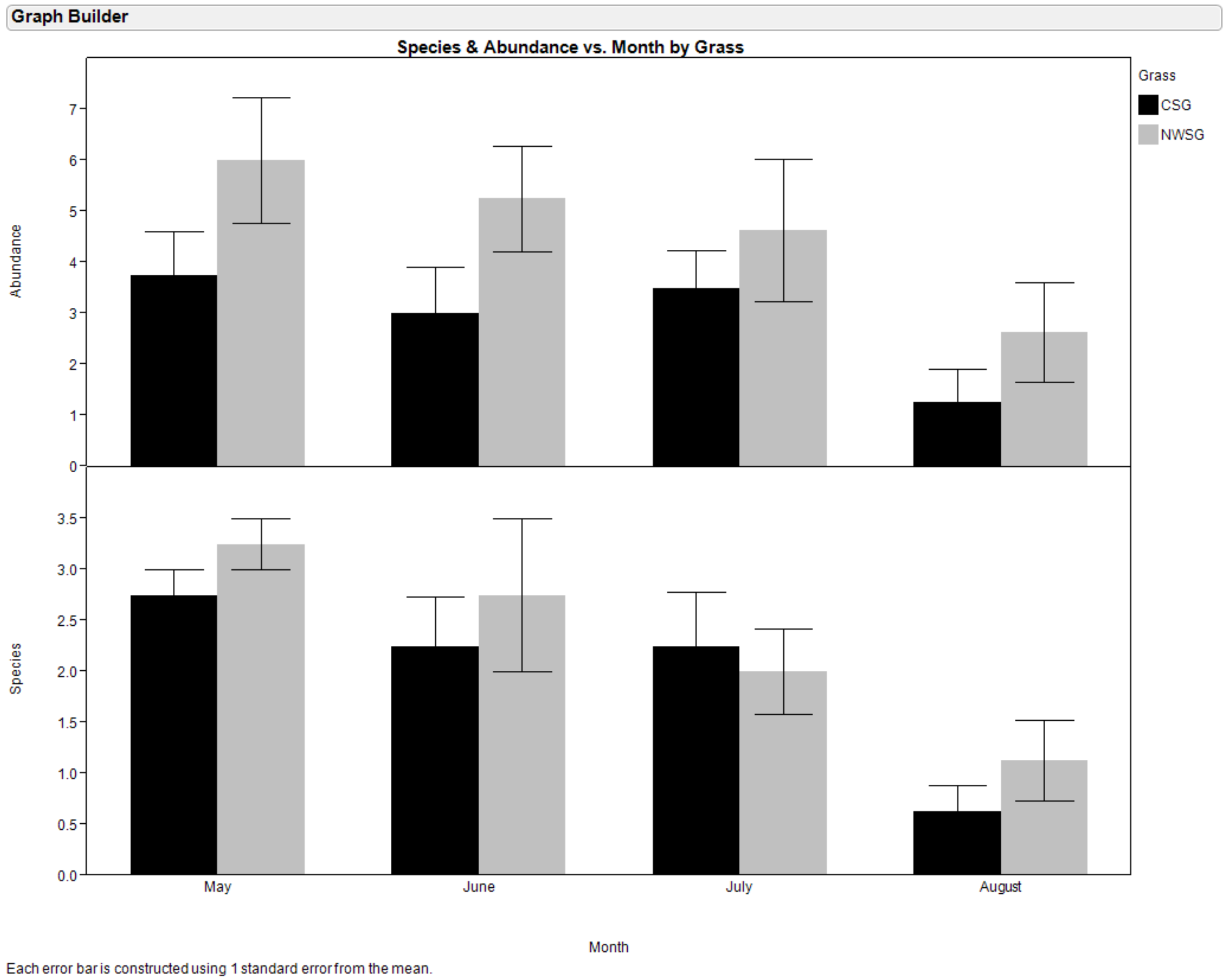


Fig. 9. Total avian species and abundance by month.

Conclusion:
This was a large project that took on numerous aspects that could only have been accomplished through collaborations. Although several unforeseen issues limited our ability to expand this project to its full potential, we were able to successfully complete our objectives and collect data that clearly indicate there are seasonal patterns in arthropod communities, that there are seasonal patterns in avian consumption of different arthropod groups, and that NWSG pastures likely support healthier beneficial insect communities. This work can be used to enhance future collaboration and encourage further integration of our research, Extension and education programs within and among units in CALS, including academic departments, ARECs, and county extension offices. Data indicating that there are clear benefits to native wildlife, especially beneficial insects, can be used to encourage Southwest Virginia cattle producers to establish native warm-season grasses on their properties.

TRAP CROPPING TO CONTROL HARLEQUIN BUGS IN COLLARDS

MATERIALS AND METHODS

Plots were established at experimental stations in Blacksburg and Virginia Beach, VA in May and September of 2011, as well as an additional plot in Painter, VA planted in September 2011. Collards (*Brassica olereacea* 'Champion') and mustard (*Brassica juncea* 'Southern Curled Giant') were seeded at 2-4 pounds per acre and grown with minimal inputs other than weed management; herbicide treatments were made according to conventional management practices (cite grower guide). Collard plots consisted of six 5 m rows with 0.3 m spacing's, each plot being a minimum of 10 m from any other. Three "treatments" were evaluated for insect injury and density. Each treatment was replicated in a randomized block design four times at each site:

(1) no trap crop: collard plot as described
(2) mustard border rows: collard plot as described with the addition of a 5 m row of mustard seeded on both sides
(3) 'dead-end' mustard border rows: collard plot as described with the addition of a 5 m row of mustard seeded on both sides to which a drench application of thiamethoxam and chlorantraniliprole (13 fl oz./A Durivo; Syngenta, Greensboro, NC) was applied at first appearance of HB in plots

Plots were scouted weekly for arrival of naturally occurring HB and, when adults were first observed, insect densities were recorded twice weekly until collard greens reached maturity (10-12 weeks). On each observation date 10 collard plants and 10 mustard plants (when applicable) were observed in each plot for adults, egg masses and nymphs. When collard greens reached a size marketable for harvest (10 weeks), 20 leaves were randomly selected from each plot and observed for HB feeding scars (distinctive white blotches).

RESULTS

Mustard greens grown as a trap crop were effective in controlling harlequin bug damage in collards. Augmentation of trap crops with insecticide was not necessary within the time frame of this experiment, but is recommended for reducing the general population of harlequin bug for those growing several successive cole crops.

More adults, egg masses and nymphs were observed in collard plots with no trap crop than those bordered by mustard on several dates at both sites (Figure 1). There was no difference in number of adults between plots bordered by treated versus untreated mustard and, only after the predetermined harvest date were there any differences in the number of egg masses and nymphs (Figure 1).

More harlequin bug adults were observed in both treated and untreated mustard border rows than in accompanying collard plots ($\alpha = 0.05$; Figure 2). While this difference was seen immediately in untreated mustard plots, differences were not seen in treated mustard border rows or 'dead-end' mustard until 60-70 days after treatment, well after expected residual efficacy of thiamethoxam (30-40 days; unpublished data).

More damaged collard leaves were observed in plots with no trap crop than in plots with mustard border rows at Virginia Beach, VA and at Blacksburg, VA ($F = 37.56$; $dF = 2, 9$; $p < 0.0001$, $F = 6.45$; $dF = 2,9$; $p = 0.0183$, respectively), while there was no difference between plots protected by untreated versus insecticide treated "dead-end" trap crop (Figure 3).

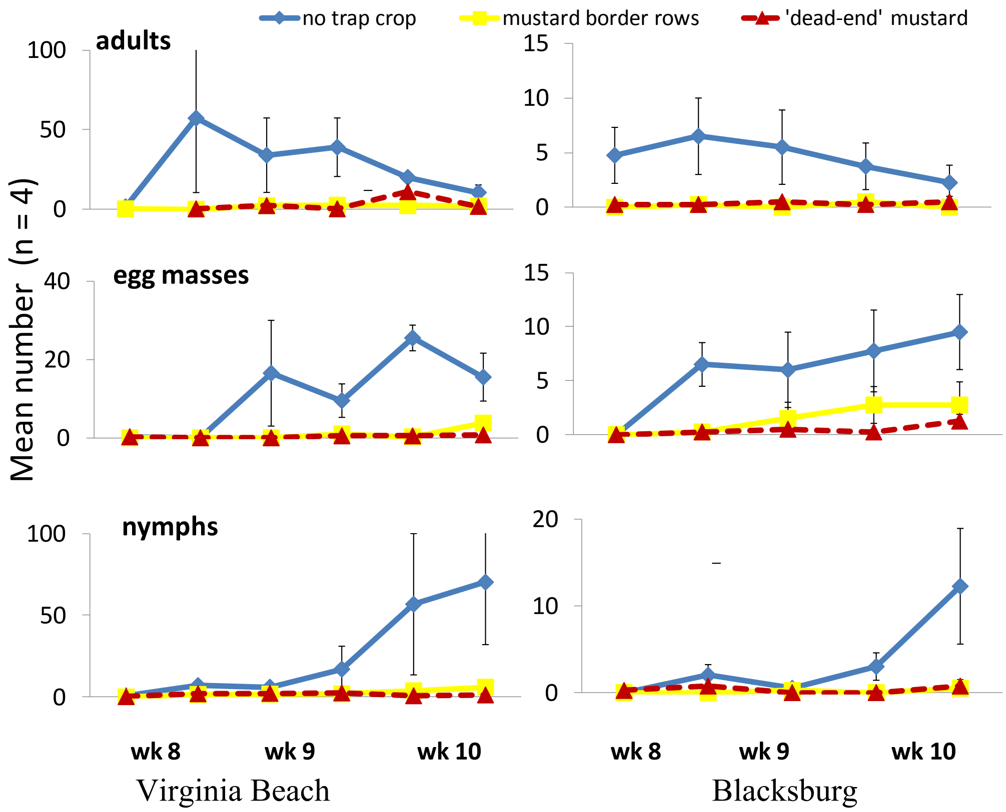
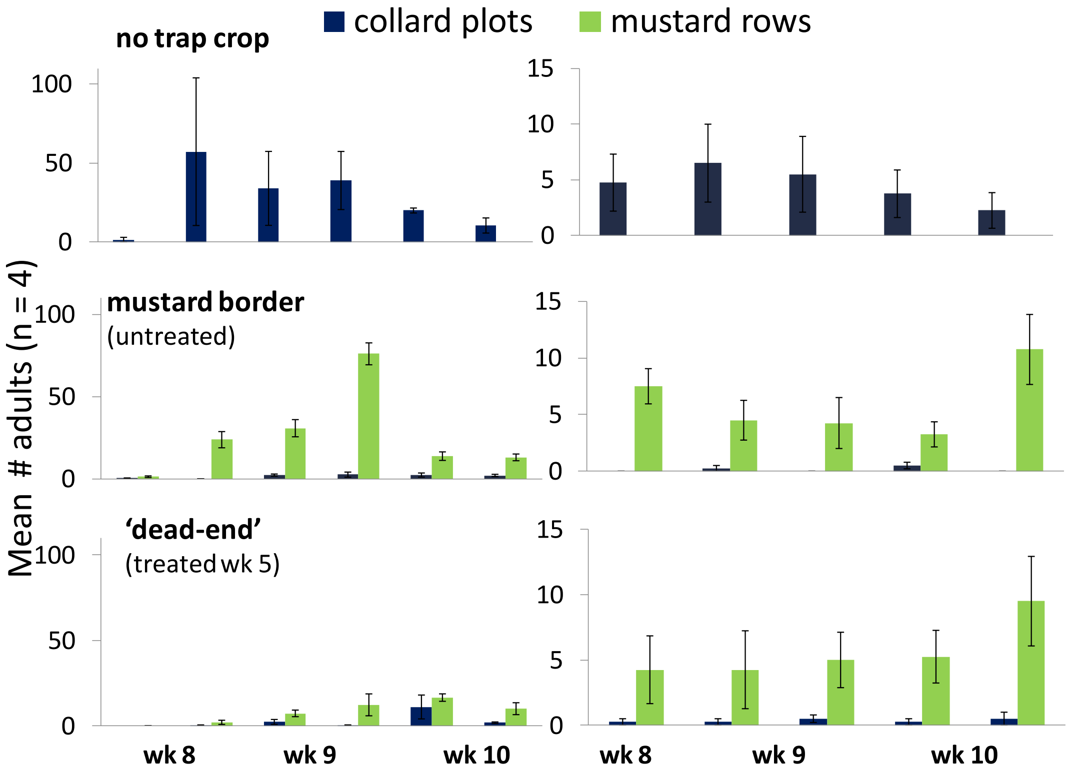


Figure 1: Insects observed in collard plots with and without trap crops. Mean (± SE) of insects observed on 10 collard plants per date after experiment start date (n = 4).



Virginia Beach Blacksburg

Figure 2: Insects observed in collard plots and mustard border rows for each 'treatment.' Mean (± SE) of insects observed on 10 collard plants or 10 mustard plants per date after experiment start date (n = 4).

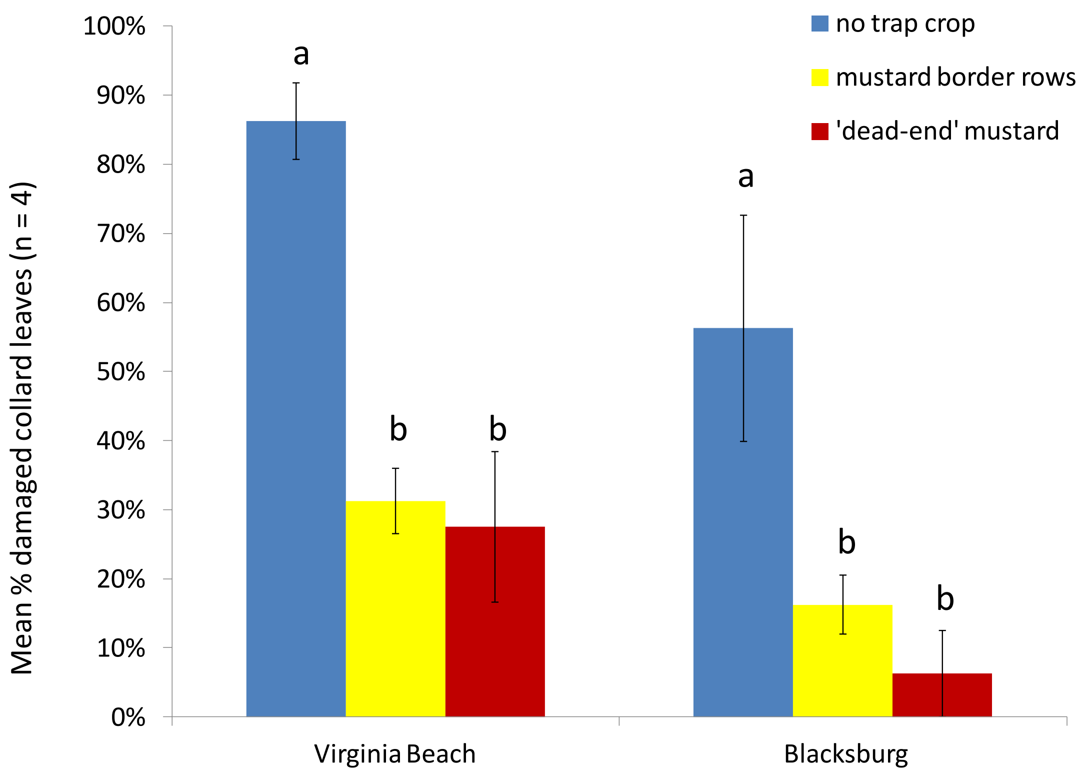


Figure 3: Damage observed in collard plots with and without trap crops. Mean (± SE) of percent out of 20 randomly selected collard leaves with harlequin bug feeding damage (n = 4).

Evaluating Novel Chemical Compounds for Control of Colorado Potato Beetle

Adam Wimer

Objectives:

1. To evaluate the toxicity and field efficacy of tolfenpyrad on CPB.
2. To assess the toxicity and field efficacy of a novel biopesticide derived from *Chromobacterium subtsugae* Martin *et al.*, on CPB.
3. To evaluate the effect of methyl salicylate release packets on the population dynamics of CPB in potato.

Objective 1: To evaluate the toxicity and field efficacy of tolfenpyrad on CPB.
Tolfenpyrad is a broad spectrum insecticide that was discovered by the Mitsubishi Chemical Corporation (now the Nihon Nohyaku Co. Ltd.) in 1996. Tolfenpyrad was registered as an insecticide in Japan in April of 2002 and until recently, there was little knowledge or development of the insecticide in the U.S. Nichino America is currently developing tolfenpyrad for use in agricultural markets in the U.S.

Tolfenpyrad has been classified in the IRAC group 21 and is a phenoxybenzylamide that inhibits respiration in some insects. Respiration is inhibited at the Complex I of the electron transport chain.
Leaf dip toxicity bioassays were conducted in spring and summer 2010 and 2011 at the Virginia Tech ESAREC in Painter, VA. Leaf dip bioassays were conducted separately on small larvae (2^{nd}-3^{rd} instars) and adult CPB. Commercially-formulated tolfenpyrad 15EC (15% ai; 150 g ai/liter) was obtained from Nichino America and mixed in distilled water for all experiments. A total of four Bioassays were conducted to determine the LC_{50} value of tolfenpyrad on CPB larvae. An initial (stock) rate of tolfenpyrad was calculated initially from a suggested field application rate of 21 fl oz/ acre. This was equivalent to a concentration of 4.57 ml product/liter (= 0.685 g AI/liter). Six rates (serial dilutions) were evaluated in these experiments including a distilled water control. Each rate was replicated four times and each replication consisted of a single dipped potato leaf and ten small larvae. Clean and unblemished potato leaves were completely submerged in each treatment and allowed to air dry for 6-12 hours. Once the leaves were dry, 10 larvae or 5 adults were placed in a Petri dish with each treated leaf; four leaves were used for each treatment. Mortality and leaf feeding was assessed after 72 hours of exposure to the leaves. Data were analyzed using Probit analysis to determine the LC_{50} value for CPB small larvae from all four bioassays conducted.
Results:

Table 1. Mean LC_{50} values for CPB larvae and adults exposed to tolfenpyrad in leaf-dip bioassays conducted in 2010 and 2011 in Painter, VA.

	LC_{50} Value (g ai/Liter)	95 % Confidence Interval (g ai/Liter)	
Life Stage Tested		Lower	Upper
Larvae	0.013	0.006	0.039
Adults	0.601	0.234	1.428

Based on leaf-dip bioassays, tolfenpyrad is highly toxic to CPB larvae with an LC_{50} level = 0.013 g ai/liter. The insecticide is also toxic to CPB adults with an LC_{50} level = 0.601 g ai/liter. Thus, tolfenpyrad is roughly 40x more toxic to larvae than adults. Nonetheless, at the proper application rate, this novel insecticide should provide control of both stages of CPB in the field.

Field efficacy trials

Experiments were also conducted in 2010 and 2011 at the ESAREC, to evaluate the effectiveness of tolfenpyrad on potatoes in the field. The trials were set up in a randomized complete block design with four replications per treatment. Individual plots consisted of two planted rows of potato 20 ft in length. Each trial contained a non-treated control and three rates of tolfenpyrad, 14, 17, and 21 fl. oz product/acre. Potatoes (var. 'Superior') were planted 25 March and 13 Aprilin 2010 and 2011, respectively. In both years spray treatments were initiated in mid-May when small larvae were detected in the plots then were repeated 7 days later (application dates = 11 and 18 May, 2010 and 20 and 27 May, 2011). At 6 days after treatment and weekly thereafter, the numbers of live small and large CPB larvae per ten randomly chosen stems were recorded. After CPB larval feeding had ceased in June, visual defoliation ratings were reported. Potato tubers were mechanically harvested July 1 in 2010 and July 14 in 2011 and yield (weight of marketable tubers) was recorded. Data were analyzed using ANOVA and means were separated using Fisher's protected LSD.
Results:

Table 2. Counts of Colorado potato beetle larvae and tuber yield following foliar insecticide applications on 11 and 18 May, 2010 to potatoes planted in Painter, VA.

		Mean no. of Colorado potato beetles / 10 stems						Yield
		May 17, 6 DAT1		May 24, 6 DAT2		June 1, 14 DAT2		
Treatment[Z]	Rate/Acre	Small larvae	Large larvae	Small larvae	Large larvae	Small larvae	Large larvae	
Untreated Check		60.0 ab	12.0	47.0 a	30.3 a	1.5 abc	9.0 bcd	45.3 cd
Tolfenpyrad	14 fl. oz	10.8 c	0.3	3.5 bc	0.0 c	4.3 abc	0.3 d	56.0 abc
Tolfenpyrad	17 fl. oz	16.3 c	0.0	0.0 c	0.0 c	0.0 c	0.0 d	56.7 abc
Tolfenpyrad	21 fl. oz	12.5 c	0.8	2.8 bc	1.5 c	0.0 c	1.3 d	58.5 ab
Tolfenpyrad + Baythroid XL	14 fl. oz + 1.6 fl. oz	5.3 c	0.8	0.0 c	1.3 c	0.8 c	0.3 d	62.5 a
Baythroid XL	1.6 fl. oz	30.8 bc	4.3	6.0 bc	9.3 bc	2.8 abc	6.8 bcd	48.1 bc
P-Value from ANOVA		0.00001	ns	0.0058	0.0000	ns	0.0004	0.0062

[Z] Note that non-ionic surfactant was added to all foliar treatments at a rate of 0.25% v/v.

Table 3. Counts of Colorado potato beetle larvae and tuber yield following foliar insecticide applications on 20 and 27 May, 2011 to potatoes planted in Painter, VA.

		Mean no. Colorado potato beetles / 10 stems						Yield (lbs)
		26-May, 6 DAT 1		2-Jun, 6 DAT 2		10-Jun, 14 DAT 2		
Treatment	Rate / acre	Small larvae	Large larvae	Small larvae	Large larvae	Small larvae	Large larvae	
Untreated Check		27.00 a	44.00 a	14.00 a	17.00 a	1.00	1.00	26.48
Tolfenpyrad	14 fl. oz	2.00 b	3.00 b	0.00 b	0.00 b	0.00	2.00	40.75
Tolfenpyrad	17 fl. oz	0.00 b	13.00 ab	0.00 b	0.00 b	0.00	6.00	36.73
Tolfenpyrad	21 fl. oz	0.00 b	0.00 b	0.00 b	2.00 b	0.00	0.00	23.29
P-Value from ANOVA		0.022	0.041	0.002	0.014	ns	ns	ns

There was a significant treatment effect on numbers of CPB larvae in 2010 and 2011 (Table 5). In both experiments, all treatments of tolfenpyrad provided effective control of CPB. From the results of the bioassays and the field trials, tolfenpyrad provides effective control of CPB and should be recommended as a foliar treatment for control of CPB in potato production. Tolfenpyrad will provide growers with an effective control treatment as well as a resistance management tool for CPB.

Objective 2: To assess the toxicity and field efficacy of a novel biopesticide derived from *Chromobacterium subtsugae* Martin *et al*., on CPB.

Bioassays were conducted to determine the activity of the Marrone BioInnovations product (MBI 203), a novel biopesticide derived from *Chromobacterium subtsugae* on CPB. Leaf dip bioassays were conducted at the ESAREC in summer 2010, as well as field trials in 2010 and 2011.

Experiment 1.

A dilution of 1/10 and 1/20 stock solution of MBI 203 along with a non treated control of water were used in the bioassays. Four leaves were dipped (completely submerged) in each treatment and allowed to dry. Once dry, a single leaf was placed into a Petri-dish with 10 small CPB larvae. Each treatment was replicated 4 times (40 larvae per treatment). The bioassay was set up on May 17, 2010 and feeding ratings and beetle mortality was assessed at 4 days and 7 days after set up.

Results:

MBI 203 inhibited larval feeding on potato leaves and caused significant mortality in the lab after 7 days post-treatment. However, in the field, MBI 203 provided no control of CPB on potatoes when sprayed as a foliar product. One explanation, which is the case with many bacterial control agents, is sensitivity to sun light. A follow-up bioassay was conducted to account for and address photo-degradation of the product.

Table 1. Feeding scale used to evaluate the amount of leaf damage caused by feeding injury.

Feeding Scale	Amount of Feeding	Percentage of leaf consumed
1	None	0
2	Little	< 10
3	Moderate	10 < 50
4	Heavy	> 50

Table 2. Summary of leaf dip bioassay evaluating MBI 203 (*Chormobacterium subtsugae*) for control of Colorado potato beetle larvae, ESAREC, Painter, VA, 2010.

		4 days after set up (May 21, 2010)		7 Days after set up (May 24, 2010)	
Treatment	Rate/ acre	% Mortality (n=40)	Leaf Damage	% Mortality (n=40)	Leaf Damage
Untreated Check	0	0	4	37.5	4
MBI 203 1/20 dilution	128 fl oz	20.0	2	90.0	2
MBI 203 1/10 dilution	256 fl oz	22.5	2	100	2

Experiment 2.

Procedure:

Only the high rate of MBI 203 was used in this experiment (1/10 dillution). An additional treatment of MBI 203 mixed with Marrone sun blocker (MBI 501 at 4 mL/Liter) was included to determine if this material has a prolonging effect to counteract photo degradation of the MBI 203 material. Two row plots of potato were sprayed with the each treatment and four leaves from the treated plot were collected at different time intervals including: 0, 4, 9, 24 and 48 hours after spraying. Once the leaves were collected, the leaf area was measured using a LiCor leaf area meter and leaves were placed in a Petri dish with 5 small CPB larvae. The leaves were then reassessed for the amount of leaf area consumed after 48 hours.

Results:

Table 3. Summary of a field and laboratory bioassay evaluating the efficacy of MBI 203 (*Chormobacterium subtsugae)* with and without a sunblocker material MBI 501 applied to potatoes for control of Colorado potato beetle larvae, ESAREC, Painter, VA, 2010.

	Mean amount of leaf tissue consumed in 48hrs by 5 CPB Larvae	
Treatment	Leaf Area Eaten (cm^2)	Percentage of leaf area

(Hrs of sunlight exposure)		consumed
Untreated Check	23.16	77 a
0-hrs without MBI 501	13.95	58 ab
0-hrs with MBI 501	11.71	51 b
4-hrs without MBI 501	14.48	60 ab
4-hrs with MBI 501	10.97	43 bc
9-hrs without MBI 501	12.84	44 b
9-hrs with MBI 501	5.62	20 c
24-hrs without MBI 501	11.27	41 bc
24-hrs with MBI 501	10.62	44 b
48-hrs without MBI 501	16.96	57 ab
48-hrs with MBI 501	16.79	50 b
P-Value from ANOVA		**0.0103**

There was a significant treatment effect of MBI 203 on potato leaf consumption by CPB larvae. After 0, 9, 24, and 48 hrs of sunlight exposure, MBI 203 + MBI 501 had significantly less leaf area consumed than the untreated control. MBI 203 alone was slightly less efficacious than in combination with MBI 501 indicting a potential enhancement by that chemical to the product. However the results at this stage are still variable and this experiment would need to be repeated to validate the results as well as clarify the variation in the results observed.

Procedure:

Field trials were also conducted in the spring and summer months of 2010 and 2011 at Va Tech's ESAREC in Painter VA, to evaluate the effectiveness of MBI 203 in field settings. The trials were set up in a randomized complete block design with four replications per treatment. Plots consisted of two planted rows of potato 20 ft in length (2010) and 15 ft in length (2011). Each trial contained a non-treated control and two rates of MBI 203, 128 and 256 fl oz/acre. In 2010 the trial was planted March 25, and March 30 in 2011. In both years the spray program started when small larvae were present within plots and consisted of two separate sprays 7 days apart. In 2010, the first spray was conducted on May 11 and the second on May 18. In 2011, the first spray took place on May 20 and the second on May 27. Data was collected from each plot as the number of small and large larvae per ten randomly chosen stems. Defoliation ratings were also reported for each trial. Yield was taken and evaluated at the end of the growing season. Plots were harvested on July 1 in 2010 and July 13 in 2011.

Results:

Table 4. Summary of foliar insecticides for the control of CPB and PLH in potatoes, ESAREC, Painter, VA, 2010 (Colorado potato beetle counts). All materials were sprayed on 11 and 18 May.

		Mean no. of Colorado potato beetles / 10 stems						PLH	% Def	Yield
		May 17, 6 DAT1		May 24, 6 DAT2		June 1, 14 DAT2				
Treatment[z]	**Rate / Acre**	**Small[z] larvae**	**Large larvae**	**Small larvae**	**Large larvae**	**Small larvae**	**Large larvae**			
Untreated Check		60.0 ab	12.0	47.0 a	30.3 a	1.5 abc	9.0 bcd	15.0 a	48.8 bc	45.3 cd
Leverage 2.7SE	3.8 fl. oz	8.5 c	0.3	0.0 c	0.0 c	6.5 a	4.5 cd	0.3 e	3.3 de	58.8 ab
MBI 203	128 fl oz	55.0 ab	4.8	42.3 a	33.0 a	3.8 abc	18.0 ab	10.0 abcd	60.0 ab	47.9 bcd

MBI 203	256 fl oz	72.5 a	10.5	26.0 abc	18.8 ab	1.8 abc	13.8 bc	6.3 bcde	37.5 c	53.1 abc
P-Value from Anova		0.00001	ns	0.0058	0.0000	ns	0.0004	0.0014	0.00001	0.0062

Table 5. Summary of foliar insecticides for the control of CPB and PLH in potatoes, ESAREC, Painter, VA, 2011. All materials were sprayed on 18 and 25 May.

		Mean number of CPB and PLH per 10 stems							% Def	Yield
		May 24, 6 DAT 1		May 31, 6 DAT 2		June 8, 14 DAT 2				
Treatment	**Rate / acre**	**Sm.[z] Larv**	**Lg. Larv**	**Sm. Larv**	**Lg. Larv**	**Sm. Larv**	**Lg. Larv**	**PLH**		
Untreated Check		22.00 ab	78.00	6.00	28.00 b	NA	2.00	8.17a	76.67 a	10.63 d
MBI 203	4qts	28.67 ab	48.00	10.00	51.33 a	NA	5.33	7.17ab	68.33 a	13.35 cd
MBI 203	8qts	22.67 ab	57.33	8.00	35.33 b	NA	1.33	3.50bc	66.67 a	14.02 cd
Entrust 80WP	1 oz	3.33 b	0.00	4.00	2.67 c	NA	0.67	5.33abc	25.83 bc	22.08 ab
MBI 203 + Entrust 80WP	4qts + 1 oz	5.33 b	6.67	0.00	2.67 c	NA	0.67	9.33a	32.50 bc	22.74 ab
MBI 203 ALT Entrust 80WP	4qts alt. 1 oz	16.67 b	20.67	2.67	0.00 c	NA	0.67	7.17ab	35.83 bc	20.93 ab
MBI 203 Alt. Entrust 80WP	8qts alt. 1 oz	48.00 a	69.33	0.00	0.67 c	NA	0.67	6.67abc	40.83 b	18.73 bc
Provado	2 fl oz	6.67 b	0.00	0.00	1.33 c	NA	1.33	2.67c	20.00 c	26.31 a
P-Value from Anova		0.0304	ns	ns	0.0001	NA	ns	0.0471	0.0001	0.0003

[z] Means followed by the same letter are not significantly different, according to Student's T test.

Despite some promising feeding inhibition activity from MBI 203 in the laboratory, experiments in 2010 and 2011 showed that the product did not provide any control of CPB larvae on potatoes in the field. However, the positive results observed in the laboratory bioassays indicate further work on formulation and application of MBI 203 in field settings may be useful.

Objective 3: To evaluate the effect of methyl salicylate release packets on the population dynamics of Colorado potato beetle in potato.

Life table experiments were conducted at the ESAREC in the spring and summer months of 2010 and 2011. Potatoes were planted March 25, 2010 and April 13 in 2011, and the experiments were initiated prior to CPB colonization. The experiments were arranged in a randomized complete block design with four replications. Potato plots (four rows by 25 ft) were spatially isolated by a minimum of 30 ft from each other. Treatments consisted of plots containing commercially available Predalure packets (2 per plot) and plots without Predalure packets. Each treatment was replicated four times. The data were collected as counts of the number of egg masses, small larvae, large larvae and adults. Data was collected from 10 random plants within the plots and collected every 3 to 5 days. In 2010, random plants were marked for predator assessment throughout the duration of the trials. In 2011, random plants were assessed in the plot for predator occurrence and frequency. At each sample date, predatory insects were collected and preserved for identification (2010) or recorded (2011). Data was used to develop life tables for CPB to examine the effect of methyl salycilate on CPB population dynamics. Life table development and analysis followed that of Kuhar et al. (2002).

Results:

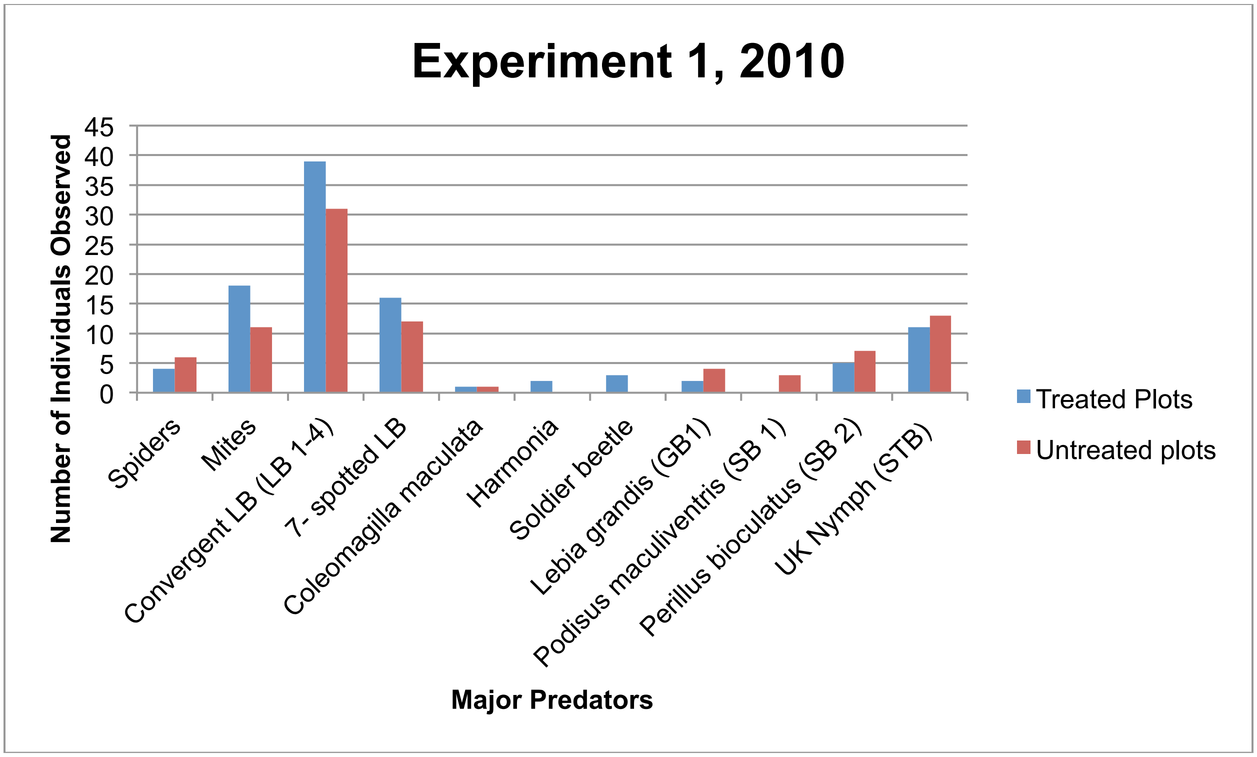
Table 1. The mean % mortality of CPB eggs and small larvae observed in life table experiments conducted on VA Tech's ESAREC in Painter VA, 2010.

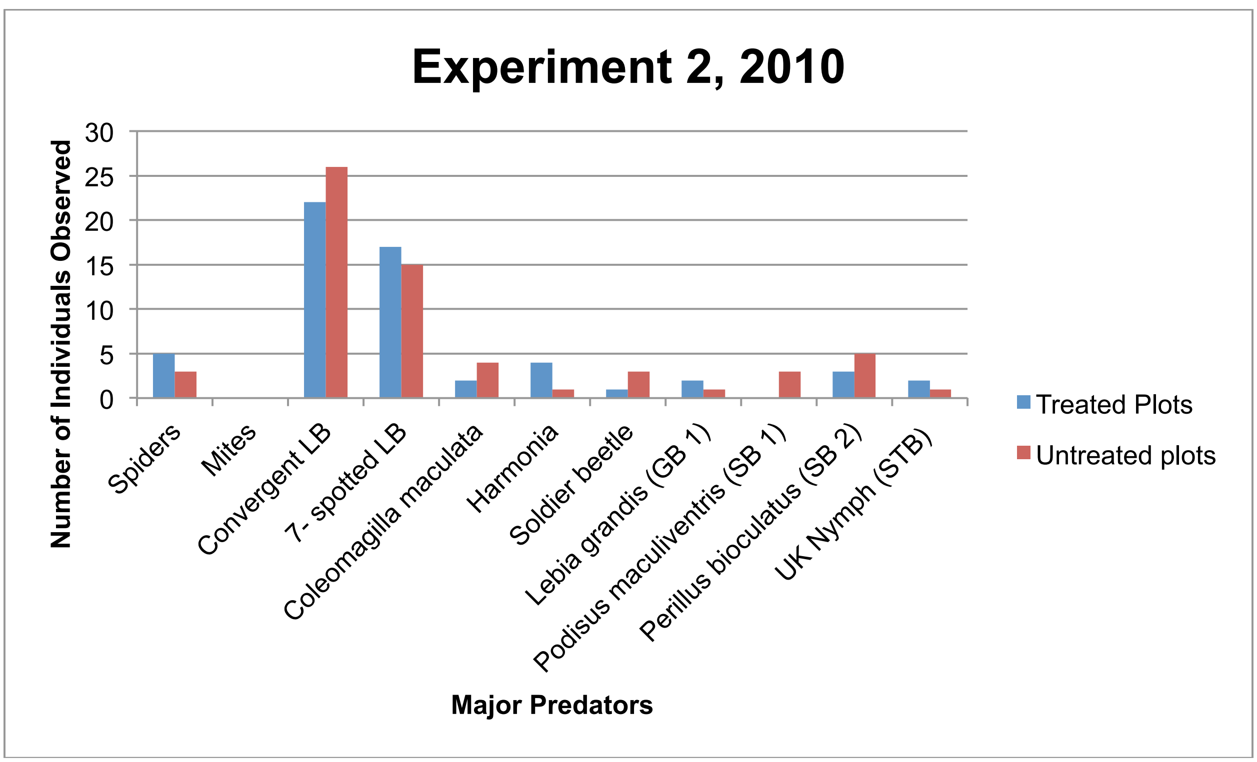
	Mean % Mortality of CPB per 10 random plants			
	Life table 1		Life table 2	
Treatment	**Eggs**	**Sm. Larvae**	**Eggs**	**Sm. Larvae**
Treated	80.2	59.1	36.8	69.1
Untreated	78.7	49.1	58.5	42.8
P-value from ANOVA	0.7203	0.5712	0.3007	0.060

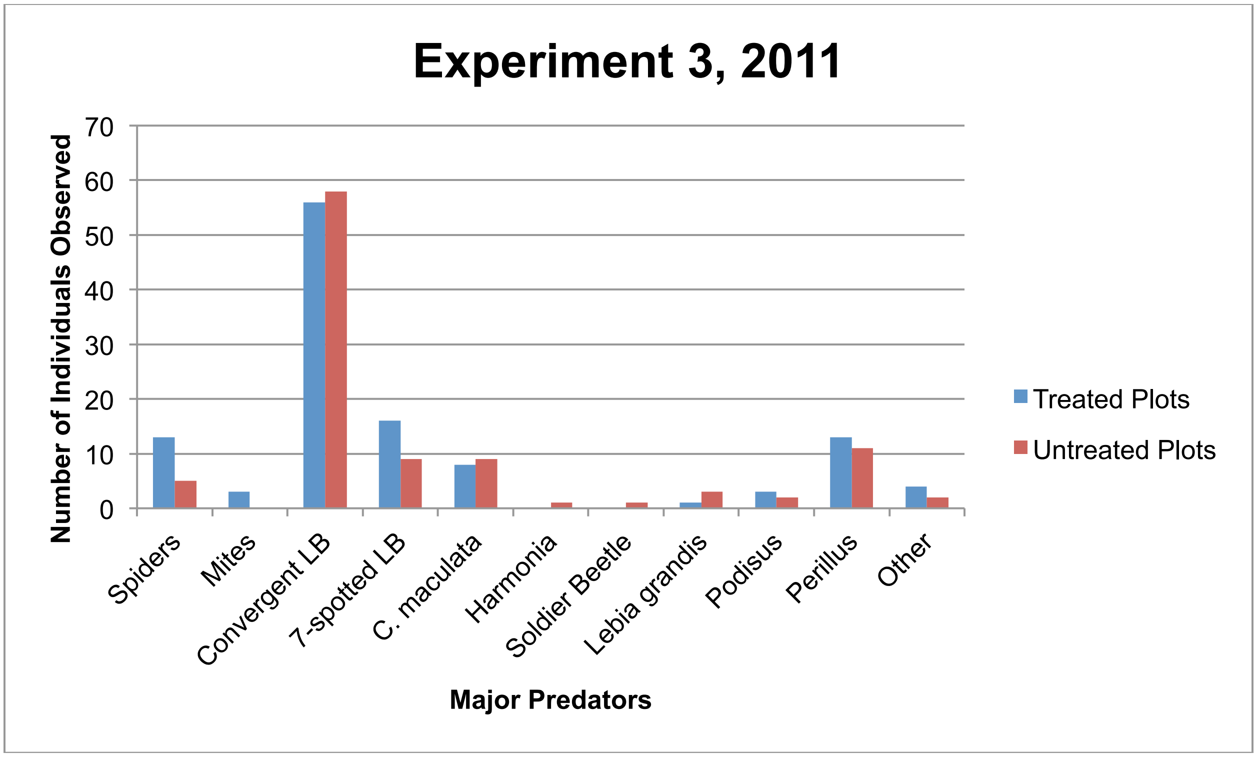
Table 2. The mean % mortality of CPB eggs and small larvae observed in life table experiments conducted on VA Tech's ESAREC in Painter VA, 2011.

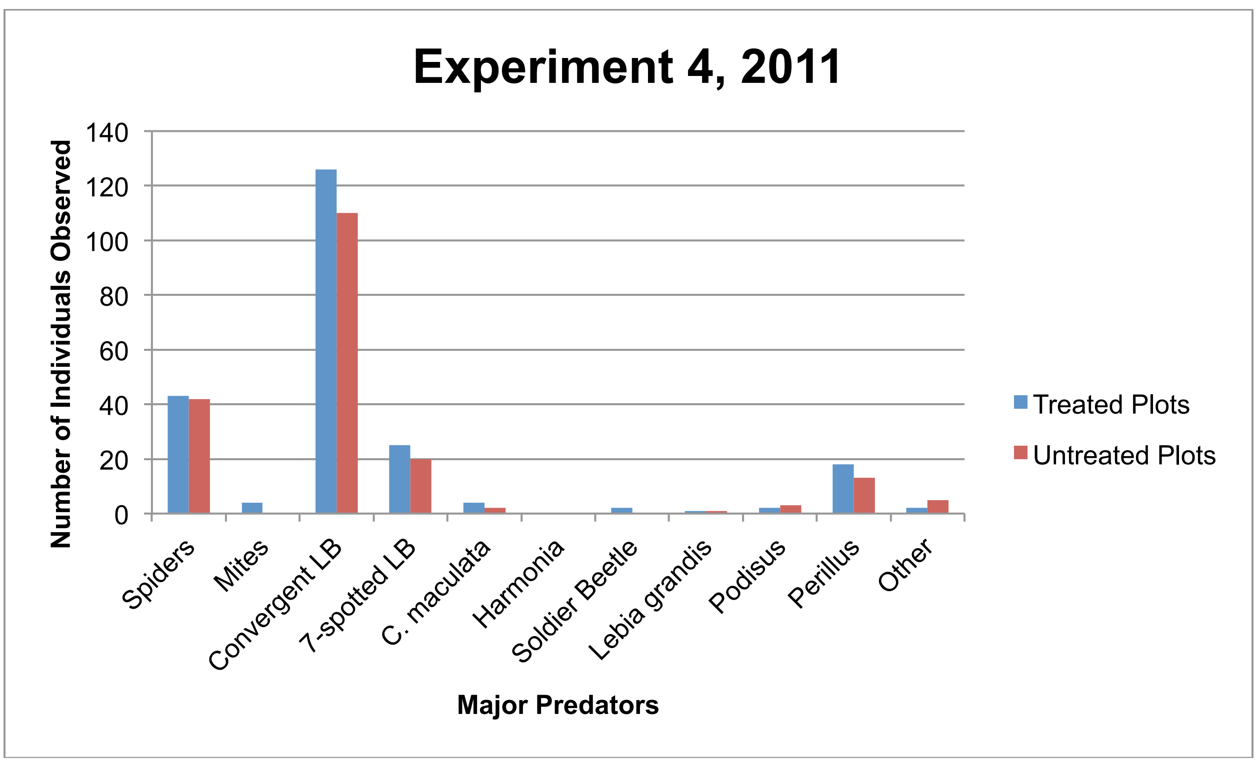
	Mean % Mortality of CPB per 10 random plants			
	Life table 1		Life table 2	
Treatment	**Eggs**	**Sm. Larvae**	**Eggs**	**Sm. Larvae**
Treated	69.2	53.6	67.6	50.1
Untreated	69.8	42.8	66.5	62.9
P-value from ANOVA	0.8612	0.4885	0.9326	0.4392

Fig. 1. Abundance of selected arthropod predators in potato plots with and without release packets of methyl salicylate in four experiments conducted in Painter, VA from 2010-11.


Experiment 1, 2010
Number of Individuals Observed
45
40
35
30
25
20
15
10
5
0
Spiders
Mites
Convergent LB (LB 1-4)
7- spotted LB
Coleomagilla maculata
Harmonia
Soldier beetle
Lebia grandis (GB1)
Podisus maculiventris (SB 1)
Perillus bioculatus (SB 2)
UK Nymph (STB)
Major Predators
Treated Plots
Untreated plots


Experiment 2, 2010
Number of Individuals Observed
30
25
20
15
10
5
0
Spiders
Mites
Convergent LB
7- spotted LB
Coleomagilla maculata
Harmonia
Soldier beetle
Lebia grandis (GB 1)
Podisus maculiventris (SB 1)
Perillus bioculatus (SB 2)
UK Nymph (STB)
Major Predators
Treated Plots
Untreated plots


Experiment 3, 2011
Number of Individuals Observed
70
60
50
40
30
20
10
0
Spiders
Mites
Convergent LB
7-spotted LB
C. maculata
Harmonia
Soldier Beetle
Lebia grandis
Podisus
Perillus
Other
Major Predators
Treated Plots
Untreated Plots


Experiment 4, 2011
Number of Individuals Observed
140
120
100
80
60
40
20
0
Spiders
Mites
Convergent LB
7-spotted LB
C. maculata
Harmonia
Soldier Beetle
Lebia grandis
Podisus
Perillus
Other
Major Predators
Treated Plots
Untreated Plots

Results from the four experiments indicted that methyl salicylate release packets (PredaLure™, AgBio) resulted in no effect on CPB egg or larval mortality, and had no significant impact on numbers of selected arthropod predators. However, the data obtained from these experiments provide us with science-based estimates of natural mortality of CPB populations in potato fields in eastern VA. An average of 36-80% of CPB eggs will be killed and an additional 42-70% of small larvae will perish from natural causes. In addition, the Convergent lady beetle was the most abundant predator found in potato fields followed by 7-spotted lady beetle, and the predatory stink bug, *Perillus bioculatus*. These data could be useful as baseline information to study the effects of environmental disruptors such as pesticides.

Volatile compounds whether synthetic or naturally derived with attractant properties to natural enemies or predatory insects could play an important role in biological control settings. However, I believe there benefit would be best utilized if they could be used as a primer to a particular setting that occurs naturally. For instance, in a situation like that observed in potato fields with CPB infestations we see high levels of natural mortality most likely attributed to predation and parasitism of CPB life stages. Incorporating an attractant into fields just prior to CPB emergence or before populations of CPB become overwhelming in a field could reduce the reliance on chemical applications for control of CPB. CPB has many natural enemies that feed on its different life stages, manipulating this natural cycle to control CPB populations during oviposition and as eggs hatch could be effective as a biological control strategy within an IPM program and minimize chemical inputs into the environment.

LABORATORY BIOASSAYS ON BROWN MARMORATED STINK BUGS

EXPERIMENT: BEAN DIP INSECTICIDE BIOASSAYS ON BROWN MARMORATED STINK BUGS

Researcher: Tom Kuhar, Entomology, Virginia Tech
Objective: To test the toxicity of various insecticides on brown marmorated stink bugs

PROCEDURES:

Insecticide solutions were mixed based on the highest labeled rate and 100 gal /acre output. Green bean (*Phaseolus vulgaris*) pods were dipped in solution for 5 sec, allowed to dry for ≈½ hr under a fume hood, then placed in a 9-cm Petri dish with filter paper and either 5 BMSB adults or nymphs (2-3 instars) per dish. There were 4 Petri dishes per treatment for a total of 20 insects tested each bout.

RESULTS:

- **Mortality of BMSB after green bean dip exposure to various pyrethroid or pyrethroid-combination insecticides evaluated at Virginia Tech in 2011**

Insecticide	Product	Product Rate / Acre	# times tested	Mean (±SE) % mortality*	
				Nymphs (2nd-4th instars)	Adults
β-Cyfluthrin	Baythroid XL	2.8 fl. oz	7	92.5 ± 7.5	88.2 ± 8.7
β-Cyfluthrin + Imidacloprid	Leverage 360	2.8 fl. oz	6	97.3 ± 1.7	74.5 ± 22.8
Bifenthrin	Bifenture 10DF	12.8 oz	9	100.0 ± 0.0	81.9 ± 2.4
Bifenthrin + Imidacloprid	Brigadier	9.8 fl. oz	6	76.7 ± 13.3	70.0 ± 30.0
Cyfluthrin	Baythroid 2E	2.8 fl. oz	5	83.3 ± 16.7	100.0 ± 0.0
Cypermethrin	Up-Cyde 2.5 EC	5 fl. oz	6	100.0 ± 0.0	40.0 ± 25.7
Etofenprox	Trebon EC	8 fl. oz	4	100.0 ± 0.0	100.0 ± 0.0
Esfenvalerate	Asana XL	9 fl. oz	6	35.0 ± 15.0	27.5 ± 10.3
Fenpropathrin	Danitol 2.4EC	16 fl. oz	5	93.3 ± 6.7	42.5 ± 37.5
λ-cyhalothrin	Lambda-cy	3.84 fl. oz	6	86.0 ±7.0	32.3 ± 20.7
λ-cyhalothrin	Warrior II	2.5 fl. oz	8	100.0 ± 0.0	72.8 ± 22.8
λ-cyhalothrin + Thiamethoxam	Endigo ZC	5.5 fl. oz	6	75.0 ± 25.0	98.7 ± 1.3
Permethrin	Permethrin 3.2EC	8 fl. oz	8	97.5 ± 1.4	98.8 ± 1.3
ζ-cypermethrin	Mustang Max	4 fl. oz	4	100.0 ± 0.0	35.0 ± 10.0

ζ-cypermethrin + Bifenthrin	Hero 1.24 EC	10.3 fl. oz	6	91.7 ± 4.4	50.0 ± 13.0

* Mortality refers to the percentage of dead + moribund individuals after 72 hr

- **Mortality of BMSB after bean dip exposure to various non-pyrethroid insecticides evaluated at Virginia Tech in 2011**

Insecticide	Product	Product Rate /Acre	# times tested	Mean (±SE) % mortality*	
				Nymphs (2nd-4th instars)	Adults
Nicotinoids					
Acetamiprid	Assail 30SG	4 oz	8	90.0 ± 10.0	32.8 ± 18.0
Clothianidin	Belay	4 fl. oz	5	75.0 ± 25.0	67.5 ± 32.5
Dinotefuran	Scorpion 3.24	7.7 fl. oz	6	76.7 ± 20.9	90.0 ± 5.0
Dinotefuran	Venom 70SG	5.5 oz	5	100.0 ± 0.0	80.0 ± 10.4
Imidacloprid	Provado 1.6F	8 fl. oz	4	25.0 ± 25.0	26.0 ± 10.0
Thiacloprid	Calypso	8 fl. oz	7	46.7 ± 20.3	54.0 ± 15.8
Thiamethoxam	Actara 50WG	5.5 oz	5	66.7 ± 33.3	81.0 ± 15.0
Other insecticide classes					
Acephate	Acephate 97UP	16 oz	6	100.0 ± 0.0	51.8 ± 16.2
Carbaryl	Sevin XLR Plus	48 fl. oz	5	80.0 ± 20.0	38.0 ± 18.0
Endosulfan	Thionex 3EC	42.6 fl. oz	5	100.0 ± 0.0	100.0 ± 0.0
Flubendiamide	Belt SC	5 fl. oz	4	40.0 ± 30.0	0.0 ± 0.0
Methomyl	Lannate LV	40 fl. oz	8	66.7 ± 25.0	75.3 ± 5.8
Oxamyl	Vydate L	48 fl. oz	6	85.0 ± 5.0	47.0 ± 17.4

* Mortality refers to the percentage of dead + moribund individuals after 72 hr

EXPERIMENT: NEUDORFF INSECTICIDES EFFICACY

Researcher: Tom Kuhar, Entomology, Virginia Tech
Objective: To test the toxicity of Neudorff insecticides on brown marmorated stink bugs

PROCEDURES:

Green bean dip bioassay:

- Insecticidal solutions were based on 100 gal / acre water output.
- Four green bean pods per treatment were dipped in solution for 5 seconds and allowed to dry for approx. ½ hour under a fume hood on 6/17/2011.
- Beans were placed in a 9-cm Petri dish with 5 BMSB nymphs (3rd instars) per dish.
- 4 Petri dishes per treatment for a total of 20 insects tested each bout.
- Mortality (dead and intoxicated) was determined 3 DAT (6/20/2011)
- Means were separated using Tukey's HSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

Greenhouse tomato whole-plant 48 hr residual efficacy bioassay on BMSB nymphs

- Four dwarf greenhouse-grown tomatoes (cv. Patio) at fruiting stage were sprayed (4 pumps) with an insecticide solution using a hand-pump at the 100/gall per acre rate on 6/29/2011.
- 48 hours after treatment, 5 BMSB nymphs were placed into 6" by 4" mesh bags.
- Bags were tied over the top tomato leaves and fruit clusters.
- Mortality (dead + moribund) was determined 3 DAT (7/1/2011).
- Numbers of stink bug feeding punctures were counted on tomato fruit.
- Data were analyzed using ANOVA. Means were separated using Tukey's HSD at the 0.05 level of significance. All proportion data were sqrt transformed to normalize when necessary.

RESULTS:

➢ **Table 1. Summary of Green bean dip bioassay of Neudorff insecticides on BMSB, Blacksburg, VA**

Treatment		Rate (ml of product per liter solution)	% mortality (dead + moribund) 72 hr
1	Untreated control		15.0 c
2	Perm-up 3.2EC	0.62 ml	100.0 a
3	Neu 1161 (0.5%)	50 ml	100.0 a
4	Neu 1161 (0.3%)	50 ml	100.0 a
5	Neu 11381	50 ml	50.0 b

➢ **Table 2. Summary of tomato whole-plant bioassays of Neudorff insecticides on BMSB, Blacksburg, VA**

Treatment		Rate (ml of product per liter solution)	% mortality (dead + moribund) 72 hr	Mean no. of stink bug feeding punctures on tomato fruit
1	Untreated control		20.0 b	3.5 a
2	Perm-up 3.2EC	0.62 ml	100.0 a	0.25 b
3	Neu 1161 (0.5%)	50 ml	95.0 a	0.5 b
4	Neu 1161 (0.3%)	50 ml	15.0 b	0.5 b
5	Neu 11381	50 ml	15.0 b	1.5 ab

EXPERIMENT: EFFECTS OF RIMON AND DIMILIN ON BROWN MARMORATED STINK BUGS

Researcher: Tom Kuhar, Entomology, Virginia Tech

Objective: To investigate the effects of two insect growth regulators, novaluron and diflubenzuron on stink bug nymphs, adults, and egg masses

GREEN BEAN DIP ASSAYS TO ASSESS MORTALITY OF BMSB NYMPHS

PROCEDURES:

Experiment 1. Insecticidal solution was based on 100 gal / acre water output. Green bean pods were dipped in solution for 5 seconds and allowed to dry for approx. ½ hour under a fume hood. After which, one bean was placed with 5 BMSB nymphs (3rd instars) per 9-cm Petri dish. A total of 4 Petri dishes were set up per treatment for a total of 20 insects. For experiment 1, beans were dipped on November 3, 2011 and % mortality (dead + moribund) was assessed on November 6, 2011.

Experiments 2 & 3. Ten 2nd – 3rd instar nymphs were placed into a quart-sized container, with four replications for each of the three treatments (12 containers total). For each treatment, green beans and carrots were dipped into each solution and allowed to dry. Food was replaced after 6 days (144 hrs). Numbers of dead and moribund nymphs as well as numbers of exuviae (cast skins) were recorded for all three treatments. Water or insecticide solution was added to the dental wick source daily. The experiment continued until all of the control insects had molted or the treated nymphs had died. This was replicated twice beginning March 28, 2011 and April 19,2011.

RESULTS:

- **EXPERIMENT 1**

Significant nymphal mortality (60-65%) occurred in the treatments with either Rimon or Dimilin (Table 1).

Table 1. Mortality of BMSB nymphs on dipped green beans; Nov. 3, 2011, Blacksburg, VA

Treatment	Product rate/acre	ml of product/ liter water	% dead and moribund 72 hr
Control			0
Rimon	50 fl. oz	3.91	65
Dimilin	16 fl. oz	1.25	60

- **EXPERIMENT 2**

Nymphal mortality was high in the untreated control in both experiments (Tables 2 & 3). Nonetheless, the Rimon and dimilin treatments resulted in >95% mortality. No molting occurred in the first experiment with either Rimon or Dimilin. In the second experiment, although a few nymphs started to molt and shed their exoskeleton, all of these nymphs died during the molting process.

Table 2. Mortality and molting of BMSB nymphs held on treated food (beans and carrots) and water, Blacksburg VA, March 28, 2011*

Treatment	Product rate/acre	ml of product/1000 ml water	Total # of insects (n)	Total # of exuviae observed	% dead and moribund
Control			39	19	48.7
Rimon	50 fl. oz	3.91	43	0	95.3
Dimilin	16 fl. oz	1.25	40	0	100.0

* Mortality was observed in 100% of the insects that attempted to molt in treated groups.

- **EXPERIMENT 3**

Table 3. Mortality and molting of BMSB nymphs held on treated food (beans and carrots) and water, Blacksburg VA, April 19, 2011

Treatment	Product rate/acre	ml of product/1000 ml water	Total # of insects (n)	Total # of exuviae observed*	# dead	% dead and moribund
Control			41	12	30	73.1
Rimon	50 fl. oz	3.91	40	3	39	97.5
Dimilin	16 fl. oz	1.25	40	2	40	100.0

*Nymphs that molted in the treated groups died soon after.

PROCEDURES:

Newly-laid egg masses (<24 h old) were collected in groups of two or three from the BMSB laboratory colony on 3 dates (April 5, 2011, April 7, 2011, and April 11, 2011). Each egg mass was randomly assigned a treatment (water, Rimon, or Dimilin) and were sprayed until runoff with either the insecticide solution or water (control). Egg masses were checked every 24 h for hatching. Number of emerging nymphs from egg masses were counted and recorded.

RESULTS:

Percentage egg hatch ranged from 69 to 80% in experiment 1 (Table 4), 60 to 90% in experiment 2 (Table 5), and 44 to 77% in experiment three (Table 6). There was no effect of treatment on egg hatch suggesting either no penetration of the insecticides across the egg chorion, or no effect on embyonic development of BMSB.

Table 4. Number of BMSB egg masses and hatched eggs per treatment, Blacksburg VA, April 5, 2011.

Treatment	Product rate/acre	ml of product/1000 ml water	# egg masses	# hatched egg masses	# eggs	# hatched eggs	% hatched eggs
Control			2	2	56	44	78.6
Rimon	50 fl. oz	3.91	2	2	56	39	69.7
Dimilin	16 fl. oz	1.25	2	2	53	42	79.3

Table 5. Number of BMSB egg masses and hatched eggs per treatment, Blacksburg VA, April 7, 2011*.

Treatment	Product rate/acre	ml of product/1000 ml water	# egg masses	# hatched egg masses	# eggs	# hatched eggs	% hatched eggs
Control			3	3	82	73	89.0
Rimon	50 fl. oz	3.91	3	2	84	51	60.7
Dimilin	16 fl. oz	1.25	3	3	84	73	86.9

*Only a single egg mass did not hatch out of all the egg masses treated (Dimilin treatment from the April 7, 2011). This could have been from desiccation or from a natural deviation from 100% egg viability.

Table 6. Number of BMSB egg masses and hatched eggs per treatment, Blacksburg VA, April 11, 2011.

Treatment	Product rate/acre	ml of product/1000 ml water	# egg masses	# hatched egg masses	# eggs	# hatched egg	% hatched eggs
Control			2	2	55	25	44.6
Rimon	50 fl. oz	3.91	2	2	56	39	69.6

Dimilin	16 fl. oz	1.25	2	2	55	42	76.4

BIOASSAYS ON ADULT MORTALITY, NATALITY AND TRANSOVARIAL EFFECTS

PROCEDURES:

Three bioassays were conducted using BMSB adults that were collected from dwellings in Bedford, VA, or sweet corn and soybeans late in the season (3^{rd} bioassay only). The first trial extended 18 days, the second trial from 5/11/2011 until 6/22/2011, and the third bioassay began on 9/5/2011 and is ongoing. For the first trial, 15 adult males and 15 adult females for each treatment were placed into a 4-liter shoebox-size plastic container. Adults were fed green beans and carrots and had a water source on cotton dental wicks. For each of the respective treatments, solutions were used as the water source and to dip food into every 3 days for the duration of the experiment. Numbers of dead adults and egg masses were recorded and removed daily from the containers and placed in labeled Petri dishes. The dishes were kept in the growth chamber at [16:8] [L:D] photoperiod. Egg masses were examined daily for egg hatch.

RESULTS:

Percentage adult mortality over the duration of the experiment ranged from 40 to 90% in the experiments with no apparent treatment effect (Table 7). There was also no detectable treatment effect on numbers of eggs deposited or percentage of those eggs hatching (Table 8) suggesting no effects of the chemicals on BMSB egg production and viability.

Table 7. Adult BMSB mortality after prolonged exposure to treated food and water, Blacksburg VA, April 11, 2011.

Treatment	Product rate/acre	ml of product/ liter water	Experiment 1 April 11 (18 days)	Experiment 2 May 11 (42 days)	Experiment 3 Sept 5 (60 days)
Control			57.5	NA	60.0
Rimon	50 fl. oz	3.91	92.5	NA	50.0
Dimilin	16 fl. oz	1.25	52.5	NA	40.0

Table 8. Natality and transovarial effects of Rimon and Dimilin on BMSB after prolonged exposure to treated food and water, Blacksburg VA, April 11, 2011.

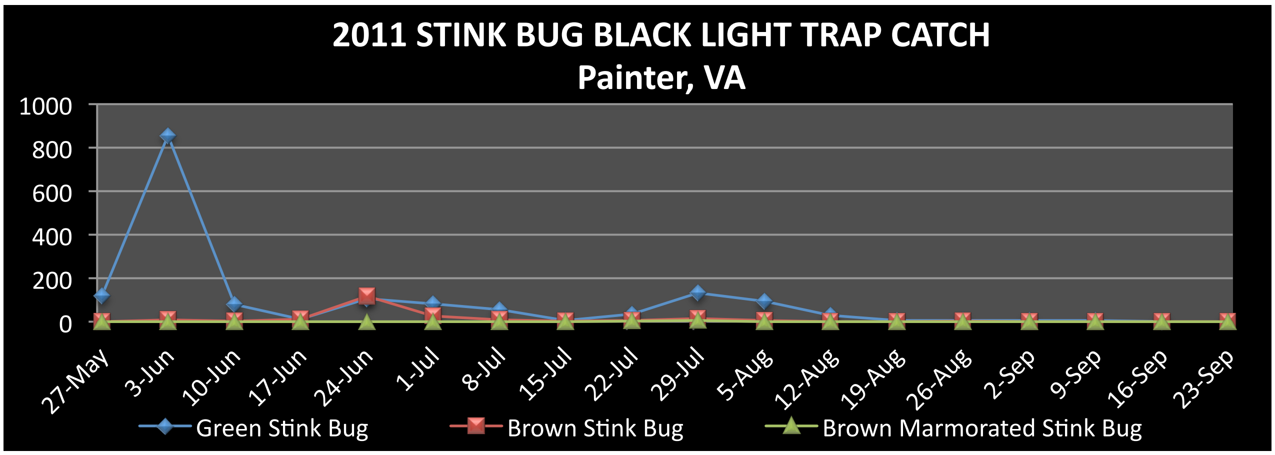
			Number egg masses deposited (% of egg hatch)		
Treatment	Product rate/acre	ml of product/ liter water	Experiment 1 April 11 (18 days)	Experiment 2 May 11 (42 days)	Experiment 3 Sept 5 (60 days)
Control			6 (100%)	4 (70.6%)	4 (98.1%)
Rimon	50 fl. oz	3.91	10 (100%)	3 (82.5%)	5 (95.8%)
Dimilin	16 fl. oz	1.25	7 (100%)	1 (100%)	4 (85.7%)

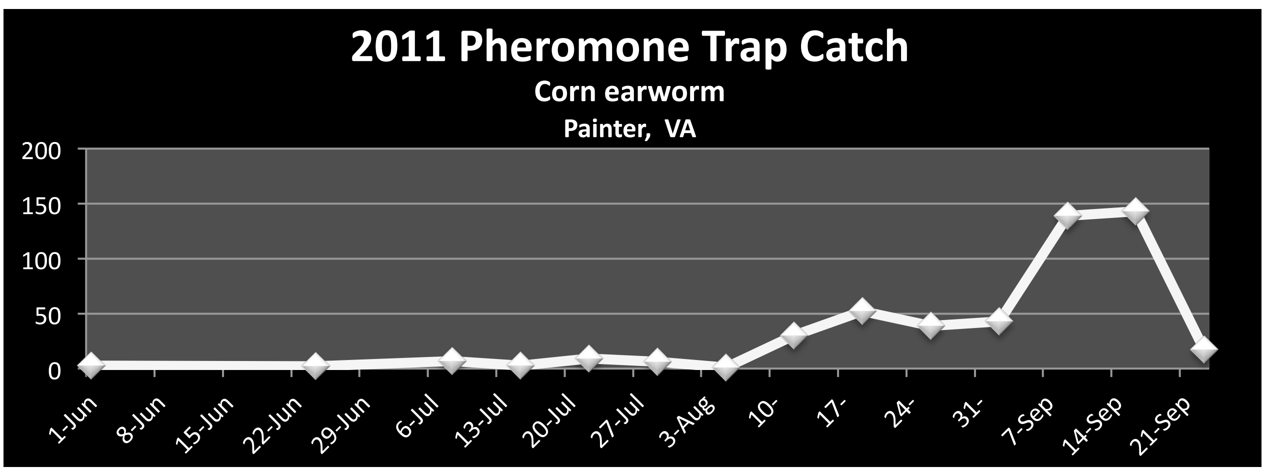
DISCUSSION

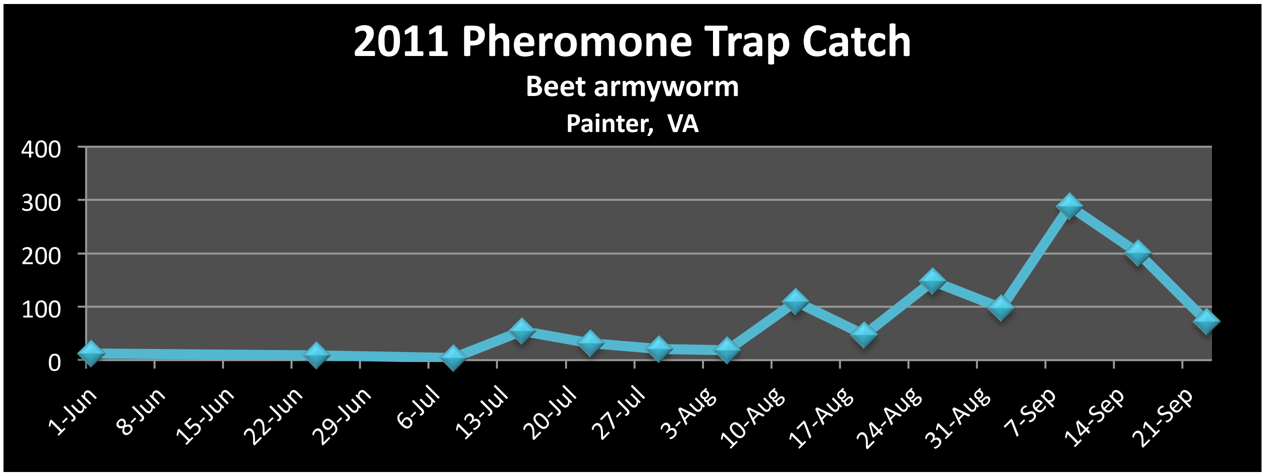
Based on the bioassays conducted, Rimon and dimilin demonstrated efficacy on BMSB nymphs by affecting the molting process. These chemicals did not appear to affect eggs when dipped in solution, adults when fed solution, or the reproductive potential of adult females when fed solution.

2011 INSECT FLIGHTS (BLACK LIGHT TRAP & PHEROMONE CATCH)

PAINTER, VA

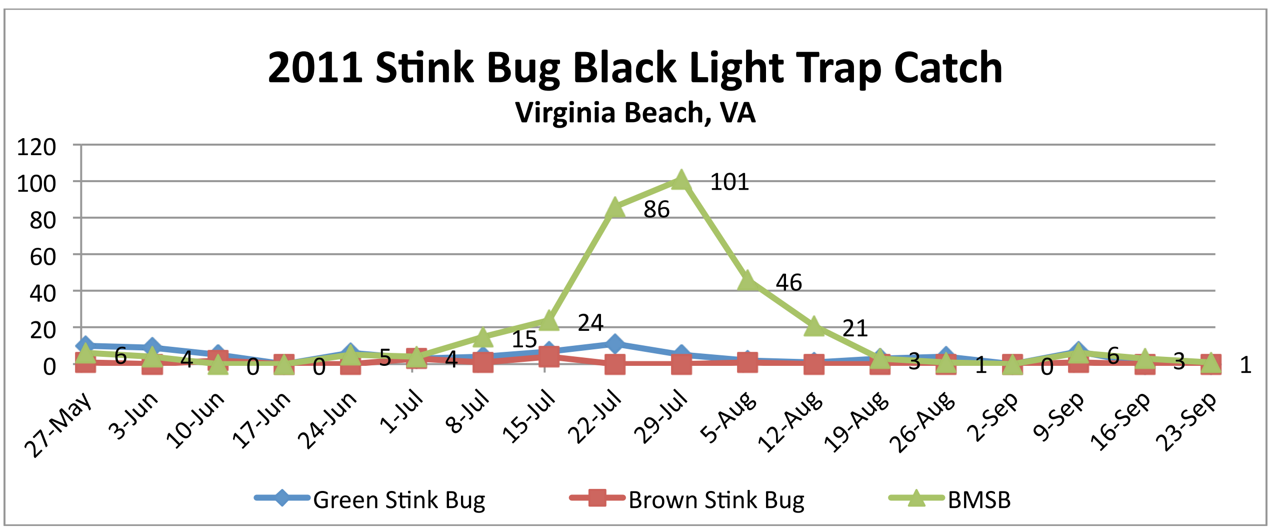


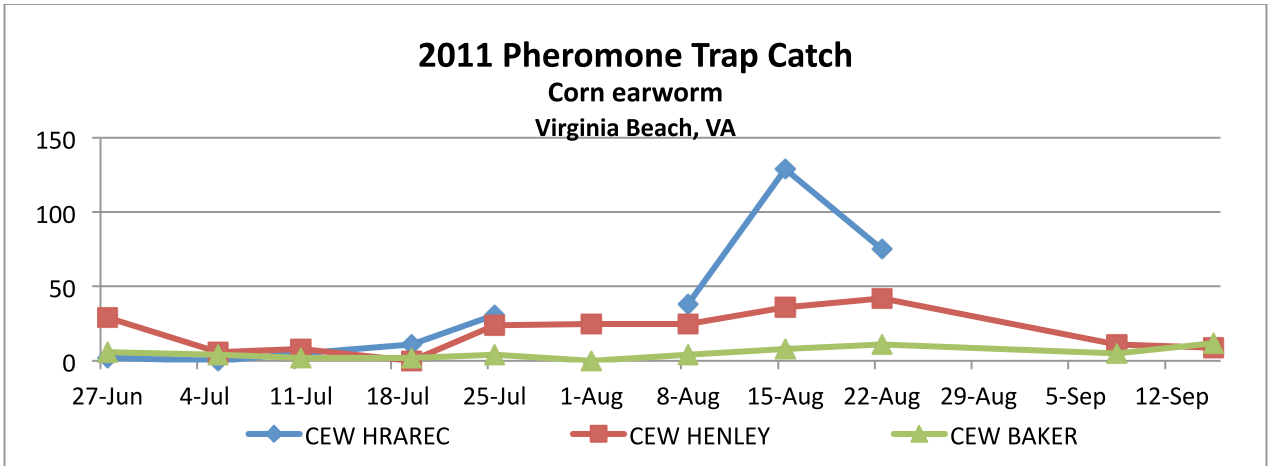


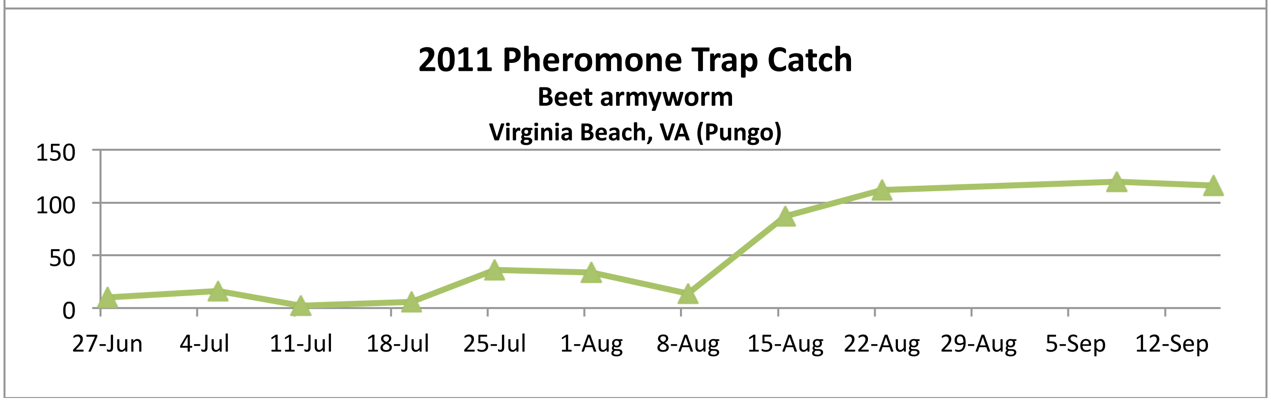


2011 INSECT FLIGHTS (BLACK LIGHT TRAP & PHEROMONE CATCH)

VIRGINIA BEACH, VA







2011 WEATHER DATA – ESAREC, PAINTER, VA

Painter, VA

January						February						March					
	Temperature						Temperature						Temperature				
Day	Max.	Min.	Mean	Rain	Snow	Day	Max.	Min.	Mean	Rain	Snow	Day	Max.	Min.	Mean	Rain	Snow
1	59	31	45.0		3	1	43	31	37.0	0.05		1	63	36	49.5	0.58	
2	59	45	52.0	0.28		2	67	35	51.0	0.11		2	59	26	42.5		
3	45	30	37.5	0.11		3	62	32	47.0			3	59	29	44.0		
4	40	22	31.0			4	39	28	33.5			4	48	26	37.0		
5	41	25	33.0			5	53	35	44.0	0.36		5	61	36	48.5		
6	41	25	33.0			6	53	36	44.5	0.03		6	57	51	54.0	0.46	
7	40	23	31.5			7	52	29	40.5			7	56	38	47.0	0.18	
8	38	26	32.0			8	44	38	41.0	0.18		8	48	30	39.0		
9	33	24	28.5			9	38	23	30.5			9	51	31	41.0		
10	33	26	29.5			10	32	27	29.5	0.18	3	10	55	48	51.5	0.64	
11	32	25	28.5	0.13		11	44	16	30.0			11	55	43	49.0	0.22	

12	36	30	33.0	0.05		12	50	24	37.0			12	61	36	48.5		
13	35	27	31.0			13	52	25	38.5			13	63	53	58.0		
14	35	25	30.0			14	65	46	55.5			14	62	33	47.5		
15	44	21	32.5			15	64	35	49.5			15	51	32	41.5		
16	43	27	35.0			16	53	25	39.0			16	55	45	50.0	0.36	
17	38	26	32.0			17	67	36	51.5			17	60	45	52.5		
18	49	35	42.0	1.58		18	73	48	60.5			18	79	48	63.5		
19	45	34	39.5			19	71	51	61.0			19	79	56	67.5	0.1	
20	45	28	36.5			20	56	34	45.0			20	60	37	48.5		
21	44	35	39.5			21	60	39	49.5			21	68	41	54.5	0.24	
22	36	20	28.0			22	54	28	41.0	0.04		22	68	54	61.0	0.16	
23	32	15	23.5			23	47	21	34.0			23	58	45	51.5	0.15	
24	30	15	22.5			24	51	25	38.0			24	55	43	49.0	0.16	
25	48	23	35.5			25	69	42	55.5	0.69		25	48	33	40.5		
26	44	35	39.5	0.84		26	63	29	46.0	0.02		26	47	38	42.5		
27	41	32	36.5	0.06		27	56	36	46.0			27	43	29	36.0	0.15	0.5
28	41	28	34.5	0.03		28	73	47	60.0			28	44	31	37.5		
29	42	28	35.0			29						29	50	27	38.5		
30	46	30	38.0									30	51	34	42.5	0.05	
31	42	31	36.5									31	46	42	44.0	0.29	
				3.08	3.00					1.66	3.00					3.74	0.50
71-Year Average				3.57						3.2						3.64	
Difference				-0.49						-1.54						0.10	

April						May						June					
	Temperature						Temperature						Temperature				
Day	Max.	Min.	Mean	Rain	Snow	Day	Max.	Min.	Mean	Rain	Snow	Day	Max.	Min.	Mean	Rain	Snow
1	48	40	44.0	0.24		1	69	43	56.0			1	93	68	80.5		
2	58	38	48.0	0.04		2	74	55	64.5			2	88	73	80.5		
3	58	41	49.5	0.06		3	81	61	71.0			3	88	61	74.5		
4	81	47	64.0			4	77	52	64.5	0.31		4	81	54	67.5		
5	81	47	64.0	0.52		5	67	49	58.0			5	82	66	74.0	0.12	
6	59	41	50.0			6	71	48	59.5			6	84	62	73.0		
7	71	51	61.0			7	72	55	63.5			7	88	62	75.0		
8	60	44	52.0	0.04		8	72	55	63.5			8	95	72	83.5		
9	54	44	49.0	0.39		9	75	50	62.5			9	99	74	86.5		
10	65	43	54.0			10	72	50	61.0			10	96	74	85.0		
11	78	53	65.5			11	71	49	60.0			11	90	72	81.0		
12	79	66	72.5			12	69	44	56.5			12	87	68	77.5	0.46	
13	76	55	65.5	0.07		13	67	54	60.5			13	84	73	78.5		

14	64	47	55.5		14	69	57	63.0		14	78	60	69.0	
15	64	42	53.0		15	79	64	71.5		15	78	62	70.0	
16	65	50	57.5	0.04	16	77	61	69.0		16	80	60	70.0	
17	65	52	58.5	0.29	17	73	62	67.5	0.19	17	86	65	75.5	5.03
18	77	57	67.0		18	73	60	66.5	0.08	18	91	68	79.5	
19	77	60	68.5		19	75	57	66.0		19	90	72	81.0	0.7
20	84	66	75.0		20	76	55	65.5		20	78	61	69.5	0.9
21	84	57	70.5		21	77	57	67.0		21	80	63	71.5	
22	61	39	50.0		22	82	57	69.5		22	88	71	79.5	
23	77	47	62.0	0.08	23	80	67	73.5	0.23	23	89	77	83.0	
24	84	64	74.0		24	89	70	79.5	0.41	24	88	74	81.0	0.07
25	86	68	77.0		25	89	68	78.5	0.02	25	86	69	77.5	0.21
26	82	68	75.0		26	90	70	80.0		26	86	65	75.5	
27	80	66	73.0		27	88	70	79.0		27	84	69	76.5	1.08
28	81	68	74.5	0.18	28	81	66	73.5		28	92	70	81.0	
29	78	55	66.5	0.02	29	86	70	78.0		29	92	71	81.5	1.71
30	72	53	62.5		30	93	73	83.0		30	85	66	75.5	
					31	93	71	82.0						
				1.97					1.24					10.28
71-Year Average				3.14					3.41					3.64
Difference				-1.17					-2.17					6.64

July						August						September					
	Temperature						Temperature						Temperature				
Day	Max.	Min.	Mean	Rain	Snow	Day	Max.	Min.	Mean	Rain	Snow	Day	Max.	Min.	Mean	Rain	Snow
1	87	65	76.0			1	92	68	80.0			1	80	57	68.5		
2	89	63	76.0			2	92	69	83.0	0.34		2	78	59	68.5		
3	88	73	80.5	0.1		3	90	74	83.0			3	81	59	70.0		
4	88	70	79.0	0.27		4	86	75	82.5	0.03		4	85	66	75.5		
5	87	72	79.5	0.42		5	82	68	83.0			5	83	70	76.5		
6	88	73	80.5	0.12		6	84	68	75.0			6	86	75	80.5		
7	89	71	80.0	0.16		7	93	77	77.0	0.16		7	84	75	79.5	0.34	
8	86	72	79.0	0.28		8	91	75	79.5	0.02		8	82	73	77.5	0.1	
9	86	72	79.0	1.8		9	93	73	78.0			9	85	71	78.0		
10	88	68	78.0			10	93	72	76.5			10	84	65	74.5		
11	89	69	79.0			11	93	73	74.5			11	85	65	75.0		
12	91	78	84.5			12	87	63	75.5			12	85	66	75.5		
13	92	74	83.0			13	86	68	77.0			13	86	65	75.5		
14	87	68	77.5	0.1		14	84	75	76.5	0.05		14	88	66	77.0		

15	80	58	69.0		15	86	70	79.0	0.03	15	88	67	77.5	
16	82	61	71.5		16	86	67	79.5	0.03	16	79	54	66.5	0.03
17	86	66	76.0		17	86	63	70.0		17	66	56	61.0	1.7
18	88	68	78.0		18	86	65	71.5		18	66	56	61.0	0.13
19	89	75	82.0		19	86	68	82.5		19	72	56	64.0	
20	90	73	81.5		20	85	68	78.5	0.13	20	76	58	67.0	
21	91	75	83.0		21	88	70	79.0		21	77	66	71.5	0.09
22	99	81	90.0		22	84	75	78.5	0.03	22	82	69	75.5	
23	98	82	90.0		23	83	57	78.0		23	77	70	73.5	0.31
24	98	79	88.5		24	85	58	71.5		24	74	68	71.0	0.6
25	96	78	87.0		25	91	74	82.5		25	74	67	70.5	0.12
26	90	75	82.5	0.38	26	88	69	78.5	0.02	26	80	69	74.5	
27	90	77	83.5		27	85	73	79.0	4.7	27	79	68	73.5	
28	90	69	79.5		28	87	70	78.5	2.38	28	81	70	75.5	0.14
29	98	77	87.5		29	87	69	78.0		29	81	66	73.5	0.15
30	97	78	87.5		30	79	64	71.5	0.09	30	81	59	70.0	
31	92	72	82.0		31	80	56	68.0						
				3.63					8.01					3.71
71-Year Average				4.59					4.23					3.67
Difference				-0.96					3.78					0.04

October					
	Temperature				
Day	Max.	Min.	Mean	Rain	Snow
1	81	58	69.5	0.95	
2	61	48	54.5	0.06	
3	60	44	52.0	0.04	
4	67	47	57.0		
5	71	58	64.5		
6	71	51	61.0		
7	71	43	57.0		
8	71	48	59.5		
9	77	48	62.5		
10	80	52	66.0		
11	75	56	65.5	0.01	
12	73	65	69.0	0.01	
13	77	66	71.5	0.01	
14	73	65	69.0	0.03	

15	73	54	63.5	
16	71	54	62.5	
17	76	62	69.0	
18	78	59	68.5	
19	77	64	70.5	1.08
20	72	55	63.5	0.02
21	64	50	57.0	
22	63	46	54.5	
23	65	40	52.5	
24	68	43	55.5	
25	66	48	57.0	
26	73	46	59.5	
27	75	62	68.5	
28	75	44	59.5	0.05
29	60	45	52.5	0.88
30	53	39	46.0	0.03
31	59	32	45.5	

71-Year Average	3.51
Difference	-3.51