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2013 RESEARCH SUMMARY

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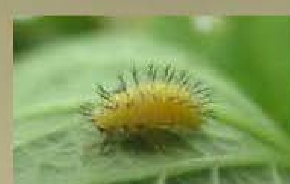

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Arthropod Pest Management Research on Vegetables in Virginia – 2013

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Foreword

This booklet contains arthropod pest management research conducted on vegetable crops in Virginia in 2013. Research was conducted at several locations including: 1) the Virginia Tech Eastern Shore Agricultural Research and Extension Center (AREC) near Painter, VA; 2) the Hampton Roads AREC in Virginia Beach, VA; 3) the Virginia Tech Kentland Research Farm near Blacksburg, VA; and 4) the Southwest Virginia 4-H Educational Center in Abingdon, 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 Tetotum loam (average pH: 5.7). Soil type at the Kentland Research Farm is Shottower loam. Most of the research involves field evaluations of insecticides. Some of the information presented herein will be published in a similar format in the journal Arthropod Management Tests: 2014, vol. 39 (Entomological Society of America). 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.

However, please note that all information is for informational purposes only. Because most of the data from the studies are based on a single season's environmental and pest conditions, it is requested that the data not be published, reproduced, or otherwise taken out of context without the permission of the authors.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 registered 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 Tom Kuhar at 540-231-6129; e-mail: tkuhar@vt.edu or Helene Doughty 757-363-3882; e-mail hdoughty@vt.edu

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Kentland Farm: Liz Fread, Ben Aigner, Ashley Lohr, and Emily Lawrence

Central Virginia: Jamie Hogue

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CONTROL OF LEPIDOPTERAN INSECTS IN CABBAGE

Location: ESAREC, Painter, VA
Variety: Bronco
Transplant Date: 11 Sep 2013
Experimental Design: 6 treatments arranged in a RCB design with 4 reps – 1 row x 20 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 38 GPA.
Foliar Treatment Dates: 16 and 25 Oct

		Mean no. lepidopteran larvae²/ 10 plants						Damage Rating¹
Treatment*	Rate / acre	18-Oct (2 DAT)	21 Oct (5 DAT)	23 Oct (7 DAT)	28 Oct (3 DAT2)	30 Oct (5 DAT2)	1 Nov (7 DAT2)	
Untreated Control		5.0	7.8 a	13.0 a	9.5 a	9.0 a	10.8 a	3.8 a
Coragen 20SC	3.5 fl. oz	4.3	1.3 b	0.5 b	0.0 b	0.0 b	0.0 b	1.6 b
Avaunt 30WDG	3.5 oz	1.5	0.3 b	0.0 b	0.0 b	0.0 b	0.0 b	1.6 b
Belt	2 fl. oz	3.0	1.0 b	1.8 b	0.8 b	0.5 b	0.0 b	1.6 b
Radiant	6 fl. oz	3.8	0.8 b	0.0 b	0.0 b	0.0 b	0.0 b	1.7 b
Fastac	3.8 fl. Oz	3.0	2.5 b	0.3 b	0.3 b	0.0 b	0.3 b	1.7 b
P-Value from Anova		ns	0.0028	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

*All treatments also received 0.125% v/v NIS
¹based on a 1-6 rating (1=no damage; 6=severely damaged)
²diamondback moth and imported cabbageworm
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 INSECTS IN COLLARDS

Location: ESAREC, Painter, VA
Variety: Vates
Transplant Date: 19 Apr 2012
Experimental Design: 9 treatments arranged in a RCB design with 4 reps – 1 row x 20 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 38 GPA.
Foliar Treatment Dates: 6 Jun (all treatments), 14 Jun (all treatments except Belt), 21 Jun (all treatments)

		Mean no. of lepidopteran larvae 14 Jun			Mean no. of lepidopteran larvae 21 Jun			Mean no. of lepidopteran larvae 28 Jun			% Marketable leaves
Treatment*	Rate / Acre	DBM¹	ICW²	Total	DBM	ICW	Total	DBM	ICW	Total	
Untreated Control		5.5 a	2.0 a	7.5 a	8.0 a	1.5	9.5 a	8.8 a	1.0	9.8 a	45.0 e
Dipel DF	4 oz	0.3 b	0.3 bc	0.5 bcd	0.3 b	0.3	0.5 b	1.8 b	0.0	1.8 b	61.3 de
Esteem	5 oz	1.0 b	0.8 b	1.8 b	1.0 b	0.8	1.8 b	1.8 b	0.5	2.3 b	65.0 cde
Dipel DF + Esteem	2 oz + 3 oz	1.0 b	0.3 bc	1.3 bcd	2.3 b	0.5	2.8 b	1.5 b	0.3	1.8 b	80.0 cd
Dipel DF + Esteem	2 oz +	0.5 b	0.0 c	1.0 bcd	0.0 b	0.5	1.0 b	0.5 b	0.0	0.5 b	76.3 cd

	5 oz										
Dipel DF + Esteem	4 oz + 3 oz	1.3 b	0.3 bc	1.0 bc	0.3 b	1.5	1.3 b	0.5 b	0.0	0.5 b	82.5 bc
Dipel DF + Esteem	5 oz + 5 oz	0.3 b	0.0 c	0.3 cd	0.3 b	0.3	0.5 b	1.3 b	0.3	1.5 b	78.8 cd
Coragen	5 fl. oz	0.0 b	0.0 c	0.0 d	0.0 b	0.3	0.3 b	0.8 b	2.0	2.8 b	96.3 ab
Belt	2 fl. oz	0.0 b	0.0 c	0.0 d	0.3 b	0.0	0.3 b	0.0 b	2.0	2.0 b	97.5 ab
P-Value from Anova		0.0001	0.0001	0.0001	0.0001	ns	0.0001	0.0001	ns	0.003	0.0001

*All treatments also received 0.25% v/v NIS

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: Bride
Transplant Date: 12 Jun 2013
Experimental Design: 4 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-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 38 GPA.
Foliar Treatment Dates: 31 Jul

		Pre-count			5 DAT			7 DAT			14 DAT		
Treatment*	**Rate / acre**	**Eggs**	**Motiles**	**Pred. mites**	**Eggs**	**Motiles**	**Pred. mites**	**Eggs**	**Motiles**	**Pred. mites**	**Eggs**	**Motiles**	**Pred.mites**
Untreated Control		47.0	73.5	2.0	1.3	2.5	0.5	39.5	33.8	5.5	0.8	0.0	0.0
GWN-1708	24 fl oz	4.3	15.0	2.5	0.5	0.8	0.3	0.3	1.0	0.5	0.8	0.0	0.0
GWN-1708	32 fl oz	3.8	5.8	0.0	0.3	1.0	0.0	1.3	0.8	0.5	1.8	0.0	0.0
Oberon 2SC	8.5 fl oz	1.3	31.3	1.5	0.5	1.8	0.0	2.8	1.3	0.0	0.3	0.0	0.0
P-Value from Anova					ns	ns	ns	ns	ns	ns	ns	ns	ns

* All treatments included 0.5% v/v non-ionic surfactant.

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).

Location: ESAREC, Painter, VA
Variety: Bride
Transplant Date: 28 Jun 2013
Experimental Design: 4 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-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 38 GPA.
Foliar Treatment Dates: 28 Jun

Treatment*	Rate / acre	Pre-count		3 DAT		5 DAT		15 DAT		22 DAT		
		Eggs	Motiles	Eggs	Motiles	Eggs	Motiles	Eggs	Motiles	Eggs	Motiles	Predatory mites
Untreated Control		22.5	35.5	7.5	59.0	24.5	41.3 a	3.3	20.3	2.5	2.8	0.0
GWN-1708	24 fl oz	15.8	47.5	3.5	17.5	1.0	0.0 b	0.3	8.8	1.8	3.3	0.3
GWN-1708	32 fl oz	19.0	18.3	2.0	5.5	1.5	0.0 b	0.0	0.8	0.0	1.3	0.3
Oberon 2SC	8.5 fl oz	19.0	60.5	3.0	8.3	0.0	0.0 b	0.3	0.0	0.5	0.5	0.0
P-Value from Anova				ns	ns	ns	0.0002	ns	ns	ns	ns	ns

* All treatments included 0.5% v/v non-ionic surfactant.

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 KALE

Location: HRAREC, Virginia Beach, VA

Variety: Vates Blue Curled

Transplant Date: 18 Apr 2013

Experimental Design: 9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-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 38 GPA.

Foliar Treatment Dates: 15 May (all treatments), 29 May (all treatments except Belt), 5 Jun (all treatments)

Treatment	Rate / Acre	Mean no. lepidopteran larvae* per 5 plants				
		21-May 6 DAT	29-May 13 DAT	5-Jun 7 DAT2	12-Jun 7 DAT3	20-Jun 15 DAT3
Untreated Control		8.0 a	3.8	13.5 a	12.3 a	4.5 a
Esteem + Radiant + NIS	5 oz + 2 fl. oz + 0.25% v/v	1.5 b	1.8	0.5 b	0.0 b	0.3 b
Esteem + Radiant + NIS	3 oz + 2 fl. oz + 0.25% v/v	2.0 b	2.0	0.0 b	0.0 b	0.5 b
Esteem + NIS	5 oz + 0.25% v/v	2.8 b	4.8	11.3 a	3.3 b	1.8 b
Radiant + NIS	2 fl. oz + 0.25% v/v	0.5 b	1.3	0.5 b	0.0 b	0.8 b
Radiant + NIS	6 fl. oz + 0.25% v/v	0.0 b	0.3	0.3 b	0.5 b	0.8 b
Belt + NIS	2 fl. oz + 0.25% v/v	1.0 b	2.0	0.0 b	0.3 b	1.0 b
P-Value from Anova		0.0175	ns	0.0124	0.0003	0.0005

***21 May, 29 May: 50%Diamondback moth, 50%Imported cabbageworm**

29 May: 90% diamondback moth, 5% imported cabbageworm, 5% cross-striped cabbageworm

5 Jun: 80% diamondback moth, 20% imported cabbagworm

12 Jun: 40% diamondback moth, 30% imported cabbageworm, 30% cross-striped cabbageworm

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 PEA APHIDS IN PEAS

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Knight
Plant Date:	4 Apr 2013
Experimental Design:	8 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method:	All foliar treatments were applied with a 2-nozzle boom equipped with 8003VS spray tips and powered by a Solo backpack sprayer delivering 30GPA
Foliar Treatment Dates:	28 May

		Mean no. pea aphids / 5 plants		Mean no. meadow spittlebugs / 5 plants	
Treatment*	**Rate / acre**	**31-May 3 DAT**	**4-Jun 7 DAT**	**31-May 3 DAT**	**4-Jun 7 DAT**
Untreated Control		6.0 a	7.5 a	4.8 a	1.3
Sivanto	10.5 fl. oz	0.3 b	0.5 b	0.0 b	0.0
Sivanto	12 fl. oz	0.8 b	1.0 b	1.0 b	0.0
Movento	5 fl. oz	0.0 b	1.0 b	2.0 b	0.3
Closer SC	2 fl. oz	0.5 b	2.3 b	2.0 b	0.3
Closer SC	3 fl. oz	1.0 b	3.0 b	0.0 b	0.0
Pyrifluquinazon	3.2 fl. oz	0.3 b	1.0 b	1.0 b	0.3
Tolfenpyrad EC	21 fl. oz	0.5 b	0.8 b	0.0 b	0.0
P-Value from Anova		<0.0001	0.0034	0.0027	ns

*All treatments also received 0.25% v/v NIS

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: 1

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Aristotle
Transplant Date:	10 Jun 2013
Experimental Design:	12 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Foliar Treatment Dates:	23, 30 Jul, 6, 14, 26 Aug

		% stink bug damage		% lepidopteran damage		% lygus bug damage
Treatment	**Rate / acre**	**20-Aug**	**4-Sep**	**20-Aug**	**4-Sep**	**20-Aug**
Untreated Control		27.5	23.8 a	0.0	2.5	1.3
Hero	7.1 fl. oz	3.8	3.8 bc	1.3	0.0	0.0
Athena	16 fl. oz	7.5	2.5 c	0.0	2.5	0.0
Gladiator	19 fl. oz	0.0	3.8 bc	1.3	2.5	1.3
Mustang Max	4 fl. oz	12.5	7.5 bc	6.3	0.0	0.0
Triple Crown	7.9 fl. oz	5.0	5.0 bc	0.0	0.0	0.0
Bifenthrin 2EC	6.4 fl. oz	1.3	2.5 c	2.5	0.0	1.3

Beleaf	2.8 oz	7.5	3.8 bc	2.5	2.5	1.3
Mustang Max + Lannate LV	4 fl. oz + 16 fl. oz	10.0	6.3 bc	0.0	1.3	0.0
Vydate L	32 fl. oz	3.8	10.0 abc	0.0	1.3	1.3
Lannate LV	24 fl. oz	1.3	3.8 bc	7.5	0.0	2.5
Lannate LV + Asana XL	24 fl. oz + 6 fl. oz	16.3	12.5 ab	3.8	0.0	0.0
P-Value from Anova		ns	0.0290	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: 10 Jun 2013
Experimental Design: 12 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Foliar Treatment Dates: 23, 30 Jul, 6, 14, 26 Aug

		% stink bug damage		% lepidopteran damage		% lygus bug damage	
Treatment	**Rate / acre**	**12-Aug**	**4-Sep**	**12-Aug**	**4-Sep**	**12-Aug**	**4-Sep**
Untreated Control		15.0	7.5	1.3	1.3	1.3 b	1.3
Belay 2.13SC + NIS	4 fl. oz + 0.25% v/v	7.5	2.5	1.3	1.3	0.0 b	0.0
Belay 2.13SC + NIS	6 fl. oz + 0.25% v/v	2.5	7.5	2.5	0.0	0.0 b	0.0
Danitol 2.4EC + NIS	21 fl. oz + 0.25% v/v	3.8	6.3	0.0	1.3	1.3 b	0.0
Closer 2SC + NIS	3 fl. oz + 0.25% v/v	2.5	3.8	1.3	0.0	7.5 a	1.3
Closer 2SC + NIS	5 fl. oz + 0.25% v/v	5.0	2.5	2.5	0.0	0.0 b	0.0
Endigo ZCX	4.5 fl. oz	8.8	2.5	2.5	5.0	0.0 b	1.3
Voliam Xpress	7 fl. oz	6.3	6.3	2.5	0.0	0.0 b	0.0
Belay 2.13SC + Bifenthrin 2EC + NIS	4 fl. oz + 4.30 fl. oz + 0.25% v/v	6.3	1.3	2.5	5.0	3.8 b	1.3
Doubletake	2 fl. oz	7.5	6.3	1.3	0.0	3.8 ab	0.0
Doubletake	4 fl. oz	5.0	10.0	0.0	1.3	3.8 b	2.5
Fastac EC	3.8 fl. oz	3.8	5.0	1.3	3.8	0.0 b	0.0
P-Value from Anova		ns	ns	ns	ns	0.0226	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 BELL PEPPERS

Location:	HRAREC, Virginia Beach, VA
Variety:	Aristotle
Transplant Date:	16 May 2013
Experimental Design:	7 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Foliar Treatment Dates:	12, 20 and 26 Jun

Treatment	Rate / acre	Mean no. thrips* / 15 blossoms									
		12-Jun		19-Jun		26-Jun		3-Jul		Total	
		Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae
Untreated Control		2.0 b	5.3	8.8 a	2.0	1.0	0.3	1.8	1.0	12.5 a	3.3
Radiant + NIS	6 fl. oz + 0.5% v/v	n/a	n/a	3.5 b	1.3	0.0	0.5	1.3	0.0	5.3 b	1.8
Experimental	n/a	n/a	n/a	6.0 ab	2.0	0.3	0.3	2.0	0.5	9.0 ab	2.8
Experimental	n/a	n/a	n/a	1.5 b	0.3	1.0	0.5	1.8	0.5	5.0 b	1.3
Admire Pro (at planting)	10.5 fl. oz	7.8 a	5.0	9.0 a	1.8	0.8	0.5	2.3	0.0	13.5 a	2.3
Verimark (at planting)	13.5 fl. oz	5.0 ab	5.8	8.5 a	0.5	0.3	1.8	0.8	0.0	11.3 a	2.3
Verimark	10.5 fl. oz	n/a	n/a	6.3 ab	2.0	1.0	0.0	1.5	0.5	9.0 ab	2.5
P-Value from Anova		0.0273	ns	0.0418	ns	ns	ns	ns	ns	0.0199	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	Mean no. *Orius insidiosus* / 15 blossoms					
		12-Jun	19-Jun	26-Jun	3-Jul	9-Jul	Total
Untreated Control		0.5	7.8	7.8	7.0	4.5	27.0 a
Radiant + NIS	6 fl. oz + 0.5% v/v	n/a	4.3	5.8	2.3	4.0	16.3 bc
Experimental	n/a	n/a	6.5	6.0	4.5	3.8	20.8 abc
Experimental	n/a	n/a	5.5	5.5	5.8	4.3	20.0 abc
Admire Pro (at planting)	10.5 fl. oz	0.0	6.3	6.8	7.0	3.8	23.8 ab
Verimark (at planting)	13.5 fl. oz	1.0	4.8	10.0	7.3	4.3	26.3 a
Verimark	10.5 fl. oz	n/a	4.3	4.0	3.0	2.5	13.8 c
P-Value from Anova		ns	ns	ns	ns	ns	0.0528

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	Mean no. fruit	Total Yield

		/ plot	(in lbs)
Untreated Control		74.5	16.8
Radiant + NIS	6 fl. oz + 0.5% v/v	50.5	13.5
Experimental	n/a	78.3	19.1
Experimental	n/a	76.0	18.7
Admire Pro (at planting)	10.5 fl. oz	74.0	17.4
Verimark (at planting)	13.5 fl. oz	60.0	16.4
Verimark	10.5 fl. oz	66.5	17.1
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).

CONTROL OF INSECTS IN POTATOES: 1

Location: ESAREC, Painter, VA
Variety: Superior
Plant Date: 11 Apr 2013
Experimental Design: 10 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
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.
Post-emergence banded treatments were applied at drag-off over the row using the same methods as described above.
Treatment Dates: In-furrow: 11 Apr
Post-emergence: 6 May
Foliar: 24 and 31 May

		Mean no. Colorado potato beetles / 10 stems							% defoliation		Mean no. European corn borer damage holes / 10 stems
		31-May			10-Jun			14-Jun			
Treatment	Rate/acre	small larvae	large larvae	adult	small larvae	large larvae	adult	adult	11-Jun	26-Jun	
Untreated Control		113.5 a	107.5 a	0.8	1.8	11.8 b	2.5	4.3	78.8 a	96.3 a	0.5
Brigadier 2SC (in-furrow)	25.6 fl. oz	0.0 c	0.3 c	0.3	2.8	7.5 b	3.0	3.0	0.0 c	26.3 b	0.5
Brigadier 2SC (in-furrow) + Brigadier 2SC (drag-off)	12.8 fl. oz + 12.8 fl. oz	1.3 c	0.0 c	0.5	1.0	11.5 b	0.8	10.0	1.3 c	23.8 b	0.0
Capture LFR (in-furrow) + Admire Pro (drag-off)	25.6 fl. oz + 5.22 fl. oz	73.0 b	44.8 b	0.5	0.0	41.8 a	0.0	40.8	61.3 b	78.8 a	0.0
Brigadier 2SC (in-furrow) +	25.6 fl. oz + 14 fl. oz	0.0 c	0.0 c	0.8	0.3	1.3 b	0.8	3.3	0.0 c	5.0 b	0.0

Gladiator (foliar)											
Capture LFR (in-furrow) + Admire Pro (drag-off) + Athena (foliar)	25.6 fl. oz + 5.22 fl. oz + 16 fl. oz	0.3 c	0.3 c	0.3	0.0	2.8 b	3.3	8.5	0.0 c	15.0 b	0.0
Brigadier 2SC (drag-off) + Gladiator (foliar)	25.6 fl. oz + 14 fl. oz	2.3 c	2.0 c	1.8	2.3	9.5 b	0.3	5.8	0.0 c	21.3 b	0.3
Capture LFR (drag-off) + Admire Pro (drag-off) + Gladiator (foliar)	25.6 fl. oz + 5.22 fl. oz + 14 fl. oz	1.0 c	1.0 c	0.8	2.3	3.5 b	1.5	3.8	0.0 c	13.8 b	0.0
Platinum 75SG (in-furrow)	2.67 oz	0.0 c	0.0 c	0.8	0.0	0.0 b	2.8	9.0	0.0 c	20.0 b	1.0
Admire Pro (in-furrow)	8.6 fl. oz	0.0 c	0.0 c	0.5	0.5	3.8 b	1.0	8.8	0.0 c	21.3 b	1.3
P-Value from Anova		0.0001	0.0001	ns	ns	0.0001	ns	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/acre	Total Yield (in lbs)	% wireworm damage	% grub damage	% total damage (wireworm + grub)
Untreated Control		12.4 c	35.5 a	2.6	38.1 a
Brigadier 2SC (in-furrow)	25.6 fl. oz	69.5 a	18.5 b	0.0	18.5 b
Brigadier 2SC (in-furrow) + Brigadier 2SC (drag-off)	12.8 fl. oz + 12.8 fl. oz	68.0 a	9.5 c	0.0	9.5 c
Capture LFR (in-furrow) + Admire Pro (drag-off)	25.6 fl. oz + 5.22 fl. oz	29.2 b	7.0 c	0.5	7.5 c
Brigadier 2SC (in-furrow) + Gladiator (foliar)	25.6 fl. oz + 14 fl. oz	70.3 a	9.0 c	0.0	9.0 c
Capture LFR (in-furrow) + Admire Pro (drag-off) + Athena (foliar)	25.6 fl. oz + 5.22 fl. oz + 16 fl. oz	65.2 a	10.0 bc	0.0	10.0 bc
Brigadier 2SC (drag-off) + Gladiator (foliar)	25.6 fl. oz + 14 fl. oz	65.0 a	14.0 bc	2.0	16.0 bc
Capture LFR (drag-off) + Admire Pro (drag-off) + Gladiator (foliar)	25.6 fl. oz + 5.22 fl. oz + 14 fl. oz	65.1 a	14.0 bc	0.5	14.5 bc
Platinum 75SG (in-furrow)	2.67 oz	61.7 a	12.0 bc	0.5	12.5 bc
Admire Pro (in-furrow)	8.6 fl. oz	70.3 a	8.5 c	0.0	8.5 c
P-Value from Anova		0.0001	0.0006	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 INSECTS IN POTATOES: 2

Location:	ESAREC, Painter, VA
Variety:	Superior
Plant Date:	11 Apr 2013
Experimental Design:	10 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers)
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA. 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. Post-emergence banded treatments were applied at drag-off over the row using the same methods as described above.
Treatment Dates:	In-furrow: 11 Apr Post-emergence: 6 May Foliar: 24 and 31 May

Treatment	Rate / Acre	Mean no. Colorado potato beetles / 10 stems					% defoliation	
		31-May		10-Jun		14-Jun		
		Small larvae	Large larvae	Large larvae	Adult	Adult	11-Jun	26-Jun
Untreated Control		97.0 a	103.8 a	11.5	5.0	15.5	100.0 a	100.0 a
Leverage 360	2.8 fl. oz	4.8 bc	6.8 bc	20.3	1.5	38.8	1.3 c	62.5 b
Endigo ZCX 2.71ZC	4 fl. oz	1.5 bc	0.8 bc	3.5	3.8	14.3	0.0 c	18.8 c
Actara 25WG	3 oz	5.3 bc	8.8 b	16.8	3.5	15.5	3.8 b	70.0 b
Besiege 1.25ZC	9 fl. oz	6.0 b	3.0 bc	0.3	1.0	4.3	0.0 c	1.3 c
Agri-Flex 1.55SC	6 fl. oz	0.0 c	0.0 c	0.0	0.0	5.0	0.0 c	3.8 c
P-Value from Anova		0.0001	0.0001	ns	ns	ns	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).

Treatment	Rate / Acre	Mean no. potato leafhopper nymphs / 10 compound leaves	Mean no. European corn borer damage holes / 10 stems	Total Yield (lbs/20 ft row)
Untreated Control		1.0	1.3	2.6 c
Leverage 360	2.8 fl. oz	0.0	0.5	42.5 ab
Endigo ZCX 2.71ZC	4 fl. oz	0.0	0.5	54.2 a
Actara 25WG	3 oz	0.3	0.5	39.7 b
Besiege 1.25ZC	9 fl. oz	0.0	0.0	49.7 ab
Agri-Flex 1.55SC	6 fl. oz	0.0	0.5	56.8 a
P-Value from Anova		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 INSECTS IN POTATOES: 3

Location:	ESAREC, Painter, VA
Variety:	Superior
Plant Date:	11 Apr 2013
Experimental Design:	7 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers)
Treatment Method:	All foliar treatments were applied with a 4-nozzle boom equipped with 110003VS spray tips spaced 20" apart spraying 2 rows at a time and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Foliar Treatment Dates:	Foliar: 23 and 30 May

		Mean no. Colorado potato beetles / 10 stems							
		29-May		5-Jun		14-Jun		% defoliation	
Treatment	**Rate / Acre**	**Small larvae**	**Large larvae**	**Small larvae**	**Large larvae**	**Large larvae**	**Adult**	**11-Jun**	**26-Jun**
Untreated Control		102.5 a	66.3 a	23.3 a	107.0 a	1.3 ab	55.0 a	67.5 a	100.0 a
Coragen 20SC	5 fl. oz	13.5 b	2.0 b	0.0 b	0.5 b	0.0 c	0.8 b	2.5 bc	23.8 c
Blackhawk	3.2 fl. oz	28.8 b	1.8 b	0.5 b	1.8 b	1.0 ab	2.8 b	0.0 c	86.3 a
HGW86 10OD	5 fl. oz	10.8 b	0.0 b	0.3 b	0.0 b	0.5 bc	3.0 b	0.0 c	92.5 a
HGW86 10OD + MSO	5 fl. oz + 0.25% v/v	6.8 b	0.0 b	0.0 b	1.0 b	0.5 bc	8.0 b	0.0 c	71.3 ab
HGW86 10SE	6.75 fl. oz	4.0 b	0.0 b	0.0 b	0.0 b	0.0 c	0.3 b	0.0 c	47.5 bc
Admire Pro (in-furrow)	1.3 fl. oz	50.8 ab	3.8 b	7.3 b	5.0 b	1.8 a	3.8 b	3.8 b	80.0 a
P-Value from Anova		0.0111	0.0039	0.0065	<0.0001	0.0015	0.0241	<0.0001	0.0019

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 / 10 compound leaves		Mean no. european corn borer damaged stems / 10 stems	
Treatment	**Rate / Acre**	**29-May**	**5-Jun**	**10-Jun**	**29-May**
Untreated Control		3.5 a	6.0	0.5	0.3
Coragen 20SC	5 fl. oz	1.0 b	2.0	0.3	0
Blackhawk	3.2 fl. oz	1.0 b	5.5	0.3	0.3
HGW86 10OD	5 fl. oz	0.3 b	1.5	0.3	0
HGW86 10OD + MSO	5 fl. oz + 0.25% v/v	0.5 b	2.8	0.0	0.5
HGW86 10SE	6.75 fl. oz	0.8 b	3.0	0.0	0.5
Admire Pro (in-furrow)	1.3 fl. oz	0.0 b	2.3	0.3	0.8
P-Value from Anova		0.0136	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).

Treatment	Rate / Acre	Small As	Large As	Bs	Total Harvest (in lbs)
Untreated Control		2.5 c	0.4	8.6	11.4 c
Coragen 20SC	5 fl. oz	18.8 a	4.9	14.4	38.2 a
Blackhawk	3.2 fl. oz	12.0 b	3.5	16.5	32.0 ab
HGW86 10OD	5 fl. oz	12.8 b	4.2	13.7	30.7 ab
HGW86 10OD + MSO	5 fl. oz + 0.25% v/v	12.8 b	2.2	13.9	28.8 b
HGW86 10SE	6.75 fl. oz	14.3 ab	6.1	16.6	37.0 a
Admire Pro (in-furrow)	1.3 fl. oz	13.8 ab	3.8	14.5	32.2 ab
P-Value from Anova		0.0005	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 INSECTS IN POTATOES: 4

Location: ESAREC, Painter, VA

Variety: Superior

Plant Date: 11 Apr 2013

Experimental Design: 5 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers)

Treatment Method: All foliar treatments were applied with a 4-nozzle boom equipped with 110003VS spray tips spaced 20" apart spraying 2 rows at a time and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
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.

Treatment Dates: In-furrow: 11 Apr.
Foliar: 31 May and 14 Jun. Coragen 20SC was applied at 5 fl. oz / acre to Movento and Regent treatments on 31 May and to the experimental, Movento and Regent on 14 Jun to control Colorado potato beetles for continued investigation into wireworm control.

Bioassay: On 1 May and 7 Jun, wireworms (*Melatonus communis)* were collected from a grower's field with high pressure. 4 wireworms were placed in a 6 qt plastic container with 2 tubers, field soil and field rates of insecticides were used for each treatment as follows: Treatment 1: Untreated control; Regent: 3.2 fl. oz/ acre; Experimental. A total of 4 containers was used for each treatment. The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 12:12 (L:D). Mortality and tuber damage was evaluated at 8 DAT for bioassay #1 and at 7, 14 and 21 DAT for bioassay #2.

Field Trial Results:

Treatment	Rate/acre	Total Yield (in lbs)	% wireworm damage	% grub damage	% total damage
Untreated Control		11.2 c	7.7	1.6	9.3
Experimental (in-furrow)	n/a	23.4 c	10	1.5	11.7
Movento + NIS (foliar)	5 fl. oz + 0.5% v/v	56.9 b	9.2	2.2	11.5
Regent 4SC (in-furrow)	3.2 fl. oz	68.5 ab	3.5	1	11.4

Platinum 75SG (in-furrow)	2.67 oz	79.8 a	9.3	2.5	11.8
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).

		Mean no. Colorado potato beetles / 10 stems					% defoliation		Mean no. potato leafhopper nymphs / 10 compound leaves
		31-May		10-Jun		14-Jun			
Treatment	**Rate/acre**	**small larvae**	**large larvae**	**large larvae**	**adult**	**Adult**	**11-Jun**	**26-Jun**	
Untreated Control		150.3 a	130.3 a	25.8 a	7.5	99.8 a	81.3 a	100.0 a	12.0 ab
Experimental (in-furrow)	n/a	95.8 ab	69.5 b	28.3 a	4.5	73.0 ab	65.0 a	62.5 b	19.8 a
Movento + NIS (foliar)	5 fl. oz + 0.5% v/v	71.0 b	76.5 b	5.0 b	1.8	66.3 ab	10.0 b	10.0 c	8.8 ab
Regent 4SC (in-furrow)	3.2 fl. oz	62.0 bc	50.5 b	0.3 b	1.8	8.8 b	2.5 b	2.5 c	8.0 ab
Platinum 75SG (in-furrow)	2.67 oz	0.3 c	0.0 c	1.3 b	1.3	3.3 b	0.0 b	13.8 c	0.3 b
P-Value from Anova		0.0001	0.0001	0.0004	ns	0.0071	0.0001	0.0001	0.0055

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).

Bioassay Results:

1. Set-up: 1 May

Treatment	Rate / acre	% dead and down wireworm (8 DAT)
Untreated control		0.0 c
Regent	3.2 fl. oz	37.5 ab
Experimental	n/a	50.0 a
P-Value from Anova		0.00223

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).

2. Set-up: 7 Jun

Treatment	Rate / acre	% dead and down wireworm (7 DAT)	% dead and down wireworm (14 DAT)	% dead and down wireworm (21 DAT)
Untreated control		0.0 b	12.5	0.0 b
Regent	3.2 fl. oz	31.3 ab	62.5	68.8 a
Experimental	n/a	62.5 a	43.8	68.8 a
P-Value from Anova		0.0102	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 INSECTS IN POTATOES: 5

Location: 4-H Educational Center, Abingdon, VA
Variety: Kennebec
Plant Date: 25 Apr 2013
Experimental Design: 10 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers)
Treatment Method: All incorporated and in-furrow treatments were applied in 450 ml of water at 19.8 GPA using a single nozzle boom equipped with an 8003 even flat spray tip powered by a Solo backpack sprayer delivering 20 mls per second. Incorporated treatments (2, 3, 4, and 5)

	were applied to the soil and cultivated with a heavy metal rake prior to cutting furrows. Furrows were cut using a commercial potato planter without the coulters on. Infurrow treatments were applied into furrows and potato seed pieces were hand planted. The Sniper or Brigadier post-emergence treatments were applied at drag-off over the row on 29 May using the same sprayer methods as described above. The Movento foliar treatment was applied to potato foliage on 31 May and 12 June with a two-nozzle boom equipped with a D3 spray tip powered by a Solo backpack sprayer delivering 20 mls per second.
Treatment Dates:	In-Furrow and incorporated: 25 Apr Post-emergence: 29 May Foliar: 31 May and 12 Jun

Treatment	Rate / acre	Mean no. Colorado potato beetles / 10 stems		Marketable tuber yield (lbs/plot)	% wireworm damaged tubers
		Small larvae	Large larvae		
Untreated Control		5.8	10.5	53.8	37.0
Lorsban 4E (Incorporated) + Sniper 2EC Post-Emergence foliar)	64 fl. oz + 19.2 fl. oz	9.5	2.5	59.8	18.5
Ditera DF (Incorporated) + Belay 2.13SC (Incorporated) + Sniper 2EC (Post-Emergence foliar)	800 + 12 fl. oz + 19.2 fl. oz	0.0	0.0	64.5	22.5
Ditera DF (Incorporated) + Belay 2.13 SC (in-furrow) + Sniper 2EC (Post-Emergence foliar)	800 + 8 fl. oz + 19.2 fl. oz	0.0	0.0	56.8	19.0
Belay 2.13SC (Incorporated) + Sniper 2EC (Post-Emergence foliar)	12 fl. oz + 19.2 fl. oz	0.3	0.5	59.8	19.0
Regent (in-furrow)	3.2 fl. oz	7.3	6.0	60.8	17.5
Brigadier (in-furrow)	25.6 fl. oz	3.8	0.5	60.8	18.0
Brigadier (in-furrow) + Brigadier (Post-Emergence banded)	12.8 fl. oz + 12.8 fl. oz	0.0	0.0	64.5	15.5
Experimental	-	4.0	6.5	58.0	25.5
Movento + NIS (foliar)	5 fl. oz + 0.5% v/v	3.8	4.3	56.0	32.0
P-Value from Anova		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 INSECTS IN POTATOES: 6

Location:	ESAREC, Painter, VA
Variety:	Superior
Plant Date:	11 Apr 2013
Experimental Design:	5 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers)
Treatment Method:	All foliar treatments were applied with a 4-nozzle boom equipped with 110003VS spray tips spaced 20" apart spraying 2 rows at a time and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA. All in-furrow treatments were applied in 900 ml of water at 19.8 GPA on 11 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 commercial potato planter without the coulters on.
Treatment Dates:	In-Furrow: 11 Apr Foliar: 24 (all foliar treatments except HGW86 10SE trt 5) and 31 May (all foliar treatments)

		Mean no. Colorado potato beetles / 10 stems							% defoliation		Total Yield (in lbs)
		31-May			10-Jun			14-Jun			
Treatment	**Rate/acre**	**small larvae**	**large larvae**	**adult**	**small larvae**	**large larvae**	**adult**	**adult**	**11-Jun**	**26-Jun**	
Untreated Control		102.3 a	134.3 a	0.0	2.5	19.0 a	1.3	24.0 a	83.8 a	100.0 a	5.4 c
Platinum 2 (in-furrow)	8 fl. oz	0.0 b	0.0 b	1.3	0.3	0.5 b	0.0	7.3 b	0.0 b	13.8 c	49.4 a
HWG86 20SC + Asana XL	13.5 fl. oz + 9.6 fl. oz	0.0 b	0.0 b	3.3	0.0	0.0 b	0.8	2.8 b	0.0 b	5.0 c	50.5 a
HGW86 10SE + Asana XL	5 fl. oz + 9.6 fl. oz	1.3 b	2.0 b	0.5	0.3	0.0 b	1.3	2.5 b	0.0 b	52.5 b	37.7 b
Platinum 2 (in-furrow) fb HGW86 10SE	8 fl. oz + 5 fl. oz	0.0 b	0.0 b	1.0	0.0	0.0 b	0.5	3.3 b	0.0 b	3.8 c	56.3 a
P-Value from Anova		0.0001	0.0001	ns	ns	0.0021	ns	0.0486	0.0001	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).

Treatment	Rate/acre	Mean no. potato leafhopper nymphs / 10 compound leaves		Mean no. European corn borer damage holes / 10 stems
		10-Jun	**17-Jun**	
Untreated Control		1.5	1.0	1.5
Platinum 2 (in-furrow)	8 fl. oz	0.3	0.0	1.3
HWG86 20SC + Asana XL	13.5 fl. oz + 9.6 fl. oz	0.0	0.0	0.0
HGW86 10SE + Asana XL	5 fl. oz + 9.6 fl. oz	0.0	0.0	0.8
Platinum 2 (in-furrow) fb HGW86 10SE	8 fl. oz + 5 fl. oz	0.0	0.0	0.0
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).

ON-FARM POTATO TRIALS: EFFICACY OF MOVENTO FOR WIREWORM CONTROL

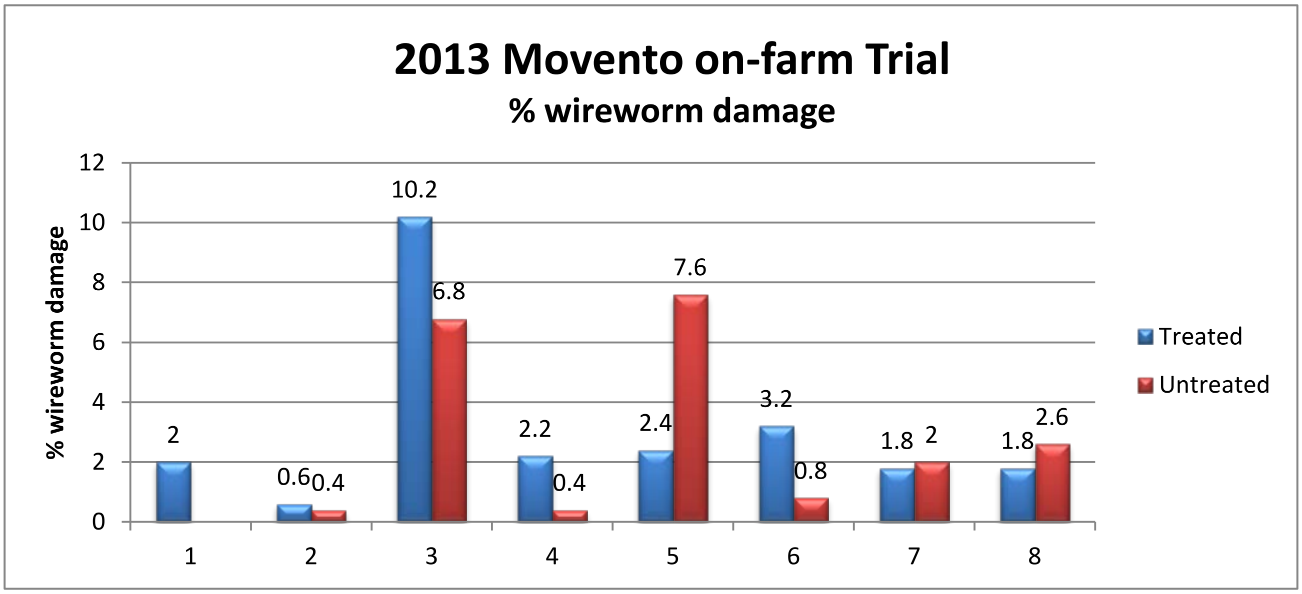
The experiment was conducted as a demonstration on-farm trial at various locations on the Eastern Shore of Virginia with a total of 8 cooperators.

Growers applied standard insecticides for the control of Colorado potato beetle and wireworm at planting. Movento was then applied twice, beginning at flowering, at the rate 5 fl. oz / acre + NIS. All fields were otherwise maintained according to standard commercial practices.

500 tubers were collected in 5 areas of the untreated portion of the field and in 5 areas of the treated portion. All tubers were examined for wireworm (*Melatonus communis* (Gyllenhal) and *Conoderus vespertinus* (F.)) and white grub damage.

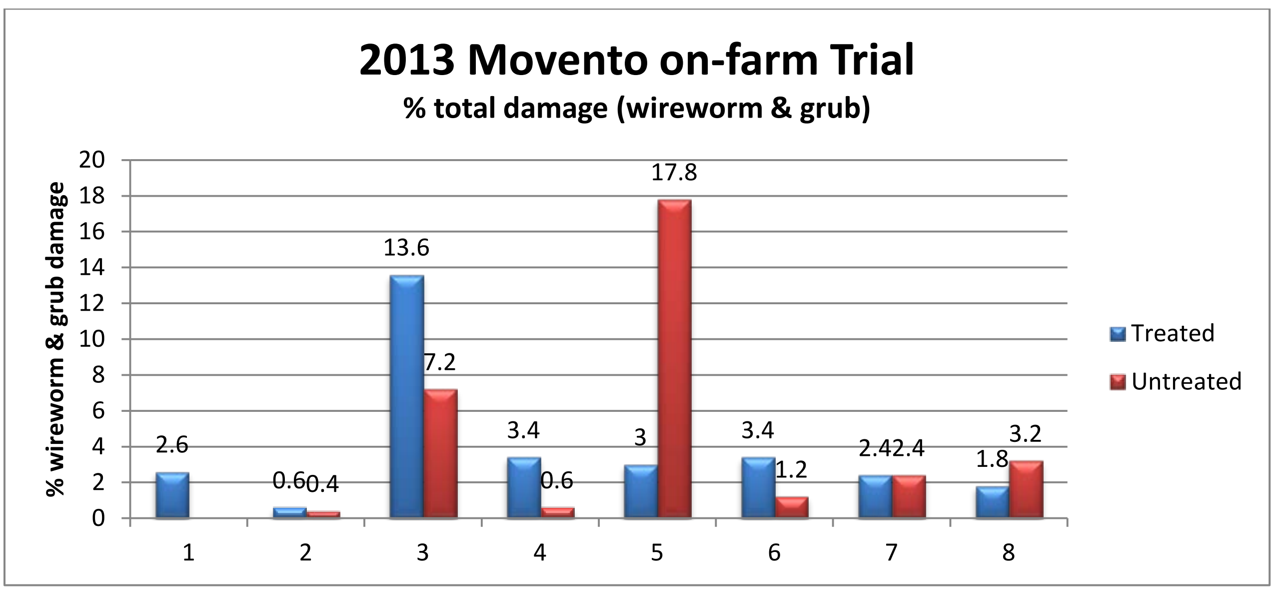
Cooperator	Location	Plant Date	Variety	At-planting insecticide	Movento applications
1. Jack Yaros (Yaros Farms)	Capeville, VA	24-Mar	Russett	Mocap 15G, Regent, Platinum	2 ground applications
2. Ronnie Bailey (Twin Cedar Farms)	Seaview, VA	27-Mar	Superior	Platinum, Regent	1 ground application; 1 helicopter application
3. David Long	Cape Charles, VA	3-Apr	Yukon gold	Platinum, Regent	2 ground applications
4.Bruce Richardson	Capeville, VA	27-Mar	Superior	Platinum, Regent	2 ground applications
5. Lee Sturgis	Painter, VA	29-Mar	Superior	Platinum	1 ground application
6. David Hickman (Dublin Farms)	Horntown, VA	n/a	Villetta Rose	Platinum, Regent	2 ground applications
7. Jimmy Holland	New Church, VA	n/a	Superior	Platinum, Regent	2 ground applications
8. Bruce Holland	New Church, VA	n/a	Superior	Platinum, Regent	2 ground applications

	Treated		Untreated	
GROWER	# wireworm damaged tubers	# white grub damage tubers	# wireworm damaged tubers	# white grub damaged tubers
1. Jack Yaros	10	3	No untreated	No untreated
2. Ronnie Bailey	3	0	2	0
3. David Long	51	17	34	2
4. Bruce Richardson	11	6	2	1
5. Lee Sturgis	12	3	38	51
6. David Hickman	16	1	4	2
7.Jimmy Holland	9	3	10	2
8. Bruce Holland	9	0	13	3



Note: No untreated in site 1

Only one application of Movento in site 4



Note: No untreated in site 1

Only one application of Movento in site 4

CONTROL OF FOLIAR INSECTS IN SNAP BEANS

Location:	ESAREC, Painter, VA
Variety:	Hickok
Plant Date:	11 Apr 2013
Experimental Design:	9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers)
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA. Field net assay: On 20 Sep (3 DAT), nets were placed over one snap bean plant in each plot with 6 stink bugs (7% brown stink bug adults, 56% brown stink bug nymphs, 11% green stink bug adults, 9% green stink bug nymphs, 17% red-shouldered stink bug adults) inserted into each net. On 23 Sep, the number of dead, live and moribund stink bugs was recorded.
Treatment Dates:	26 Aug (for whiteflies and bean leaf beetles), 3 (flowering), 10 (at 50% pinning) and 17 Sep.

Treatment	Rate / acre	Mean no. whiteflies / 10 plants	Mean no. live bean leaf beetles / 10 plants	Mean no. dead bean leaf beetles / 10 plants	% lepidopteran damage	% stink bug damage
Untreated Control		155.8	2.0	0.8 b	29.8 a	2.3
Triple Crown	4.5 fl. oz	51.5	2.8	2.5 b	4.5 c	0.0
Mustang Max	4 fl. oz	108.8	0.5	3.0 b	1.3 bc	2.8
Hero	6.4 fl. oz	95.8	1.5	1.8 b	3.5 c	0.0
Hero	7.1 fl. oz	116.3	2.0	1.5 b	2.0 c	0.0
Hero	8 fl. oz	93.8	1.0	4.0 ab	3.0 c	0.0
Experimental	n/a	85.3	1.5	3.8 ab	7.0 bc	5.0
Experimental	n/a	50.3	1.3	8.0 a	6.3 bc	4.3
Radiant + NIS	6 fl. oz + 0.25% v/v	54.0	1.5	0.3 b	15.3 b	5.5
P-Value from Anova		ns	ns	0.0577	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 / acre	% dead stink bug	% moribund stink bug	% dead and moribund stink bug
Untreated Control		4.2 b	0.0 b	4.2 d
Triple Crown	4.5 fl. oz	35.0 a	17.5 ab	52.5 ab
Mustang Max	4 fl. oz	56.7 a	5.0 b	61.7 ab
Hero	6.4 fl. oz	55.7 a	0.0 b	55.7 ab
Hero	7.1 fl. oz	54.2 a	4.2 b	58.3 ab
Hero	8 fl. oz	44.2 a	33.3 a	77.5 a

Experimental	n/a	35.0 a	0.0 b	35.0 bc
Experimental	n/a	12.5 b	4.2 b	16.7 cd
Radiant + NIS	6 fl. oz + 0.25% v/v	46.7 a	4.2 b	50.8 ab
P-Value from Anova		0.0003	0.0456	0.003

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 INSECTS AND STINK BUGS IN SOYBEANS

Location: ESAREC, Painter, VA
Variety: NK549-A5
Plant Date: 15 Jul 2013
Experimental Design: 8 treatments arranged in a RCB design with 4 reps – 3 rows x 20 ft. (2.5-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 110003VS spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates: 27 Aug, 3 and 10 Sep

Table 1. Efficacy of insecticides for the control of insects in soybeans, Painter, VA 2013 (lepidopteran pests)

		Mean no. lepidopteran larvae				
Treatment	**Rate / acre**	**3-Sep**	**10-Sep**	**17 Sep Soybean looper**	**17 Sep Green cloverworm**	**Total lepidopteran pests 17-Sep**
Vydate L	32 fl. oz	1.8	4.0	14.0 a	0.0 bc	14.3 a
Lannate LV	24 fl. oz	0.0	2.5	0.5 c	0.0 c	0.5 c
Lannate LV + Asana XL	24 fl. oz + 6 fl. oz	0.3	2.0	0.8 c	0.0 bc	0.8 c
Besiege	9 fl. oz	1.0	0.5	1.0 c	0.0 bc	1.0 c
Belt	2.5 fl. oz	0.0	1.3	0.0 c	0.0 bc	0.0 c
Belt + Besiege	3 fl. oz + 9 fl. oz	0.3	0.5	0.0 c	0.0 bc	0.0 c
Endigo ZCX	4.5 fl. oz	0.3	2.8	6.8 b	0.3 bc	7.5 b
Untreated Control		0.3	5.5	2.0 bc	2.0 a	4.5 bc
P-Value from Anova		ns	ns	0.0003	0.0007	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).

Table 2. Efficacy of insecticides for the control of insects in soybeans, Painter, VA 2013 (stink bugs & beetles)

		Mean no. stink bugs			Mean no. bean leaf beetles		
Treatment	**Rate / acre**	**3-Sep**	**10-Sep**	**17-Sep**	**3-Sep**	**10-Sep**	**17-Sep**
Vydate L	32 fl. oz	0.0	0.0 b	0.3	4.8	3.0	1.5 a
Lannate LV	24 fl. oz	0.3	0.3 b	0.0	3.3	0.5	0.8 ab
Lannate LV + Asana XL	24 fl. oz + 6 fl. oz	1.0	0.3 b	0.3	4.5	1.8	0.3 b
Besiege	9 fl. oz	0.5	0.0 b	0.0	3.5	0.0	0.0 b
Belt	2.5 fl. oz	1.3	0.0 b	1.0	3.5	0.8	1.0 ab
Belt + Besiege	3 fl. oz + 9 fl. oz	1.3	0.0 b	0.0	4.8	2.8	0.3 b
Endigo ZCX	4.5 fl. oz	0.3	0.0 b	0.0	4.0	4.0	0.0 b
Untreated Control		0.3	1.3 a	0.5	2.0	1.5	1.5 a

P-Value from Anova	ns	0.0128	ns	ns	ns	0.0522

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).

Table 3. Efficacy of insecticides for the control of insects in soybeans, Painter, VA 2013 (beneficial insects)

		Mean no. beneficial insects							
		10-Sep / 30 sweeps				17-Sep / 3 beat sheets			
Treatment	Rate / acre	Lady bugs	Predatory insects	Parasitic hymenopterans	Mean total beneficials	Lady bugs	Predatory insects	Parasitic hymenopterans	Mean no. total beneficials
Vydate L	32 fl. oz	0.5	0.5	0.5	1.5	0.0	0.0	0.0	0.0
Lannate LV	24 fl. oz	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5
Lannate LV + Asana XL	24 fl. oz + 6 fl. oz	0.0	0.5	0.0	0.5	0.0	0.5	0.3	0.8
Besiege	9 fl. oz	0.0	0.3	0.0	0.3	0.0	0.3	0.3	0.5
Belt	2.5 fl. oz	0.0	1.0	0.3	1.3	0.0	0.3	0.5	0.8
Belt + Besiege	3 fl. oz + 9 fl. oz	0.0	0.8	0.0	0.8	0.3	0.0	0.3	0.5
Endigo ZCX	4.5 fl. oz	0.0	0.3	0.3	0.5	0.0	0.0	1.3	1.3
Untreated Control		0.0	2.8	0.0	2.8	0.3	0.3	0.0	0.5
P-Value from Anova		ns	ns	ns	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).

RESIDUAL EFFICACY OF FOLIAR INSECTICIDES IN SOYBEANS

Location: Kentland Research Center, Blacksburg, VA
Variety: SS 4312N R2
Plant Date: 20 May 2013
Experimental Design: 10 treatments arranged in a RCB design with 4 reps – 8 rows x 24 ft.
Treatment Method: All foliar treatments were applied with a 4-nozzle boom equipped with 110003VS spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 30 GPA.
Treatment Dates: 21 Jul and 15 Aug
Procedures: 1, 5, 10 and 15 DAT1, one compound leaf collected from the top canopy of the middle of each plot was placed in a 1-liter plastic container with 10 Mexican bean beetle adults (*Epilachna varivestis*) collected from untreated snap beans located at Kentland Farm. At 1, 5, 10, 13, 18, 22, 25 and 34 DAT2, the procedure was repeated.

Table 1. Mortality of Mexican bean beetle adults placed on soybean leaves at various days after foliar applications of insecticide treatments to soybeans at flowering stage, Blacksburg, VA, 2013

Treatment	Rate / acre	Proportion dead beetles after 72 hrs			
		1 DAT	5 DAT	10 DAT	15 DAT

UTC		0.0 b	0.1 c	0.1 b	0.0
Doubletake	2.0 fl. oz	0.8 a	0.8 ab	0.2 ab	0.0
Doubletake	4.0 fl. oz	0.9 a	0.9 ab	0.3 ab	0.0
Lorsban Advanced	32.0 fl. oz	1.0 a	0.8 ab	0.1 b	0.0
Karate Z	1.9 fl. oz	1.0 a	0.8 ab	0.3 ab	0.0
MustangMaxx	4.0 fl. oz	1.0 a	1.0 ab	0.1 b	0.0
Brigade 2EC	6.4 fl. oz	1.0 a	0.9 ab	0.1 b	0.0
Orthene 97	16.0 oz	0.5 ab	0.4 bc	0.3 ab	0.0
Endigo ZCX	4.5 fl. oz	1.0 a	1.0 a	0.4 ab	0.0
Leverage 360	2.8 fl. oz	1.0 a	1.0 a	0.6 a	0.2
P-Value from Anova		<.0001	<.0001	0.016	ns

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

Table 2. Mortality of Mexican bean beetle adults placed on soybean leaves at various days after foliar applications of insecticide treatments to soybeans at R-3 pod stage, Blacksburg, VA, 2013

Treatment	Rate / acre	Proportion dead beetles after 72 hrs						
		5 DAT	10 DAT	13 DAT	18 DAT	22 DAT	25 DAT	34 DAT
UTC		0.0 b	0.3 b	0.2	0.1	0.1 b	0.1 b	0.00
Doubletake	2.0 fl. oz	0.8 a	0.8 ab	0.3	0.5	0.0 b	0.0 b	0.00
Doubletake	4.0 fl. oz	0.6 a	1.0 a	0.7	0.6	0.2 a	0.0 b	0.00
Lorsban Advanced	32.0 fl. oz	0.3 ab	0.7 ab	0.5	0.4	0.1 b	0.0 b	0.00
Karate Z	1.9 fl. oz	0.8 a	0.9 ab	0.5	0.2	0.0 b	0.0 b	0.00
MustangMaxx	4.0 fl. oz	0.9 a	1.0 a	0.5	0.2	0.0 b	0.0 b	0.00
Brigade 2EC	6.4 fl. oz	0.5 ab	1.0 a	0.9	0.5	0.2 a	0.0 b	0.00
Orthene 97	16.0 oz	0.3 ab	0.7 ab	0.2	0.2	0.0 b	0.0 b	0.00
Endigo ZCX	4.5 fl. oz	0.8 a	1.0 a	0.7	0.4	0.2 a	0.5 a	0.00
Leverage 360	2.8 fl. oz	0.7 a	0.9 ab	0.7	0.5	0.4 a	0.6 a	0.10
P-Value from Anova		0.0003	0.017	ns	ns	0.018	< 0.001	ns

All data were analyzed using analysis of variance procedures. Means were separated using Tukey's HSD 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 INSECTS IN SUMMER SQUASH: 1

Location: ESAREC, Painter, VA
Variety: Payroll
Plant Date: 1 Aug 2013
Experimental Design: 11 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 110003VS spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates: 23, 30 Aug, 6 Sep.

		Mean no. dead cucumber beetles		Mean no. live cucumber beetles / 5 plants	Mean no. melon aphids / 10 leaves			Total mean no. marketable-size fruit
Treatment	Rate / acre	30-Aug	6-Sep	30-Aug	30-Aug	6-Sep	13-Sep	

Untreated Control		0.5	0.3 c	4.8	112.5 a	52.0 ab	7.3 a	12.0
Closer + NIS	1.5 fl. oz + 0.25% v/v	n/a	2.0 c	n/a	n/a	0.0 c	0.0 b	16.3
Closer + NIS	2 fl. oz + 0.25% v/v	n/a	0.8 c	n/a	n/a	0.0 c	0.3 b	13.3
Fastac	3.8 fl. oz	0.0	5.5 bc	6.0	82.3 ab	84.5 a	6.3 a	13.3
Hero	5.12 fl. oz	0.0	3.8 c	4.3	45.0 bc	97.3 a	4.5 ab	10.3
Mustang Max	4 fl. oz	0.0	2.3 c	4.3	98.3 a	28.3 bc	4.0 ab	12.3
Gladiator	18 fl. oz	1.0	4.5 c	4.5	46.3 bc	83.8 a	3.0 ab	13.0
Beleaf	2.8 oz	0.3	0.0 c	2.8	4.8 c	0.8 c	0.0 b	12.8
Triple Crown	4.5 fl. oz	1.8	8.3 bc	3.3	17.8 c	18.0 bc	0.5 b	14.0
Venom	2 oz	1.3	75.5 a	3.8	15.3 c	1.5 c	1.0 b	12.0
Voliam Flexi	4 fl. oz	1.3	20.0 b	3.0	2.3 c	4.0 bc	0.0 b	10.0
P-Value from Anova		ns	<0.0001	ns	0.0002	0.0003	0.0173	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 INSECTS IN SUMMER SQUASH: 2

Location: HRAREC, Virginia Beach, VA
Variety: Payroll
Transplant Date: 18 Jul 2013
Experimental Design: 9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 110003VS spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates: 14, 21 and 28 Aug

		Mean no. cucumber beetles / 5 plants		Mean no. squash bugs / 5 plants						Mean no. melon aphids / 10 leaves	
				Adult		Nymphs		Egg Masses			
Treatment	**Rate / acre**	**21-Aug**	**28-Aug**	**21-Aug**	**28-Aug**	**21-Aug**	**28-Aug**	**21-Aug**	**28-Aug**	**28-Aug**	**5-Sep**
Untreated Control		7.5	3.8	0.3	0.3	0.3	3.8	0.8	0.0	184.5 bc	47.0 bc
Fastac	3.8 fl. oz	7.6	2.4	0.0	0.0	0.0	0.0	0.6	0.2	494.8 a	116.2 ab
Hero	5.12 fl. oz	11.7	4.0	0.3	0.0	0.0	0.0	0.3	0.0	506.7 ab	140.7 ab
Mustang Max	4 fl. oz	11.0	2.3	0.0	0.0	0.0	1.5	0.8	0.0	423.8 ab	186.5 ab
Gladiator	18 fl. oz	8.5	1.0	0.0	0.0	0.0	0.0	0.5	0.0	283.8 abc	139.5 ab
Beleaf	2.8 oz	7.0	1.8	0.0	0.0	0.5	0.3	0.3	0.3	5.5 c	0.0 c
Triple Crown	4.5 fl. oz	9.0	5.0	0.3	0.0	0.3	0.0	0.0	0.5	116.8 c	31.8 bc
Venom	2 oz	17.0	4.3	0.8	0.0	0.8	0.0	1.3	0.3	7.5 c	2.3 c
Voliam Flexi	4 fl. oz	11.5	5.5	0.0	0.3	0.0	1.8	1.0	2.3	5.3 c	0.3 c
P-Value from Anova		ns	ns	ns	ns	ns	ns	ns	ns	0.0017	0.0086

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 INSECTS IN HUBBARD SQUASH

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Blue Hubbard
Plant Date:	22 Jul 2013
Experimental Design:	9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with 110003VS spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates:	10 and 21 Aug

		Mean no. cucumber beetles / 5 plants				Mean no. aphids / 10 leaves		Mean no. marketable fruit/20 ft row
Treatment	**Rate / acre**	**14-Aug**	**19-Aug**	**26-Aug**	**5-Sep**	**26-Aug**	**5-Sep**	
Untreated Control		7.3 ab	10.5 a	1.8	1.8	71.5	23.0	6.0
Hero EC	5.12 fl. oz	0.0 c	0.3 b	0.0	0.5	70.3	57.0	5.8
Mustang Max	4 fl. oz	0.0 c	0.8 b	0.0	1.0	29.0	176.8	6.5
Gladiator	18 fl. oz	0.8 c	3.3 b	0.3	0.3	165.0	30.8	8.5
Beleaf 50SG	2.8 oz	6.5 ab	9.5 a	3.8	0.5	0.0	0.3	6.3
Triple Crown	4.5 fl. oz	0.0 c	2.8 b	0.3	0.3	0.0	8.3	7.3
Venom 70SG	2 oz	7.5 a	8.5 a	2.3	2.0	0.5	0.8	7.0
Voliam Flexi 40WDG	4 oz	3.5 bc	2.8 b	1.3	2.5	1.0	1.0	6.0
Assail 30SG + Lambda-Cy 1E	4 oz + 2.56 fl. oz	0.8 c	1.0 b	0.0	0.8	0.5	7.8	7.3
P-Value from Anova		0.0001	<0.0001	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).

CONTROL OF LEPIDOPTERAN INSECTS IN SWEET CORN: 1

Location:	ESAREC, Painter, VA
Variety:	Merit
Plant Date:	5 Jul 2013
Experimental Design:	9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method:	All foliar treatments were applied with a 1-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates:	23, 26, 28, 30 Aug and 2, 4 Sep (6 applications) beginning at silking

Treatment	Rate / Acre	Mean no. lepidopteran larvae* / 25	% clean ears	% ears with tip damage	% marketable ears (clean

		ears		only	or tip damage only)
Untreated Control		38.3 a	0.0 c	11.0	11.0 c
Besiege (3 appl.) fb. Warrior II plus Lannate LV (3 appl.)	9 fl. oz fb. 1.92 fl. oz + 24 fl. oz	8.8 b	85.0 a	6.0	91.0 a
Hero fb. Hero fb. Hero fb. Mustang Max + Lannate LV fb. Hero + Lannate LV fb. Mustang Max + Lannate LV	6.4 fl. oz fb 6.4 fl. oz fb 6.4 fl. oz fb 4 fl. oz + 16 fl. oz fb 6.4 fl. oz + 16 fl. oz fb 4 fl. oz + 16 fl. oz	6.8 b	54.0 b	19.0	73.0 b
Hero fb. Hero fb. Hero fb. Mustang Max fb. Mustang Max fb. Hero	6.4 fl. oz fb 6.4 fl. oz fb. 6.4 fl. oz fb 4 fl. oz fb. 4 fl. oz fb 6.4 fl. oz	8.3 b	46.0 b	19.0	65.0 b
Hero fb. Hero fb. Hero fb. Mustang Max fb. Hero fb. Mustang Max	6.4 fl. oz fb 6.4 fl. oz fb 6.4 fl. oz fb 4 fl. oz fb 6.4 fl. oz fb 4 fl. oz	7.0 b	46.0 b	16.0	62.0 b
Fastac (6 appl.)	3.8 fl. oz	10.3 b	48.0 b	16.0	64.0 b
P-Value from Anova		<0.0001	<0.0001	ns	<0.0001

***48% corn earworm; 43% armyworm; 9% European corn borer**

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 INSECTS IN SWEET CORN: 2

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	Applause
Plant Date:	15 Jun 2013
Experimental Design:	10 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (3-ft row centers)
Treatment Method:	All foliar treatments were applied with a 1-nozzle boom equipped with 45 cores and D3 spray tips and powered by Solo backpack sprayer delivering 53 GPA.
Treatment Dates:	2, 6, 9, 14, 19, 25 and 28 Aug.

Treatment	Rate / acre	Mean no. corn earworm	% ears with tip damage	% unmarketable ears	% stink bug damage	% total damage

		/ 20 ears	only			
Untreated Control		15.0 a	47.5 a	28.8 a	8.8	85.0 a
Hero fb Hero fb Hero fb Mustang Max + Lannate fb Hero + Lannate LV fb Mustang Max + Lannate LV + Mustang Max + Lannate LV	6.4 fb 6.4 fb 6.4 fb 4 + 16 fb 6.4 + 16 fb 4 + 16 fb 4 + 16 fl. oz	0.0 c	1.3 cd	0.0 c	8.8	10.0 cde
Hero fb Hero fb Hero fb Mustang Max fb Mustang Max fb Hero fb Mustang Max	6.4 fb 6.4 fb 6.4 fb 4 fb 4 fb 6.4 fb 4 fl. oz	0.5 c	2.5 cd	0.0 c	8.8	11.3 bcd
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 fl. oz	0.5 c	2.5 cd	0.0 c	1.3	3.8 de
Bifenthrin 2EC	6.4 fl. oz	0.0 c	0.0 d	0.0 c	1.3	1.3 e
Besiege SC	6 fl. oz	1.0 bc	8.8 bc	0.0 c	10.0	18.8 bc
Endigo ZCX	4.5 fl. oz	0.0 c	0.0 d	0.0 c	7.5	7.5 de
Fastac	2.8 fl. oz	0.0 c	1.3 cd	0.0 c	1.3	2.5 de
Permethrin 3.2EC	8 fl. oz	0.3 c	2.5 cd	0.0 c	0.0	2.5 de
Lannate LV	16 fl. oz	2.8 b	16.3 b	5.0 b	2.5	16.3 b
P-Value from Anova		<0.0001	<0.0001	0.0001	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 SLUGS IN SWEET CORN

Location: Kentland Research Farm, Blacksburg, VA
Variety: Argent
Plant Date: 9 Apr 2013
Experimental Design: 5 treatments arranged in a RCB design with 4 reps – 2 rows x 20 ft. (3-ft row centers)
Treatment Method: All foliar treatments were applied with a 1-nozzle boom equipped with 8003VS spray tips and powered by a Solo backpack sprayer delivering 38GPA.
Treatment Dates: 5 Jun

			% slug feeding	
Treatment	**Rate / acre**	**Stand**	**13-Jun**	**19-Jun**
Untreated Control		40.5	45.0	37.5
Sluggo	10 lbs	43.3	35.0	32.5
Sluggo	22 lbs	42.5	20.0	27.5
Ortho 3.35% metaldehyde granules	12. 3 lbs	37.5	42.5	25.0
Lannate LV	24 fl. oz	41.5	35.0	35.0
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 WIREWORMS IN SWEET POTATOES

Location:	ESAREC, Painter, VA
Variety:	Hernandez
Plant Date:	6 Jun 2013
Experimental Design:	9 treatments arranged in a RCB design with 4 reps – 3 rows x 20 ft. (3-ft row centers)
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. All broadcast PPI treatments were applied in 1800 ml of water at 15 GPA using a 3 nozzle boom equipped with 11003VS spray tips powered by a CO2 backpack sprayer at 40psi. Incorporation was done mechanically with a small field cultivator. Ditera DF was applied by shaking granules uniformly over row area and incorporating as aforementioned. Post-emergence treatments were applied using the same methods as described above.
Treatment Dates:	In-furrow and pre-plant incorporated: 11 Apr Post-emergence: 24 Jun

Treatment	Rate / acre	Timing of application	Vigor 15 Jul	Vigor 8 Aug	Total yield (in lbs)	% wireworm damage	% grub damage	% total damage
Untreated Control			1069.3	1751.3	108.9	12.1 a	10.8	22.9
Lorsban + Sniper	64 fl. oz + 19.2 fl.oz	Broadcast PPI + Post-emergence	1796.8	1828.3	103.1	2.5 c	5.8	8.3
Ditera DF + Belay + Sniper	50 lbs + 12 fl. oz + 19.2 fl. oz	Broadcast PPI + Broadcast PPI + Post-emergence	945.4	1780.5	100.5	6.3 bc	6.3	12.5
Ditera DF + Belay + Sniper	50 lbs + 8 fl. oz + 19.2 fl. oz	Broadcast PPI + in-furrow + Post-emergence	837.6	1827.2	95.2	10.4 ab	4.6	15
Belay + Sniper	12 fl. oz + 19.2 fl. oz	Broadcast PPI + Post-emergence	984.2	1579.1	93.4	4.2 bc	3.3	7.5
Lorsban	64 fl. oz	Broadcast PPI	723.3	1586.0	96.3	7.5 abc	6.7	14.2
Lorsban + Sniper	64 fl. oz + 19.2 fl.oz	Broadcast PPI + Post-emergence	610.7	1396.0	93.6	4.2 bc	6.3	10.4
Belay + Sniper	12 fl. oz + 19.2 fl. oz	Broadcast PPI + Post-emergence	982.0	1604.9	97.9	6.7 abc	5.8	12.5
Belay + Sniper + Sniper	9 fl. oz + 9.6 fl. oz + 19.2 fl. oz	Broadcast PPI + Broadcast PPI + Post-emergence	941.5	1402.0	80.9	4.2 c	9.2	13.3

P-Value from anova		ns	ns	ns	0.0358	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 POTATO APHIDS IN SPRING TOMATOES

Location: HRAREC, Virginia Beach, VA
Variety: Florida 47
Transplant Date: 24 Apr 2013
Experimental Design: 7 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates: 8 and 22 May

		Mean no. potato aphids			
Treatment	**Rate / acre**	**15-May**	**21-May**	**29-May**	**5-Jun**
Untreated Control		50.3 a	91.8 a	8.8 a	18.8
Sivanto	7 fl. oz	0.8 b	2.5 b	0.0 b	3.0
Sivanto	10.5 fl. oz	0.0 b	1.3 b	0.0 b	0.3
Closer	1.5 fl. oz	3.0 b	13.3 b	0.0 b	2.0
Closer	2 fl. oz	1.5 b	2.3 b	0.0 b	1.3
Movento	5 fl. oz	8.3 b	13.5 b	0.3 b	1.5
HGW86 10SE	13 fl. oz	0.0 b	0.0 b	0.0 b	0.0
P-Value from Anova		0.0001	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).

CONTROL OF THRIPS IN SPRING TOMATOES

Location: ESAREC, Painter, VA
Variety: Florida 47
Transplant Date: 25 Apr 2013
Experimental Design: 5 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates: 11, 18, 27 Jun, 3, 10 and 15 Jul

		Mean no. thrips*												Mean no. *Orius* bugs/ 10 compound leaves
		18-Jun		26-Jun		5-Jul		10-Jul		15-Jul		22-Jul		
Treatment	**Rate / acre**	**Larvae**	**Adult**	**Larvae**	**Adult**	**Larvae**	**Adult**	**Larvae**	**Adult**	**Larvae**	**Adult**	**Larvae**	**Adult**	
Untreated Control		9.0	5.5	0.3 b	12.0	1.3	3.3	9.3	1.5	4.0 a	4.0	4.0 a	2.0	0.3
Radiant + NIS	6 fl. oz + 0.25% v/v	1.8	4.5	0.0 b	8.3	0.5	1.0	0.3	2.5	0.3 b	1.3	0.3 b	3.5	0.0

Experimental	n/a	0.5	4.3	0.0 b	8.8	0.5	2.5	0.0	0.8	0.8 b	3.3	0.5 b	1.3	0.3
Experimental	n/a	1.5	5.0	0.0 b	15.0	0.8	3.3	0.0	1.3	0.0 b	2.3	0.3 b	1.5	0.0
Fastac	3.8 fl. oz	5.8	7.8	3.3 a	19.0	1.8	2.0	3.0	2.5	1.3 b	1.3	1.5 b	2.0	0.3
P-Value from Anova		ns	ns	0.0254	ns	ns	ns	ns	ns	0.0379	ns	0.0095	ns	ns

*18 Jun: 60% tobacco thrips; 40% flower thrips
26 Jun: 88% tobacco thrips; 12% flower thrips
5 Jul: 79% tobacco thrips; 21% flower thrips
10 Jul: 92% tobacco thrips; 8% flower thrips
15 Jul: 47% tobacco thrips; 53% flower thrips
22 Jul: 65% tobacco thrips; 17% cereal thrips; 19% flower thrips

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	% thrips damage	% stink bug damage
Untreated Control		10.4 ab	7.5 ab
Radiant + NIS	6 fl. oz	7.5 abc	9.2 ab
Experimental	n/a	7.5 ab	0.0 c
Experimental	n/a	14.2 a	9.2 a
Fastac	3.8 fl. oz	4.2 bc	0.0 bc
P-Value from Anova		0.0168	0.0175

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 IN INSECTS IN SPRING TOMATOES

Location:	ESAREC, Painter, VA
Variety:	Florida 47
Transplant Date:	13 Jun 2013
Experimental Design:	6 treatments arranged in a RCB design with 4 reps – 1 row x 40 ft. (6 ft. row centers) on plastic mulch
Treatment Method:	All at-planting treatments were applied by digging a hole with a spade for each transplant, pouring 100 ml of insecticide solution in the hole, setting the transplant in it and covering the root zone with soil. All drip chemigation treatments were applied with the use of HN55 Chemical injectors (Chemilizer Products Inc., Largo, FL). Each insecticide amount was diluted in 150 ml of water, poured into the chemilizer feeding tube and flushed with an additional 300 ml of water.
Treatment Dates:	At-planting treatment dates: 13 Jun Drip irrigation treatment dates: 27 Jun (treatments 2 and 6) and 11 Jul (treatments 2 only); 3 Jul and 17 Jul (Treatment 3-Coragen)

Treatment	Rate / acre	Mean no. thrips / 10 leaves 12 Jul	% thrips damage at harvest	% lepidopteran damage at harvest	% stink bug damage at harvest
Untreated control		0.8	11.0	11.0	4.0
Admire Pro (at planting) + Verimark (drip irrigation 14 DAP) + Verimark (drip irrigation 28 DAP)	10.5 fl. oz + 10 fl. oz + 10 fl. oz	0.5	4.0	6.5	3.0
Admire Pro (at planting) + Coragen	10.5 fl. oz	0.3	6.5	8.5	5.0

(drip irrigation)	+ 5 fl. oz				
Admire Pro (at planting)	10.5 fl. oz	0.3	3.5	11.0	6.5
Verimark (at planting)	13.5 fl. oz	0.0	10.0	5.0	4.5
Verimark (at planting) + Admire Pro (drip irrigation)	13.5 fl. oz + 10.5 fl. oz	1.0	8.1	8.4	2.0
P-Value from ANOVA		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).

					Yield (in lbs)				
Treatment	**Rate / acre**	**Mean no. blossoms / 3 plants**	**Mean no. fruit / 3 plants**	**Vigor rating**	**Small fruit**	**Medium fruit**	**Large fruit**	**X-large fruit**	**Total Yield**
Untreated control		175.5	10.0	100.0 cd	7.8	3.4	6.5	4.5	22.3
Admire Pro (at planting) + Verimark (drip irrigation 14 DAP) + Verimark (drip irrigation 28 DAP)	10.5 fl. oz + 10 fl. oz + 10 fl. oz	205.5	7.3	120.0 a	12.7	3.8	4.1	3.6	24.2
Admire Pro (at planting) + Coragen (drip irrigation)	10.5 fl. oz + 5 fl. oz	173.8	9.8	105.0 bcd	4.4	1.1	3.0	3.5	11.9
Admire Pro (at planting)	10.5 fl. oz	154.5	5.5	97.5 d	9.0	2.2	2.9	3.3	17.4
Verimark (at planting)	13.5 fl. oz	209.5	8.5	111.3 abc	12.2	5.2	5.9	4.5	27.7
Verimark (at planting) + Admire Pro (drip irrigation)	13.5 fl. oz + 10.5 fl. oz	170.5	8.5	112.5 ab	9.1	4.3	5.6	4.6	23.5
P-Value from Anova		ns	ns	0.008	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).

CONTROL OF LEPIDOPTERAN INSECTS IN FALL TOMATOES: 1

Location: ESAREC, Painter, VA
Variety: HBN602
Transplant Date: 22 Jul 2013
Experimental Design: 7 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates: 26 Aug, 2 Sep, 9 Sep, 16 and 25 Sep.

Treatment	Rate / acre	Mean no. lepidopteran larvae / 5 plants		Mean no. potato aphids / 5 plants	% lepidopteran damage to fruit	
		2-Sep	9-Sep		4-Oct	16-Oct
Untreated Control		1.5 a	3.5 a	0.8	25.0 a	4.2
Coragen 20SC	5 fl. oz	0.0 b	0.0 c	0.0	3.3 b	0.0
Avaunt 30WG	3.5 oz	0.0 b	0.0 c	93.0	0.0 c	0.0
Belt	1.5 fl. oz	0.0 b	0.0 c	0.0	3.3 bc	0.0
Radiant + NIS	6 fl. oz + 0.25% v/v	0.0 b	0.5 bc	1.3	2.5 bc	0.0
Voliam Xpress	9 fl. oz	0.0 b	0.0 c	0.0	0.0 c	0.0
Fastac	3.8 fl. oz	0.0 b	0.8 b	0.0	32.5 a	1.7
P-Value from Anova		0.0002	<0.0001	ns	<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).

CONTROL OF LEPIDOPTERAN INSECTS IN FALL TOMATOES: 2

Location: ESAREC, Painter, VA
Variety: HBN602
Transplant Date: 22 Jul 2013
Experimental Design: 9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)
Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Treatment Dates: 27 Aug, 4, 10, 17 and 24 Sep.

Treatment	Rate / acre	Mean no. lepidopteran larvae / 5 plants		% lepidopteran damage	
		3-Sep	10-Sep	17-Sept	1-Oct
Untreated Control		1.5	2.3 a	13.3	12.5 a
Dipel DF	4 oz	0.5	0.3 b	3.3	5.8 ab
Esteem	5 oz	0.5	0.3 b	8.3	11.7 a
Dipel DF + Esteem	2 oz + 3oz	1.0	0.3 b	0.0	3.3 ab
Dipel DF + Esteem	2 oz + 5 oz	0.5	0.3 b	6.7	5.0 ab
Dipel DF + Esteem	4 oz + 3 oz	0.0	0.0 b	0.0	0.0 b
Dipel DF + Esteem	5 oz + 5 oz	0.0	0.0 b	3.3	4.2 ab
Coragen 20SC	5 fl. oz	0.0	0.0 b	1.7	0.0 b
Belt	1.5 fl. oz	0.3	0.0 b	1.7	0.0 b
P-Value from Anova		ns	<0.0001	ns	0.0288

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 INSECTS IN FALL TOMATOES: 3

Location: ESAREC, Painter, VA
Variety: HBN602
Transplant Date: 22 Jul 2013
Experimental Design: 9 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. (6-ft row centers)

Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.

Treatment Dates: 29 Aug, 5, 12, 19 and 26 Sep.

		Mean no. lepidopteran larvae / 5 plants		% lepidopteran damage	
Treatment	**Rate / acre**	**5-Sep**	**12-Sep**	**19-Sep**	**1-Oct**
Untreated Control		2.3	3.3 a	11.7 a	15.0 a
Esteem + Radiant	5 oz + 2 fl. oz	0.3	0.5 bc	0.0 b	3.3 b
Esteem + Radiant	3 oz + 2 fl. oz	0.3	0.0 c	5.0 ab	4.2 b
Esteem	5 oz	1.0	1.3 ab	15.0 a	10.8 a
Radiant	2 fl. oz	0.5	0.3 bc	5.0 ab	2.5 b
Radiant	6 fl. oz	0.5	0.5 bc	0.0 b	2.5 b
Belt	1.5 fl. oz	0.0	0.0 c	1.7 b	0.0 b
Experimental	n/a	0.3	0.3 bc	1.7 b	1.7 b
Experimental	n/a	0.0	0.0 c	0.0 b	1.7 b
P-Value from Anova		ns	0.0175	0.0193	0.0016

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 WATERMELONS

Location: HRAREC, Virginia Beach, VA

Variety: Jamboree

Transplant Date: 11 Jul 2013

Experimental Design: 4 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft. on plastic mulch (6-ft row centers)

Treatment Method: All foliar treatments were applied with a 3-nozzle boom equipped with 45 cores and D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.

Treatment Dates: 22 Jul

		Pre-count (per 10 leaves)		3 DAT (per 10 leaves)			7 DAT (per 10 leaves)			14 DAT (per 10 leaves)	
Treatment*	**Rate / acre**	**Eggs**	**Motiles**	**Eggs**	**Motiles**	**Pred. mites**	**Eggs**	**Motiles**	**Pred. mites**	**Eggs**	**Motiles**
Untreated Control		23.3	4.8	22.3	14.8	1.0	34.3	18.0	1.0	0.0	0.8
GWN-1708	24 fl oz	23.0	4.0	3.5	5.0	0.0	7.3	2.0	0.0	0.0	0.8
GWN-1708	32 fl oz	37.5	8.8	23.5	8.0	0.3	13.0	4.0	0.3	0.0	0.5
Oberon 2SC	8.5 fl oz	10.5	7.0	43.5	3.0	0.3	3.8	2.8	1.0	0.0	1.5
P-Value from Anova		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

* All treatments included 0.5% v/v non-ionic surfactant.

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).

Bioassays with Esteem tank-mixed with Insecticides for enhanced control of lepidopteran larvae

Objective: To test the toxicity of field-rate applications of Dipel DF and Esteem on key lepidopteran pests of cole crops and fruiting vegetables

DIAMONDBACK MOTH (*PLUTELLA XYLOSTELLA*)

PROCEDURES:

- Populations of diamondback moth (DBM) larvae were collected from collards at the ESAREC in Painter, VA on 17 Jun. 9-cm disks were cut out of collards leaves. Disks were dipped into field-rate insecticidal concentrations for approximately 3 seconds, left to dry under a fume hood for one hour, and placed into 9-cm Petri dishes with 5 diamondback moth larvae. Each treatment had a total of 20 larvae (4 Petri dishes x 5 larvae).
- Insecticide solutions were based on 40 gal / acre water.
- Mortality and pupation were recorded at 1, 3, 7 and 10 days. The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 15:9 (L:D).
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of field-collected diamondback moth larvae fed collard leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% dead or moribund DBM			% pupated DBM		
Treatment	**amount / 500 ml water***	**1 DAT**	**3 DAT**	**7 DAT**	**1 DAT**	**3 DAT**	**7 DAT**
Dipel + NIS	0.39 g	30.0 bc	55.0	65.0 b	35.0 a	35.0 a	35.0 a
Esteem + NIS	0.49 g	35.0 b	70.0	85.0 ab	10.0 c	10.0 cd	15.0 abc
Dipel + Esteem + NIS	0.2 g + 0.29 g	25.0 bc	75.0	90.0 a	10.0 c	10.0 cd	10.0 bcd
Dipel + Esteem + NIS	0.2 g + 0.49 g	30.0 bc	75.0	95.0 a	5.0 c	5.0 d	5.0 cd
Dipel + Esteem + NIS	0.39 g + 0.29 g	80.0 a	80.0	95.0 a	5.0 c	5.0 d	5.0 cd
Dipel + Esteem + NIS	0.49 g + 0.49 g	85.0 a	80.0	100.0 a	0.0 c	0.0 d	0.0 d
Coragen 20SC + NIS	0.49 g	90.0 a	90.0	100.0 a	0.0 c	0.0 d	0.0 d
Belt + NIS	0.2 g	80.0 a	65.0	80.0 ab	15.0 bc	25.0 abc	25.0 ab
Untreated Control		0.0 c	65.0	65.0 b	30.0 ab	30.0 ab	35.0 a
Untreated Control + NIS		15.0 bc	70.0	85.0 ab	5.0 c	15.0 bcd	15.0 bcd

P-Value from Anova	<0.0001	ns	0.0076	0.0023	0.0029	0.0012

*NIS rate: 0.25% v/v

IMPORTED CABBAGEWORM (*PIERIS RAPAE*)

PROCEDURES:

- Imported cabbageworm larvae (3rd and 4th instars) were collected from collards planted at Virginia Tech Kentland Research Farm near Blacksburg, VA on 9 Sep. For each treatment, 20 cabbage disks (approx. 8 cm diameter.) were dipped in solution for 5 seconds and allowed to air dry for approximately ½ hour outside. Each cabbage disk was then placed in a 9-cm Petri dish with a single larva.
- Insecticide solutions were based on 40 gal / acre water.
- Mortality was determined at 24, 48, and 72 hrs after exposure.
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of field-collected imported cabbageworm fed cabbage disks dipped in field-rate insecticide concentrations, Blacksburg, VA, 2013

Treatment*	No. live larvae 72 hr	No. dead larvae 72 hr	No. larvae parasitized by *Cotesia glomerata*	No. adult parasitoids emerging	% Mortality 72 hr
Untreated control	12	3	5	83	15
Dipel 4 oz/A	0	20	0	0	100
Esteem 5 oz/A	5	13	2	3	65
Dipel 2 oz/A + Esteem 3 oz/A	1	17	2	0	85
Dipel 2 oz/A + Esteem 5 oz/A	0	19	1	0	95
Dipel 4 oz/A + Esteem 3 oz/A	1	19	0	0	95
Dipel 5 oz/A + Esteem 5 oz/A	0	19	2	32	91
Coragen 20SC 5 fl oz/A	0	13	7	107	65

*All treatments also received 0.5% v/v Biosurf NIS (including the untreated control)

CORN EARWORM (*HELICOVERPA ZEA*)

Larval Assays – Kentland Research Center

PROCEDURES:

- Corn earworm (*Helicoverpa zea*) larvae (3rd to 5th instars) were collected from sweet corn planted at Virginia Tech Kentland Research Farm near Blacksburg, VA on 9 Sep.
- For each treatment, 20 tomato leaves (variety = 'Babay cakes') were excised from untreated plants in the field and dipped in solution for 5 seconds and allowed to air dry for approx. ½ hour outside. A single leaf was then placed in a 9-cm Petri dish with a single larva.
- Insecticide solutions were based on 40 gal / acre water.
- Mortality was determined at 24, 48, and 72 hrs after exposure.
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of field-collected corn earworm larvae fed tomato leaves dipped in field-rate insecticide concentrations, Blacksburg, VA; 2013

Treatment	No. live larvae 72 h	No. dead larvae 72 h	No. moribund larvae 72 h	No. actively feeding larvae	% larval mortality 72 h
Untreated Control	20	0	0	20	15
Dipel 4 oz/A	14	6	0	0	100
Esteem 5 oz/A	19	0	1	0	65
Dipel 2 oz/A + Esteem 3 oz/A	15	5	0	0	85
Dipel 2 oz/A + Esteem 5 oz/A	17	3	0	0	95
Dipel 4 oz/A + Esteem 3 oz/A	17	3	0	0	95
Dipel 5 oz/A + Esteem 5 oz/A	14	6	0	0	91
Coragen 20SC 5 fl oz/A	1	6	13	0	65

*All treatments also received 0.5% v/v Biosurf NIS (including the untreated control)

Larval Assays – ESAREC

PROCEDURES:

- Populations of corn earworm (CEW) larvae were collected from sweet corn at the ESAREC in Painter, VA on 12 Sep. One corn earworm was placed into a vial with a treated tomato compound leaf for a total of 10 corn earworms in 10 vials for each treatment. Each tomato leaf was treated by dipping into field-rate insecticidal concentrations for approximately 3 seconds. Leaves were then left to dry under a fume hood for one hour before exposure to corn earworms.
- Insecticide solutions were based on 40 gal / acre water.
- Mortality and % feeding were recorded at 1, 3, 5, 7 and 10 days. The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 13:11 (L:D).
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of field-collected corn earworm larvae fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% dead CEW					% moribund CEW				
Treatment	amount / 500 ml water	1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	1 DAT	3 DAT	5 DAT	7 DAT	10 DAT
Untreated Control		0.0	0.0	10.0	60.0 ab	90.0	0.0 c	0.0 b	10.0 bc	0.0 b	0.0
Dipel DF	0.39 g	0.0	10.0	70.0	90.0 a	100.0	50.0 abc	10.0 b	0.0 c	0.0 b	0.0
Esteem	0.49 g	0.0	0.0	20.0	30.0 ab	70.0	20.0 bc	10.0 b	10.0 bc	10.0 b	20.0
Dipel DF + Esteem	0.2 g + 0.29 g	10.0	10.0	50.0	60.0 ab	100.0	20.0 bc	20.0 b	0.0 c	0.0 b	0.0
Dipel DF +	0.2 g + 0.49	0.0	40.0	60.0	90.0	100.0	0.0 c	0.0 b	0.0 c	0.0 b	0.0

Esteem	g				a						
Dipel DF + Esteem	0.39 g + 0.29 g	0.0	10.0	40.0	50.0 ab	90.0	70.0 ab	40.0 b	30.0 bc	10.0 b	10.0
Dipel DF + Esteem	0.49 g + 0.49 g	0.0	30.0	30.0	60.0 ab	90.0	40.0 abc	30.0 b	50.0 ab	30.0 b	10.0
Coragen 20SC	0.49 ml	10.0	10.0	10.0	20.0	100.0	90.0 a	90.0 a	90.0 a	80.0 a	0.0
P-Value from Anova		ns	ns	ns	0.0091	ns	<0.0001	<0.0001	<0.0001	<0.0001	ns

		% total dead & moribund CEW				
Treatment	**amount / 500 ml water**	**1 DAT**	**3 DAT**	**5 DAT**	**7 DAT**	**10 DAT**
Untreated Control		0.0 c	0.0 c	20.0 b	60.0 ab	90.0
Dipel DF	0.39 g	50.0 abc	20.0 bc	70.0 ab	90.0 ab	100.0
Esteem	0.49 g	20.0 bc	10.0 bc	30.0 b	40.0 b	90.0
Dipel DF + Esteem	0.2 g + 0.29 g	30.0 bc	30.0 bc	50.0 ab	60.0 ab	100.0
Dipel DF + Esteem	0.2 g + 0.49 g	0.0 c	40.0 bc	60.0 ab	90.0 ab	100.0
Dipel DF + Esteem	0.39 g + 0.29 g	70.0 ab	50.0 abc	70.0 ab	60.0 ab	100.0
Dipel DF + Esteem	0.49 g + 0.49 g	40.0 bc	60.0 ab	80.0 ab	90.0 ab	100.0
Coragen 20SC	0.49 ml	100.0 a	100.0 a	100.0 a	100.0 a	100.0
P-Value from Anova		<0.0001	<0.0001	0.0032	0.0165	ns

Table 2. Summary of feeding by field-collected corn earworm larvae fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% feeding				
Treatment	**amount / 500 ml water**	**1 DAT**	**3 DAT**	**5 DAT**	**7 DAT**	**10 DAT**
Untreated Control		16.3 a	61.5 a	71.5 a	77.5 a	77.5 a
Dipel DF	0.39 g	6.1 bc	37.0 bc	48.0 b	50.5 b	51.5 bc
Esteem	0.49 g	17.1 a	38.0 b	40.0 bc	47.0 bc	51.5 b
Dipel DF + Esteem	0.2 g + 0.29 g	7.6 b	14.7 de	27.4 cd	26.5 de	30.0 de
Dipel DF + Esteem	0.2 g + 0.49 g	1.5 cd	17.5 de	21.0 d	26.5 de	27.0 de
Dipel DF + Esteem	0.39 g + 0.29 g	2.7 c	21.7 cd	26.3 cd	30.5 cd	33.0 cd
Dipel DF + Esteem	0.49 g + 0.49 g	2.5 cd	7.4 ef	12.5 de	15.5 ef	16.5 ef
Coragen 20SC	0.49 ml	0.0 d	4.1 f	5.3 e	5.5 f	6.0 f
P-Value from Anova		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

BEET ARMYWORM (*SPODOPTERA EXIGUA*)

Egg Assays

PROCEDURES:

- Due to unusual low pressure in field settings, laboratory-reared beet armyworm (BAW) egg masses were purchased from Bio-Serv. Upon arrival of the egg masses, on 17 Sep, egg masses were cut from the wax paper, dipped into insecticidal concentrations for approximately 3 seconds, and placed into a 9-cm Petri dish lined with moistened paper filter.
- Insecticide solutions were based on 40 gal / acre water.

- The number of hatched eggs and dead eggs (no visible larvae with coloration change) were recorded at 1, 3 and 7 DAT. The number of dead and moribund larvae was also recorded at 1, 3 and 7 DAT. The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 13:11 (L:D).
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.
-

RESULTS:

Table 1. Summary of mortality data of laboratory-reared beet armyworm egg masses dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% egg hatch			% dead eggs (within egg mass)			% dead BAW larvae			% moribund BAW larvae		
Treatment	amount / 500 ml water	1 DAT	3 DAT	7 DAT	1 DAT	3 DAT	7 DAT	1 DAT	3 DAT	7 DAT	1 DAT	3 DAT	7 DAT
Untreated Control		0.0	58.3	62.5	0.0	0.0	0.0	0.0	0.0 c	0.0 d	0.0	8.3	2.8
Dipel DF	0.39 g	0.0	77.4	91.2	2.1	2.1	8.6	0.0	20.9 bc	46.7 bc	0.0	0.0	0.0
Esteem	0.49 g	0.0	68.9	75.0	28.7	0.0	0.0	0.0	8.3 bc	26.4 c	0.0	0.0	0.0
Dipel DF + Esteem	0.2 g+ 0.29 g	0.0	78.8	83.1	4.3	12.0	10.9	0.0	18.8 bc	19.7 c	0.0	0.0	0.0
Dipel DF + Esteem	0.2 g + 0.49 g	0.0	74.3	84.9	38.3	18.6	14.1	0.0	40.5 b	66.7 ab	0.0	0.0	0.0
Dipel DF + Esteem	0.39 g + 0.29 g	0.0	81.5	80.8	0.0	16.7	16.7	0.0	34.4 b	64.3 ab	0.0	1.1	0.0
Dipel DF + Esteem	0.49 g + 0.49 g	0.0	80.6	83.4	0.0	17.6	15.2	0.0	33.9 bc	50.4 bc	0.0	0.0	0.0
Coragen 20SC	0.49 g	0.0	71.3	86.8	3.2	15.0	13.2	0.0	95.8 a	86.8 a	0.0	0.0	0.0
P-Value from Anova		ns	ns	ns	ns	ns	ns	ns	0.0023	<0.0001	ns	ns	ns

Larval Assays

Experiment 1: 2nd instar larvae

PROCEDURES:

- Due to unusual low pressure in field settings, laboratory-reared beet armyworm (BAW) 2nd instar larvae were purchased from Bio-Serv. On 4 Sep, tomato compound leaves were dipped into insecticidal concentrations for approximately 3 seconds, left under a fume hood to dry for one hour and placed into a 9-cm Petri dish with 5 beet armyworm larvae.
- Insecticide solutions were based on 40 gal / acre water.
- Mortality was recorded at 24, 48 and 96 h. The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 13:11 (L:D).
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of laboratory-reared beet armyworm fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

Treatment	amount / 500 ml water	% dead or moribund BAW larvae		
		24 h	48 h	96 h
Untreated Control		10.0 a	65.0 d	95.0
Dipel DF	0.39 g	85.0 b	90.0 abc	100.0
Esteem	0.49 g	100.0 b	100.0 a	100.0
Dipel DF + Esteem	0.2 g+ 0.29 g	85.0 b	75.0 cd	100.0
Dipel DF + Esteem	0.2 g + 0.49 g	75.0 b	65.0 d	100.0
Dipel DF + Esteem	0.39 g + 0.29 g	90.0 b	95.0 ab	100.0
Dipel DF + Esteem	0.49 g + 0.49 g	75.0 b	80.0 bcd	100.0
Coragen 20SC	0.49 g	100.0 b	90.0 ab	100.0
P-Value from Anova		0.0001	0.0029	ns

➢ <u>Experiment 2: late instar larvae</u>

PROCEDURES:

- On 10 Sep, large instar laboratory-reared BAW larvae were used to replicate the early instar experiment aforementioned. All materials and methods were replicated.
- Insecticide solutions were based on 40 gal / acre water.
- The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 13:11 (L:D). Mortality was recorded at 1, 3, 5, 7 DAT. The number of live and dead pupae was also recorded at 1, 3, 5, 7 DAT. At 10 DAT, the number of emerged moths was recorded. % feeding was recorded at 3 DAT.
- All data were analyzed using analysis of variance procedures. Means were separated using Tukey's HSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of laboratory-reared beet armyworm egg masses fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

Treatment	amount / 500 ml water	% dead BAW larvae			% TOTAL PUPATION	% DEAD PUPAE		% LIVE PUPAE			% feeding	% emergence
		1 DAT	3 DAT	7 DAT		3 DAT	7 DAT	1 DAT	3 DAT	7 DAT		
Untreated Control		0.0	0.0 c	0.0 c	95.0 a	5.0 b	50.0 b	100.0	95.0 a	50.0 a	6.0	41.7 a
Dipel DF	0.39 g	10.0	10.0 bc	20.0 bc	85.0 ab	14.6 b	90.0 ab	100.0	85.4 a	10.0 ab	1.5	0.0 b
Esteem	0.49 g	0.0	0.0 c	0.0 c	100.0 a	35.0 ab	95.0 ab	100.0	65.0 ab	5.0 ab	1.0	0.0 b
Dipel DF + Esteem	0.2 g+ 0.29 g	10.0	60.0 a	75.0 a	25.0 cd	66.7 a	100.0 ab	0.0	33.3 b	0.0 ab	1.5	0.0 b
Dipel DF + Esteem	0.2 g + 0.49 g	0.0	5.0 bc	15.0 c	90.0 a	10.0 b	100.0 a	100.0	90.0 a	0.0 b	1.5	0.0 b
Dipel DF + Esteem	0.39 g + 0.29 g	15.0	50.0 ab	60.0 ab	45.0 bc	44.4 ab	100.0 ab	100.0	55.6 ab	0.0 ab	14.3	0.0 b
Dipel DF + Esteem	0.49 g + 0.49 g	10.0	85.0 a	85.0 a	15.0 cd	0.0 b	100.0 ab	0.0	100.0 a	0.0 ab	5.0	0.0 b
Coragen 20SC	0.49 g	0.0	80.0 a	100.0 a	0.0 d	n/a	n/a	n/a	n/a	n/a	0.0	0.0 b
P-Value from Anova		ns	<0.0001	<0.0001	<0.0001	0.0039	0.0258	ns	0.0039	0.0258	ns	0.0289

Objective: To test the toxicity of field-rate applications of Esteem and Radiant on key lepidopteran pests of cole crops and fruiting vegetables

BEET ARMYWORM (*SPODOPTERA EXIGUA*)

Egg Assays

PROCEDURES:

- Due to unusual low pressure in field settings, laboratory-reared beet armyworm (BAW) egg masses were purchased from Bio-Serv. Upon arrival of the egg masses, on 17 Sep, egg masses were cut from the wax paper, dipped into insecticidal concentrations for approximately 3 seconds, and placed into a 9-cm Petri dish lined with moistened paper filter.
- Insecticide solutions were based on 40 gal / acre water.
- The number of hatched eggs and dead eggs (no visible larvae and coloration change) were recorded at 1, 3 and 7 DAT. The number of dead and moribund larvae was also recorded at 1, 3 and 7 DAT. The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 13:11 (L:D).
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of laboratory-reared late instar beet armyworm larvae fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% egg hatch			% dead eggs (within egg mass)			% dead BAW larvae			% moribund BAW larvae		
Treatment	**amount / 500 ml water**	**1 DAT**	**3 DAT**	**7 DAT**	**1 DAT**	**3 DAT**	**7 DAT**	**1 DAT**	**3 DAT**	**7 DAT**	**1 DAT**	**3 DAT**	**7 DAT**
Untreated Control		0.0	75.0	43.5	0.0 b	0.0	0.0 C	0.0	0.0 c	28.3	0.0	0.0	0.0
Esteem + Radiant	0.49 g + 0.2 ml	0.0	57.5	51.7	0.0 b	40.9	34.2 ab	0.0	50.0 b	74.5	0.0	31.6	0.0
Esteem + Radiant	0.29 g + 0.2 ml	0.0	48.9	27.9	2.8 ab	51.1	58.1 a	0.0	74.0 ab	50.0	0.0	0.0	0.0
Esteem	0.49 g	0.0	84.4	46.4	0.0 b	15.6	9.7 bc	0.0	59.9 ab	89.5	0.0	0.0	0.0
Radiant	0.2 ml	0.0	63.4	49.4	8.5 a	36.4	36.4 ab	0.0	100.0 a	100.0	0.0	0.0	0.0
Radiant	0.59 ml	0.0	73.6	12.3	1.8 ab	26.4	5.3 bc	0.0	98.9 ab	95.8	0.0	0.0	0.0
P-Value from Anova		ns	ns	ns	0.0235	ns	0.0119	ns	0.0058	ns	ns	ns	ns

Larval Assays

- **Experiment 1: 2nd instar larvae**

PROCEDURES:

- Due to unusual low pressure in field settings, laboratory-reared beet armyworm (BAW) 2nd instar larvae were purchased from Bio-Serv. On 4 Sep, tomato compound leaves were dipped into insecticidal concentrations for approximately 3 seconds, left under a fume hood to dry for one hour and placed into a 9-cm Petri dish with 5 beet armyworm larvae.
- Insecticide solutions were based on 40 gal / acre water.
- Mortality was recorded at 24, 48 and 96 h. The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 13:11 (L:D).
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of laboratory-reared beet armyworm fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% total dead & moribund		
Treatment	**amount / 500 ml water**	**24 h**	**48 h**	**96 h**
Untreated Control		25.0 b	85.0	95.0
Esteem + Radiant	0.49 g + 0.2 ml	100.0 a	100.0	100.0
Esteem + Radiant	0.29 g + 0.2 ml	100.0 a	100.0	100.0
Esteem	0.49 g	95.0 a	95.0	95.0
Radiant	0.2 ml	100.0 a	100.0	100.0
Radiant	0.59 ml	100.0 a	100.0	100.0
P-Value from Anova		<0.0001	ns	ns

Experiment 2: late instar larvae

PROCEDURES:

- On 10 Sep, large instar laboratory-reared BAW larvae were used to replicate the early instar experiment aforementioned. All materials and methods were replicated.
- Insecticide solutions were based on 40 gal / acre water.
- The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 13:11 (L:D). Mortality was recorded at 3 and 7 DAT. The number of live and dead pupae was also recorded at 3 and 7 DAT. % feeding was recorded at 3 and 7 DAT.
- All data were analyzed using analysis of variance procedures. Means were separated using Tukey's HSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of laboratory-reared late instar beet armyworm larvae fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% dead BAW larvae		% TOTAL PUPATION	% DEAD PUPAE		% feeding	
Treatment	**amount / 500 ml water**	**3 DAT**	**7 DAT**		**3 DAT**	**7 DAT**	**3 DAT**	**7 DAT**
Untreated Control		10.0	10.0	90.0	10.0	10.0	1.3	3.8 a
Esteem + Radiant	0.49 g + 0.2 ml	30.0	30.0	65.0	30.0	30.0	0.0	0.0 ab
Esteem + Radiant	0.29 g + 0.2 ml	35.0	35.0	65.0	35.0	35.0	0.0	0.0 b
Esteem	0.49 g	0.0	0.0	100.0	0.0	0.0	1.0	1.0 ab
Radiant	0.2 ml	40.0	40.0	60.0	40.0	40.0	1.8	1.8 ab

Radiant	0.59 ml	50.0	50.0	50.0	50.0	50.0	0.0	0.0 b
P-Value from Anova		ns	ns	ns	ns	ns	ns	0.0152

CORN EARWORM (*HELICOVERPA ZEA*)

PROCEDURES:

- Populations of corn earworm (CEW) larvae were collected from sweet corn at the ESAREC in Painter, VA on 11 Sep. One corn earworm was placed into a vial with a treated tomato compound leaf for a total of 10 corn earworms in 10 vials for each treatment. Each tomato leaf was treated by dipping into field-rate insecticidal concentrations for approximately 3 seconds. Leaves were then left to dry under a fume hood for one hour before exposure to corn earworms.
- Insecticide solutions were based on 40 gal / acre water.
- Mortality and % feeding was recorded at 1, 3, 5, 7 and 10 DAT. The containers were maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 13:11 (L:D).
- This experiment was replicated on 12 Sep since tomato leaves were picked out of treated plots (7 DAT2) from the field experiment and additionally dipped in field-rate insecticidal concentrations.
- All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Data were sqrt transformed to normalize when necessary.

RESULTS:

Table 1. Summary of mortality data of field-collected corn earworm larvae fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% dead CEW					% moribund CEW				
Treatment	**Amount / 500 ml water**	**1 DAT**	**3 DAT**	**5 DAT**	**7 DAT**	**10 DAT**	**1 DAT**	**3 DAT**	**5 DAT**	**7 DAT**	**10 DAT**
Untreated Control		0.0	0.0 b	10.0 b	60.0 b	80.0	0.0 c	20.0	0.0	0.0	0.0
Esteem + Radiant	0.49 g + 0.2 ml	30.0	80.0 a	100.0 a	100.0 a	100.0	70.0 a	20.0	0.0	0.0	0.0
Esteem + Radiant	0.29 g + 0.2 ml	30.0	90.0 a	100.0 a	100.0 a	100.0	70.0 a	10.0	0.0	0.0	0.0
Esteem	0.49 g	10.0	10.0 b	30.0 b	70.0 ab	80.0	10.0 bc	10.0	20.0	10.0	0.0
Radiant	0.2 ml	40.0	80.0 a	90.0 a	100.0 a	100.0	60.0 ab	20.0	10.0	0.0	0.0
Radiant	0.59 ml	10.0	70.0 a	100.0 a	100.0 a	100.0	80.0 a	30.0	0.0	0.0	0.0
P-Value from Anova		ns	<0.0001	<0.0001	0.0	ns	<0.0001	ns	ns	ns	ns

		% total dead & moribund CEW				
Treatment	**Amount / 500 ml water**	**1 DAT**	**3 DAT**	**5 DAT**	**7 DAT**	**10 DAT**
Untreated Control		0.0 b	20.0 b	10.0 c	60.0 b	80.0

Esteem + Radiant	0.49 g + 0.2 ml	100.0 a	100.0 a	100.0 a	100.0 a	100.0
Esteem + Radiant	0.29 g + 0.2 ml	100.0 a	100.0 a	100.0 a	100.0 a	100.0
Esteem	0.49 g	20.0 b	20.0 b	50.0 b	80.0 ab	80.0
Radiant	0.2 ml	100.0 a	100.0 a	100.0 a	100.0 a	100.0
Radiant	0.59 ml	100.0 a	100.0 a	100.0 a	100.0a	100.0
P-Value from Anova		<0.0001	<0.0001	<0.0001	0.0052	ns

Table 2. Summary of feeding data of field-collected corn earworm larvae fed tomato leaves dipped in field-rate insecticide concentrations, Painter, VA; 2013

		% feeding			
Treatment	**Amount / 500 ml water**	**3 DAT**	**5 DAT**	**7 DAT**	**10 DAT**
Untreated Control		33.7 a	39.0 a	44.5 a	45.5 a
Esteem + Radiant	0.49 g + 0.2 ml	7.4 b	7.9 b	7.9 b	7.9 b
Esteem + Radiant	0.29 g + 0.2 ml	3.7 b	3.7 b	3.7 b	3.7 b
Esteem	0.49 g	32.8 a	34.8 a	38.3 a	38.3 a
Radiant	0.2 ml	8.9 b	9.0 b	9.0 b	9.0 b
Radiant	0.59 ml	4.5 b	4.5 b	4.5 b	4.5 b
P-Value from Anova		<0.0001	<0.0001	<0.0001	<0.0001

Kudzu Bug Host Plant Choice Bioassay

Objective: To test the host preference of the bean plataspid (or kudzu bug) (*Megacopta cribraria*) between soybeans, lima beans and snap beans

PROCEDURES:

- Adult kudzu bugs were collected from wisteria vines at a private residence in Virginia Beach, VA on 13 Jun, and from a soybean field at the ESAREC, Painter, VA on 18 Jun.
- Populations from Virginia Beach were placed in 2 cages, cage 1 and cage 2, (each containing 90 kudzu bugs) and the ESAREC population was placed in cage 3 (containing 26 kudzu bugs). One soybean plant, one lima bean plant and one snap bean plant was placed in each cage at equidistance from each other. Each plant was grown from seed in growing medium in a 4 inch pot and was placed in the cage when reaching approximately 4 inches in height.
- Cages were kept indoors in a laboratory maintained at 27 ± 2°C, 40 to 70% RH, and a photoperiod of 15:9 (L:D).
- The number of kudzu bugs located on the foliage, the stem, or the pot of each plant species was recorded 4 to 5 times per day from 21 Jun to 1 Jul.
- The total number of egg masses was also recorded for each plant species.

RESULTS:

- All kudzu bugs were not readily attracted to the plants provided in each cage with approximately 40-50% of the population remaining on the outer perimeter or the flooring of the cage.

- Based on total % of kudzu bugs found on foliage, stem and pot, adult kudzu bugs appeared to prefer snap bean to soybean as host plant in cage 1 and cage 3 (table 1). In cage 2, soybean was a preferred host in comparison to snap beans or lima beans.
- Over all 3 cages, when comparing various locations, snap beans were a preferred host of adult kudzu bugs in comparison to soybean and lima beans (Table 1, Figure 1). However, kudzu bugs typically feed and aggregate on stems of host plants. Based on observations recorded for % kudzu bug found on selected host plant stems, kudzu bugs were most often observed feeding and aggregating on soybean stems (Figure 2).
- Lima beans were the least preferred host of adult kudzu bugs in comparison to soybean and snap beans in all 3 cages.
- Soybeans were the preferred host for oviposition with 11 egg masses laid on soybean foliage (beginning 21 Jun) in comparison to none for snap beans and lima beans across all 3 cages (Table 2). These results demonstrate that despite possible suitability of other legume crops (snap beans and lima beans) as host for kudzu bugs, soybean is a preferred host for successful colonization.

Table 1. Summary of kudzu bug host plant choice assay; ESAREC, Painter, VA; 2013

	% KUDZU BUG								
	ON SOYBEAN FOLIAGE	ON SOYBEAN STEM	ON SOYBEAN POT/SOIL	ON LIMA FOLIAGE	ON LIMA STEM	ON LIMA POT / SOIL	ON SNAP BEAN FOLIAGE	ON SNAP BEAN STEM	ON SNAP BEAN POT / SOIL
CAGE 1	1.2	2.0	5.7	0.8	2.2	4.3	0.8	0.4	9.2
CAGE 2	1.1	6.5	8.0	0.5	0.2	0.5	0.3	1.2	12.4
CAGE 3	4.9	3.2	13.2	0.4	0.0	2.1	6.8	1.9	20.4
Average of 3 cages	2.4	3.9	8.9	0.5	0.8	2.3	2.6	1.2	14.0

	% KUDZU BUG ON SOYBEAN	% KUDZU BUG ON LIMA BEANS	% KUDZU BUG ON SNAP BEANS
CAGE 1	8.9	7.2	10.4
CAGE 2	15.6	1.1	13.9
CAGE 3	21.2	2.5	29.1
Average of 3 cages	15.2	3.6	17.8

Table 2. Kudzu bug oviposition and emergence activity in all 3 cages (21 Jun – 1 Jul)

	No. egg masses	No hatched egg masses
Soybean	11	2
Lima Bean	0	0
Snap Bean	0	0

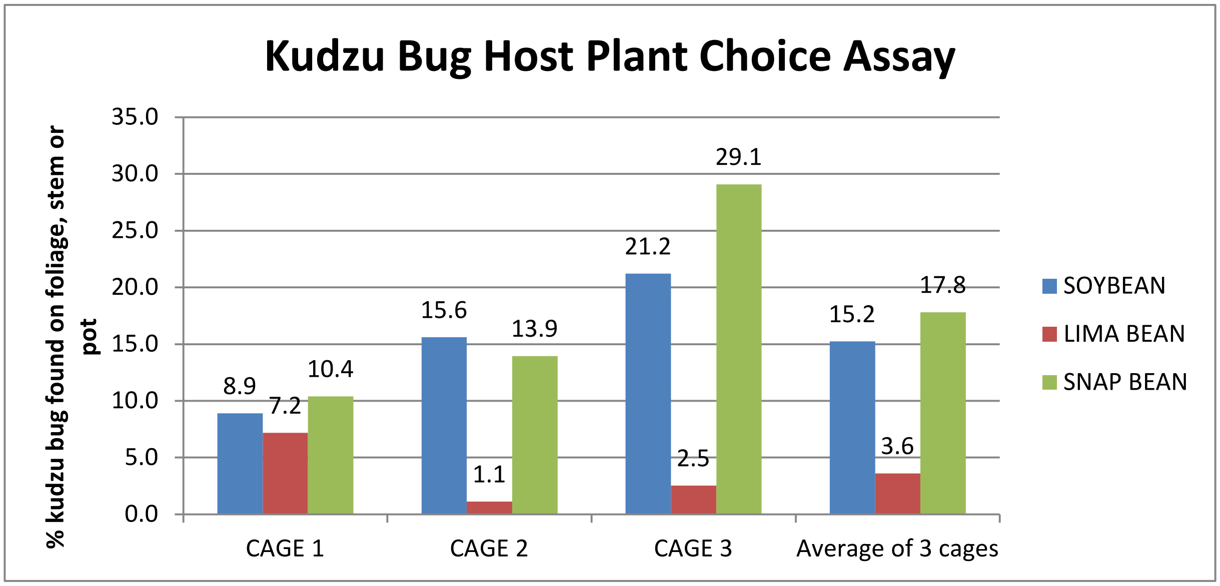


Figure 1. % kudzu bug found on selected host plants

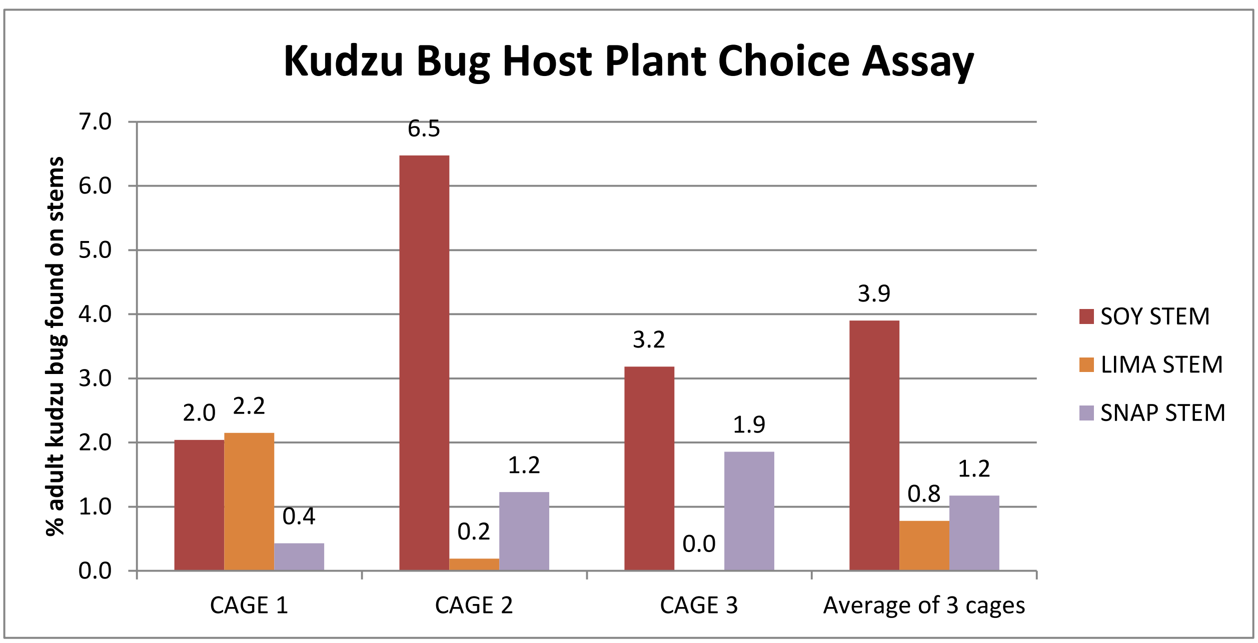


Figure 2. % kudzu bug found on select host plants stems

Graduate Student Research

BROWN MARMORATED STINK BUG RESEARCH

JOHN AIGNER

Introduction

Brown marmorated stink bug (BMSB). *Halyomorpha halys* (Stal) is an invasive pest native to East Asia. It was first discovered in the U.S. near Allentown, PA in the mid-1990s. BMSB was first detected in VA in 2004, and has since been detected in 85% of the continental United States, as well as parts of Canada, and Europe. BMSB is highly polyphagous and can feed on over 300 host plants including vegetables such as sweet corn, pepper, tomato, bean, and others.

BMSB has shown susceptibility to several insecticides including carbamates, pyrethroids and neonicotinoids. These insecticides are considered broad spectrum and can have a negative impact when applied to foliage by killing natural enemies and potentially flaring secondary pests. However, some neonicotinoids can be placed at the root zone of the plant and be systemically translocated throughout the plant, allowing only insects that feed on that plant to be affected by the insecticide. The objective of this study was to evaluate the toxicity and field efficacy of four systemically-applied neonicotinoids for control of BMSB.

Materials and Methods

LC_{50} Determination

BMSB overwintering adults (Fig. 1) were placed in a temperature chamber and exposed to temperatures of 26°C ± 2 and a 16:8 L:D ratio (Medal et al. 2012). They were fed a diet of snap beans, carrots and peanuts before producing eggs with viable offspring after approximately 5 weeks. 'Caprice' snap beans, *Phaseolus vulgaris,* were planted in 1 liter pots in the greenhouse at Virginia Tech in Blacksburg, VA. Concentrations of dinotefuran, imidacloprid, clothianidin and thiamethoxam at 0, 0.001, 0.01, 0.1 and 1 ppm were prepared and placed in 60mL centrifuge tubes. At the three leaf stage, snap bean plants were excised at the base of the plant and submerged in each insecticide for 24 hours in each solution to allow the insecticide to be taken up by the bean plant and translocated throughout the tissue (Prabhaker et al.). Ten lab reared BMSB 2^{nd} – 4^{th} instars (Fig. 2) were then placed on the plants and evaluated after 72 hours and was replicated four times for each sample date (Fig. 3) . This was repeated on four separate dates for each insecticide. PoloPlus version 1.0 (LeOra Software Company, El Cerrito, CA) has been used to determine LC_{50} values.

Field Efficacy Experiments

'Aristotle' bell peppers (*Capsicum annuum*) were planted every 15 inches at Kentland Farm in Blacksburg, VA in June 2012 and 2013 using 12 inch raised beds covered with black plastic. 'Baby Cakes' tomatoes (*Solanum lycopersicum*) were also tested in 2013. This experiment was set up in a randomized complete block design and replicated four times with an untreated control and the following treatments: untreated control imidacloprid, clothianidin, dinotefuran, thiamethoxam and dinotefuran +; plots were 20 feet long and each insecticide was applied at the high rate recommended on its respective label (Table 1). Application dates were selected based on pre-harvest intervals (PHI) established on the labels of the treatments. The longest PHI was used as a starting point from an anticipated harvest date based on previous harvests in related studies.

The first treatments were applied approximately 21 days after planting by placing the insecticide solution directly at the base of each plant within its respective plot using a single nozzle pump action Solo® sprayer. A second application of all materials was made 30 days after the first application.

Twenty randomly selected fruit were harvested from each plot on three dates August for both years of this study. Each pepper was inspected for stink bug damage and recorded. This damage is indicated by a yellow spongy area on The proportion of damaged peppers from each treatment was Arcsine √ transformed, when necessary, and then analyzed using JMP version 10.0 (SAS Institute, Cary, NC).

Results and Discussion

LC_{50} Determination

Systemic LC_{50} values were determined to be 0.013ppm and 0.068ppm for imidacloprid and dinotefuran, respectively. The LC_{50} value for thiamethoxam is ~0.1ppm and for clothianidin is ~0.01ppm. These data have been presented in the Figure 4 below. Both thiamethoxam and clothianidin will need to continue to be monitored to verify the estimated values. Thus far, the LC_{50} values for thiamethoxam and dinotefuran have been estimated to be comparable to glass vial bioassays conducted using BMSB 5th instars by Nielsen et al. (2008). Wallingford et al. (2013) found in leaf dip bioassays using harlequin bug that these values ranged from 0.385 – 0.573 ppm. To our knowledge, our study is the first to attempt to determine LC_{50} values for neonicotinoids when applied systemically to control BMSB.

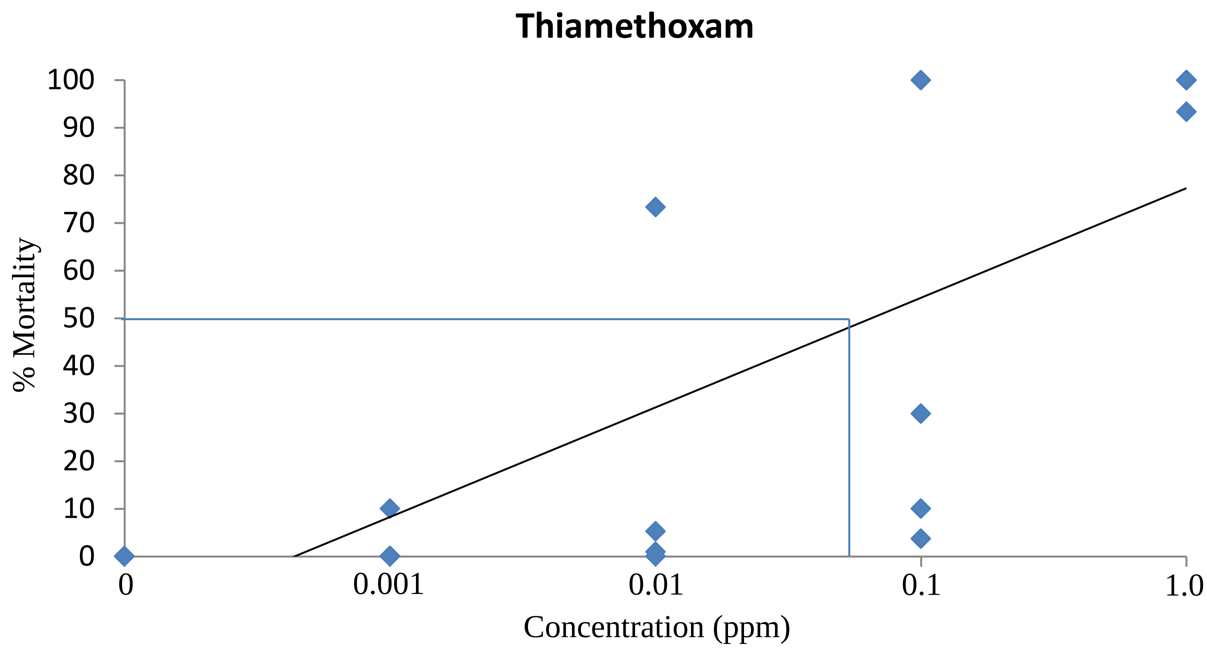


Fig. 1. Mortality of BMSB nymphs after 72 hr exposure to snap beans treated systemically with thiamethoxam. Blue lines indicate an estimation of LC_{50} level.

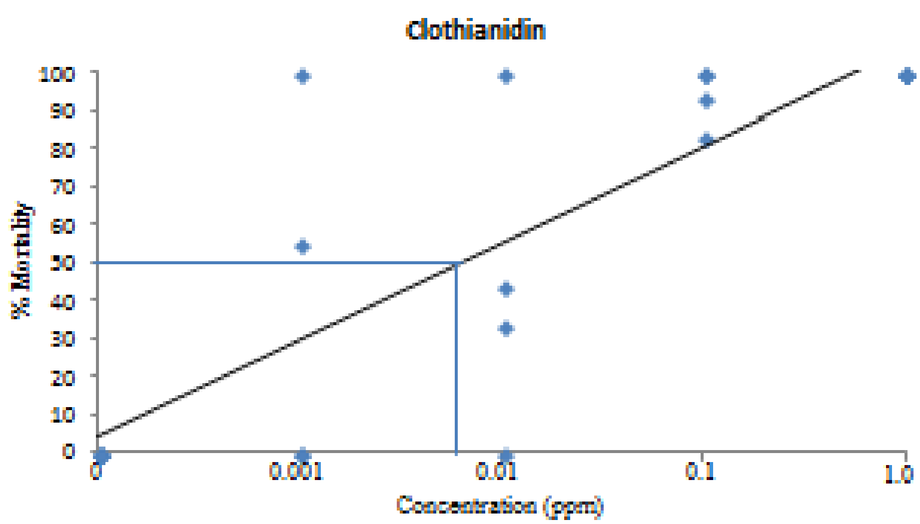


Fig. 2. Mortality of BMSB nymphs after 72 hr exposure to snap beans treated systemically with clothianidin. Blue lines indicate an estimation of LC_{50} level.

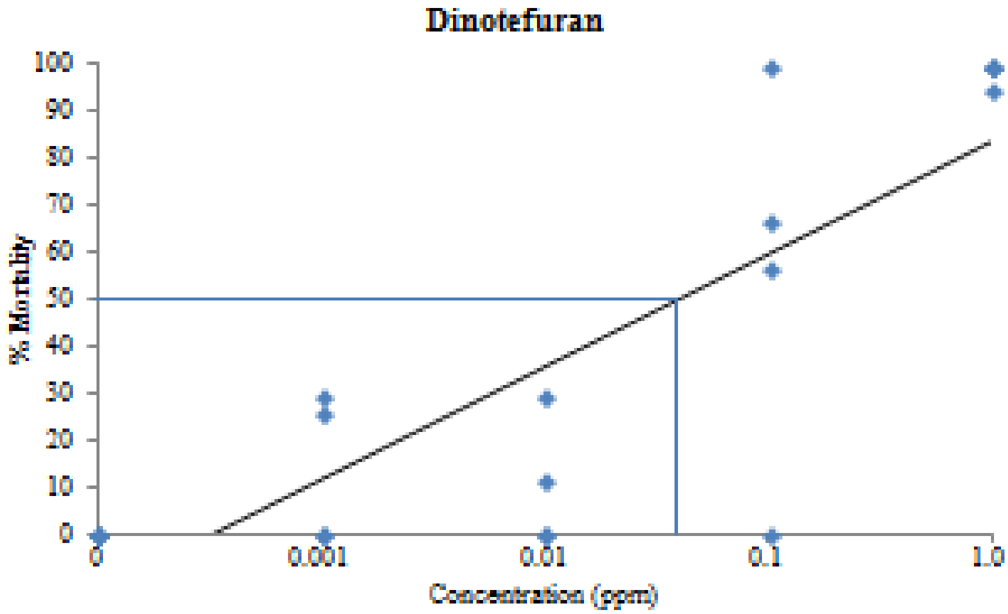


Fig. 3. Mortality of BMSB nymphs after 72 hr exposure to snap beans treated systemically with dinotefuran. Blue lines indicate an estimation of LC_{50} level.

Field Efficacy Experiments

In 2012 (pepper) and 2013 (pepper and tomato) there was a significant treatment effect on BMSB feeding damage to fruit at harvest, with all insecticides resulting in less damage than the untreated control. The addition of four foliar applications of the pyrethroid fenpropathrin to a systemic application of clothianidin did not result in a significant further reduction in stink bug damage. These data show that two systemic applications of dinotefuran or thiamethoxam can reduce damaged fruit by up to 50% in both crops.

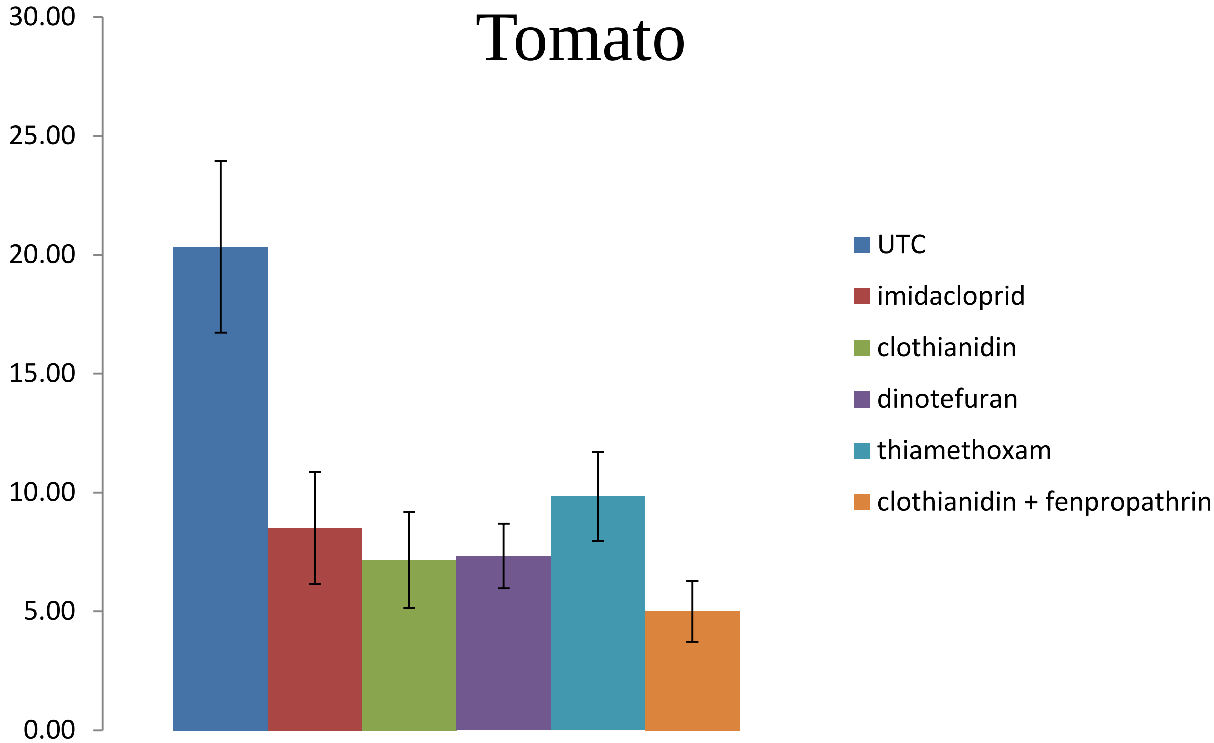


Fig. 5. Cumulative percent stink bug damage of tomato fruit for the 2013 season for each insecticide.

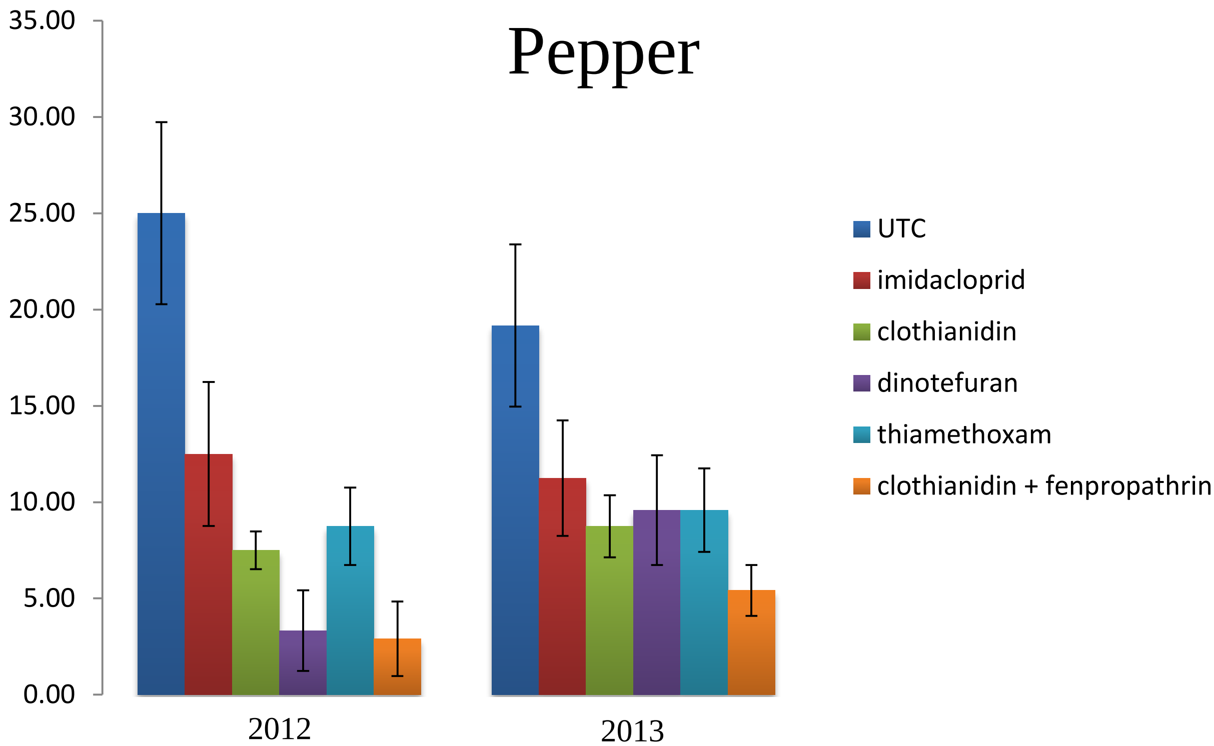


Fig. 6. Cumulative percent stink bug damage of pepper fruit for 2012-2013 seasons for each insecticide.

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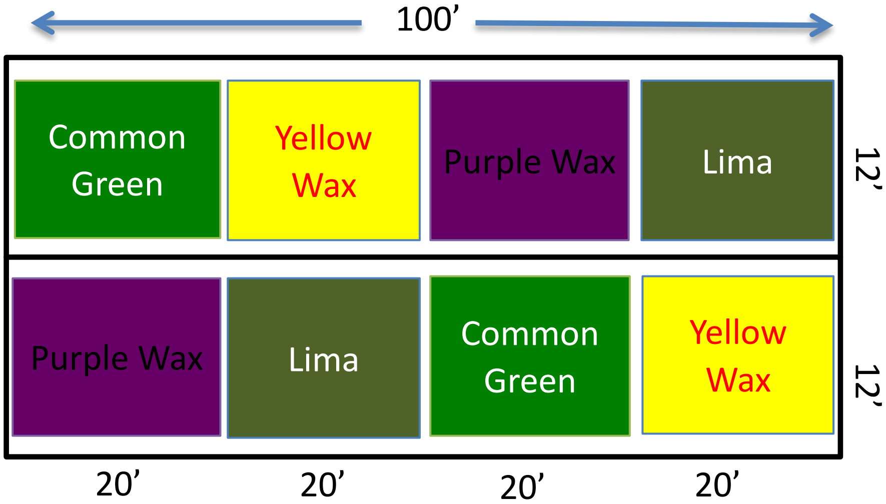
HOST PREFERENCE, OVIPOSITION AND DEVELOPMENT OF MEXICAN BEAN BEETLE ON FOUR *PHASEOLUS* VARIETIES

LOUIS NOTTINGHAM

Experimental Design:

On May 3rd, 2013, four varieties of *Phaseolus* beans (Caprice - green snap; Rocdor - yellow wax snap; Dragon's Tongue - purple Dutch wax snap; Fordhook 242 - lima) were planted at four separate locations at Kentland farm in Blacksburg, Virginia. Each plot occupied 100 x 24 feet of a crop bed. Within each plot, eight equally sized subplots with 2 replicates of each of the bean variety (see Figure 1.).

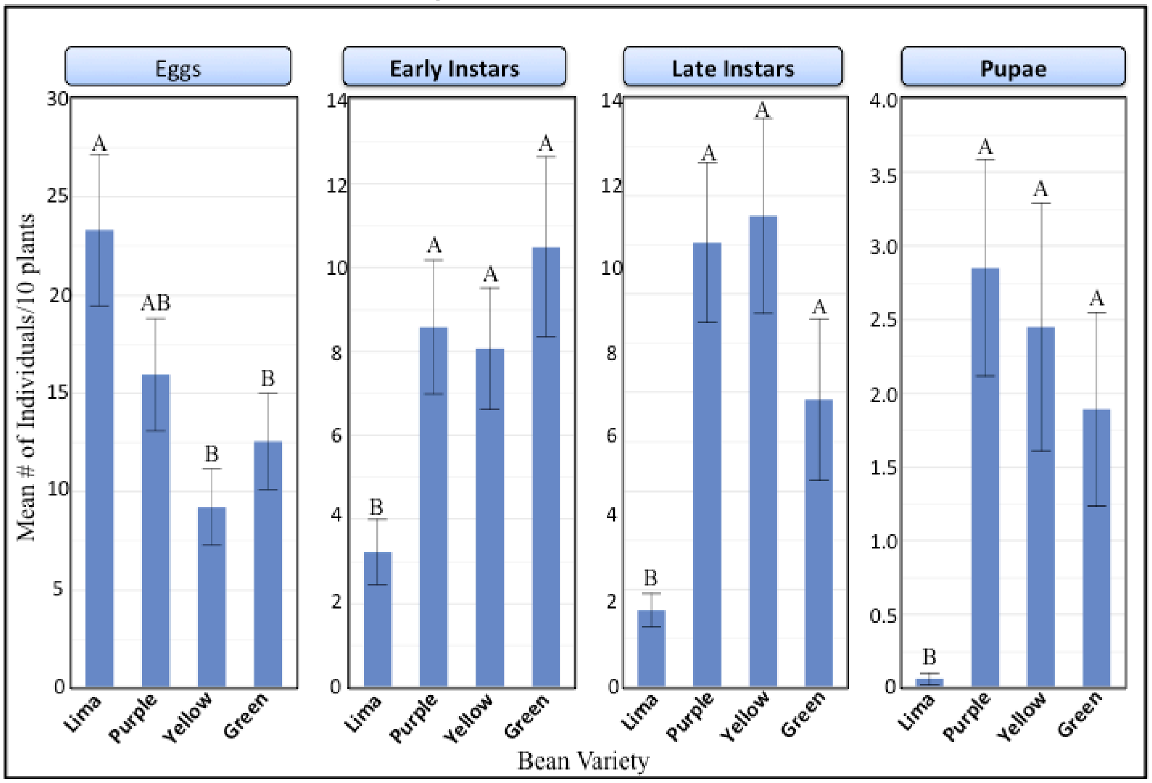
Figure 1. Plot plan for one (of four) plots at Kentland farm



Sampling:
Sampling occurred every Monday and Friday from 6/10/13 (date after first MBB siting) to 7/19/2013. Every subplot was sampled on sampling days. Within each subplot, 10 plants were manually searched, counting MBB overwintered adults, eggs, egg masses, early larvae, late larvae, pupae and F1 adults. Larvae were distinguished as early or late in the field based on size (<2mm were considered early; >2mm were considered late). F1 adults were easily distinguished by their light yellow color; overwintering adults were dull copper in color.
Harvested snap beans were rated for MBB feeding injury. 100 pods were taken from each subplot. Marketable pods (no feeding injury) were separated from damaged pods. The number of damaged pods was documented as a percentage of total pods sampled out of each subplot.

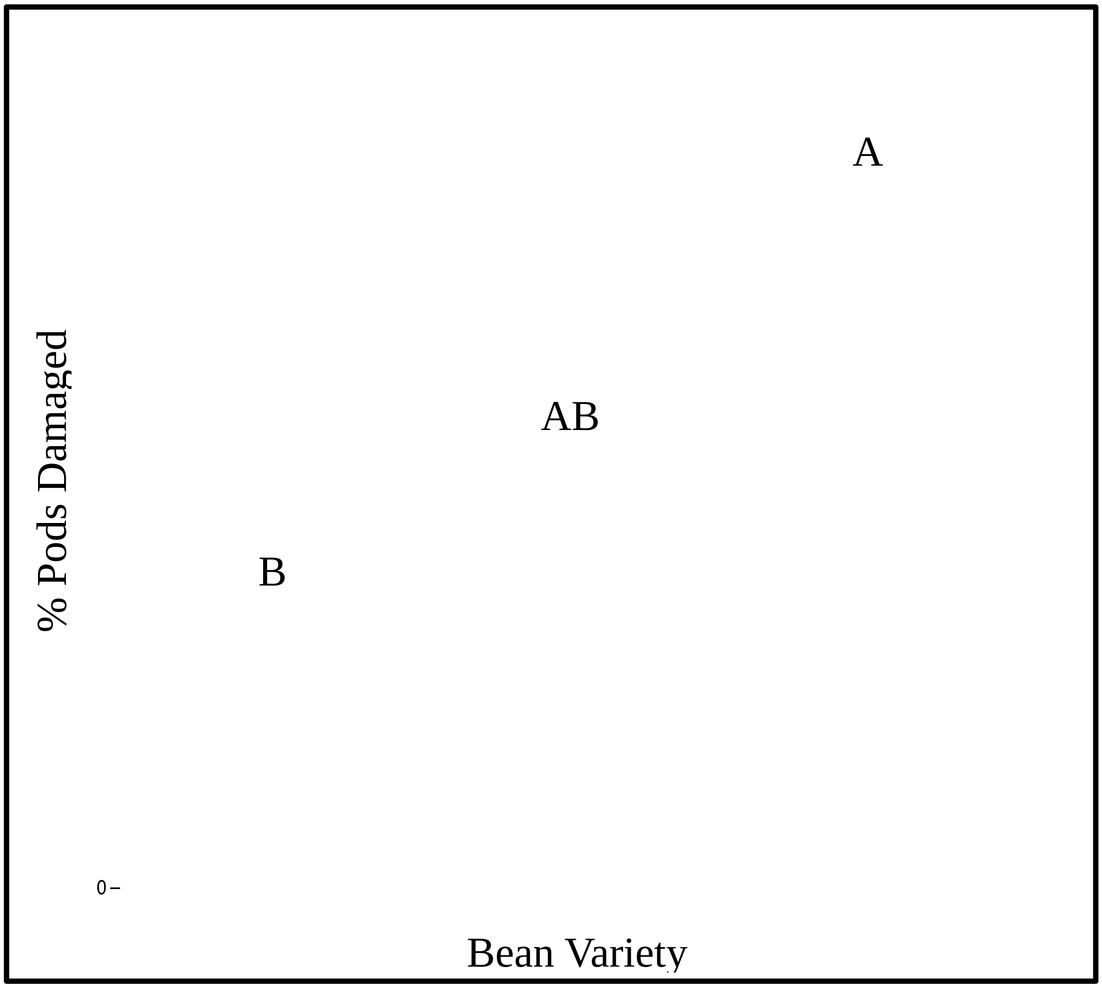
Results:
1. No differences were observed in the number of MBB adults (overwintering, F1, or combined) amongst the 4 bean varieties (not shown in charts).
2. There were significantly fewer MBB eggs deposited in Caprice (green snap) and Rocdor (yellow snap) beans than in Fordhook 242 (lima). Number of eggs deposed in Dragon’s Tongue (purple snap) was not different from the other three varieties (Chart 1).
3. There were significantly fewer early larvae, late larvae, and pupae in lima bean than the three snap bean varieties (Chart. 1).
4. There were significantly fewer damaged pods among Caprice (green snap) plots than Rocdor (yellow wax) plots. The amount of damaged pods in Dragon’s Tongue plots was not different than either Caprice or Rocdor (Damage on Lima bean pods was not analyzed because lima pods were not yet mature at time of harvest for snap beans) (Chart 2).

Chart 1. Cumulative MBB life stage data from 2013.



*Data not connected by the same letter are significantly different.

Chart 2. Average % pods damaged from each bean variety, 2013.



*Data not connected by the same letter are significantly different.
*Lima beans were not included due to longer time requirement for pod maturation.

Conclusions:

MBB adults exhibited a preference to laying eggs in Fordhook 242, lima, beans compared to snap bean varieties. However, very few larvae and pupae developed in lima beans, especially when compared to the three wax varieties. Our findings suggest that Fordhook 242 may be suitable as a trap crop to manage MBB, where snap beans are the commodity crop.

Caprice beans experienced the least damage to pods of the 3 snap bean varieties, though it was only significantly different from yellow.

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Common Name: **Mexican bean beetle**
Scientific Name: ***Epilachna varivestis* Mulsant**

Authors: Louis Nottingham and Dr. Thomas Kuhar
Department of Entomology, Virginia Tech

Fig 1. Mexican bean beetle adult, eggs, larva and pupae.

Mexican Bean Beetle (MBB), *Epilachna varivestis* Mulsant (Fig. 1), is an herbivorous lady beetle (Coccinellidae) that feeds on bean crops (legumes) in North America. It is similar to the squash lady beetle, *Epilachna borealis*, which feeds primarily on cucurbits. MBB can cause significant defoliation damage to various bean crops particularly in the genus *Phaseolus* (snap beans, lima beans, pole beans, etc.). It will also feed on soybean, alfalfa, beggarweed, kudzu, and other legumes.

Identification

Mexican bean beetle can be easily confused with other ladybeetle species despite behavioral and morphological differences (Fig. 2). All life stages of MBB can be readily found within the canopy of bean plants. When there is a severe infestation, characteristic feeding damage to bean leaves will be apparent as well (Fig. 3).

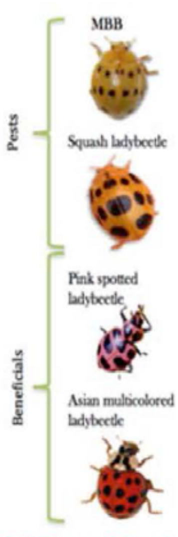

Fig 2. Common ladybeetles found in Virginia

Adult MBB are similar in size and shape to their beneficial relatives (commonly referred to as "labybugs"). They are yellow or bronze, with 16 black spots arranged into three rows. The color of the head and "pronotum" (plate behind the head) are consistent with the yellowish color of the elytra. Adults are 6-8mm long and 4-6mm wide; though size can vary based on their diet. Males are generally smaller than females, and can be distinguished by a notch at the end of the last abdominal segment. Adults can walk and fly, but are generally sluggish once they have located a suitable host plant. Most of their time is spent feeding or mating within the plant canopy; but adult MBB will fly long distances if food becomes scarce or when locating overwintering sites.

Eggs are yellow or orange, and generally deposited in clusters of 40-60 on the underside of bean leaves. They are usually1.2mm long and 0.6mm wide. Eggs hatch after about seven days.

Larvae are cylindrical with forked spines covering the body. They are about 8mm long. The body is yellow and the spines are either black, or yellow with black tips. Larvae generally remain attached to the bottom of leaves while constantly feeding. The larval stage requires around 2 weeks to develop.

Pupae are similar in appearance and size to the larvae, except the spiny covering of the larvae turns pale and is pushed to the hind end of the insect. The rest of the pupa is yellow and relatively smooth. At this stage, the beetle attaches itself to its host plant by at its anterior end and becomes immobile. Pupation lasts 9 days.

2013 Virginia Polytechnic Institute and State University ENTO-51NP

Native Range and Distribution

Mexican bean beetle is native to the plateau region of Mexico. In 1918, MBB appeared in Alabama and quickly increased its range to cover the entire East Coast, from Florida to New England. A 2013 grower survey showed MBB to be most commonly found in the Appalachian region of the mid-Atlantic, especially in organic agricultural systems. There are sparse populations in the Rocky Mountains and Great Plants. MBB is uncommon in Pacific Coast states.

Fig 3. MBB damage on snap

Damage

MBB larvae and adults feed primarily on foliage, but will also eat pods and flowers as leaves become scarce. Injury to beans appears in the form of holes in the tissue at first, but the beetle will continue to feed until only a vein skeleton remains. Larvae are responsible for the majority of feeding injury to bean crops. Each larva can consume between 30 - 70 cm^2 of foliage before pupation. Snap bean crops can usually withstand at least 20% defoliation before yield decreases; however, this amount varies with crop growth stage, bean variety and environmental conditions.

Management

<u>**Cultural Methods**</u>: Because these beetles can fly long distances and overwinter as adults in various locations, common cultural pest management strategies like crop rotation or post-season crop destruction are ineffective. However, other cultural methods may prove advantageous in certain systems. Planting beans as early as possible may allow beans to mature before beetle populations reach economically damaging levels. On the other hand, delaying bean planting until early summer may cause reduced beetle survival, due to MBB's reduced success as temperatures increased above 80°F. Other cultural methods, such as trap-cropping and the use of reflective mulch, are currently being researched.

<u>**Mechanical**</u>: Row covers can be used to prevent beetles form accessing the bean crop. Because MBB is easily visible within the leaf canopy, hand removal is a viable method for smaller farms and gardens.

Fig 4. *Pediobius* on MBB larva

<u>**Biological Control**</u>: A parasitoid wasp, *Pediobius foveolatus,* is available for purchase. The wasp has been shown to prevent between 70 to 100% yield loss resulting from MBB. However, timing of the release is critical and it can take up to three weeks to receive wasps in the mail. It is best to release the wasp when MBB larvae first appear. Because it is native to India, it is unable to survive winters in a temperate climate; therefor, wasps must be purchased and released annually.

<u>**Insecticides**</u>: Conventional bean producers generally utilize systemic seed treatments; however, they are only effective for ~20 days after planting. Foliar applications of various carbamate, pyrethroid or neonicotinoid insecticides will control MBB. Consult the Commercial Vegetable Production Recommendations (VCE Pub. No. 456-420) for a list of products and rates.

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EFFECT OF BUCKWHEAT FARMSCAPES ON ABUNDANCE AND PARASITISM OF *P. RAPAE* IN COLLARDS

CHRIS PHILLIPS

Buckwheat (*Fagopyrum esculentum* Moench) with its abundant nectaries and long bloom period is often planted on vegetable farms, vineyards, and orchards to supply nectar and pollen to attract and conserve natural enemies (Powell 1986, Lee and Heimpel 2005). However, scientific data demonstrating the actual biological control benefit of such companion plantings are scarce. The objective of this experiment was to determine the effect of buckwheat farmscapes on imported cabbageworm, *Pieris rapae* (L.), in collards (*Brassica oleracea* L. var. *acephala* DC). In 2012 and 2013, buckwheat was planted in the center of four spatially-isolated 150 × 8 m collard fields and lepidopteran pest abundance and larval parasitism were compared at distances of 1, 15, 30, 45, and 60 m from the buckwheat (Fig. 1). *Pieris rapae* (L.) was the predominant lepidopteran pest species comprising over 90% of the total larvae observed on collards.

RESULTS

LEPIDOPTERAN PEST ABUNDANCE. Overall, the proximity to buckwheat had no significant effect on the density of *P. rapae* larvae in collards (R2 = 0.001, p=0.56, y=0.002x+1.42; Fig 2). In 2012, 364 lepidopteran larvae were observed with *P. rapae* being the most abundant (Table 1). The only other species observed was cross-striped cabbageworm *Evergestis rimosalis* (Guenee), and no significant differences were detected in abundance with distance from buckwheat (R^2 < 0.001, p=0.98; Fig 2). In 2013, 353 larvae were observed with *P. rapae* again being the most abundant throughout sampling, and no significant differences were detected (R^2 = 0.008, p=0.21; Fig 2).

PARASITOID ABUNDANCE. On all sample dates, parasitoid numbers were very low on yellow sticky traps. Only 37 parasitoids were collected, 13 in 2012 and 24 in 2013. This suggests that yellow sticky traps may not be an adequate tool for monitoring parasitoids in collards.

PARASITISM. Over the three collection dates, 431 larvae were collected with an average parasitism of 68% (±1.82). No significant difference in parasitism with distance was detected (R^2 = 0.005, p = 0.48, y=0.048x+71.51; Fig 3). In 2012, two collections were made with parasitism rates of 70 (±4.19) and 65% (±1.79), and no significant differences were detected with distance from buckwheat (R^2 = 0.007, p = 0.63). In 2013, a single collection was made with parasitism rates of 68% (±3.09), and again no significant difference was detected with distance from buckwheat (R^2 = 0.002, p = 0.86; Fig 3).

PREDATOR COMMUNITIES. In 2012 a total of 407 insects were collected, 296 in the spring and 112 in the fall. In the spring sample, 214 predators, 34 parasitoids, and 48 known pests were collected. In the fall, 22 predators, 8 parasitoids and 82 known pests were collected. In 2013, 339 insects were collected 212 predators and parasitoids and 127 pests. In both years, almost all of the collected pests were tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois).

Over the four sample periods, seven families of insect predators were collected, the most abundant being anthocorids, syrphids and cantharids. Braconids were the most abundant parasitoid, accounting for about half of the total parasitoids collected. Relatively few significant agricultural pests were found on the buckwheat with the exception of *L. lineolaris*.

DISCUSSION

In the current study, parasitism rates of *P. rapae* did not differ with distance from buckwheat. The average rates of parasitism were around 70% throughout the 120 m plots of collards. Although the buckwheat companion planting did not appear to have a significant effect on Pieris populations in collards, several predatory arthropod species, including anthocorids, syrphids and cantharids were collected in high numbers from the flowering buckwheat. The population dynamics and movement of these beneficial species from the buckwheat into adjacent cash crops should be investigated in future studies.

Famscaping has tremendous potential in improving natural pest control and studies such as this help in improving our understanding of the ecology in these systems. However, we still need to increase our knowledge of how plant-provided resources impact natural enemy activity (Powell 1986, Van Emden 1990, Heimpel and Jervis 2005, Winkler et al. 2010). Future research will have to be aimed at improving our ability to unambiguously evaluate if, in fact, plant-provided resources lead to improved pest suppression in different cropping systems.

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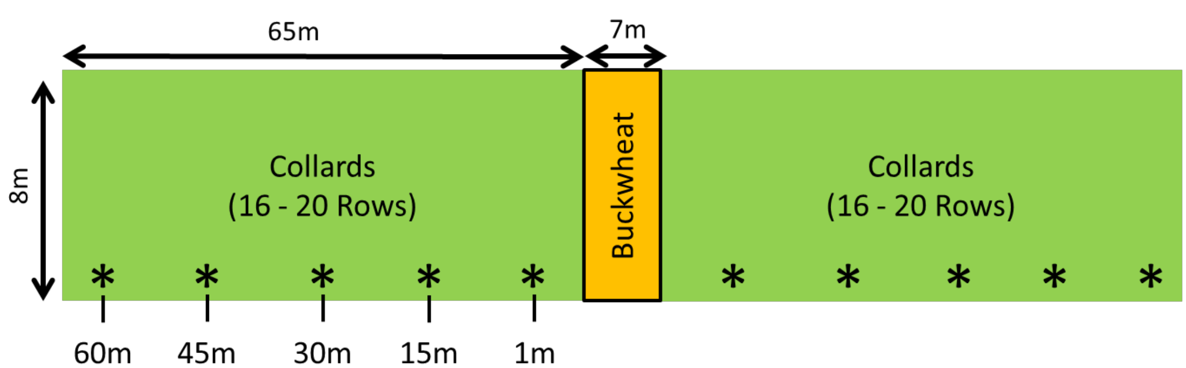


Fig 1. Diagram of collard plot with buckwheat farmscape used to sample insects in 2012 and 2013. Sample distances are denoted by *.

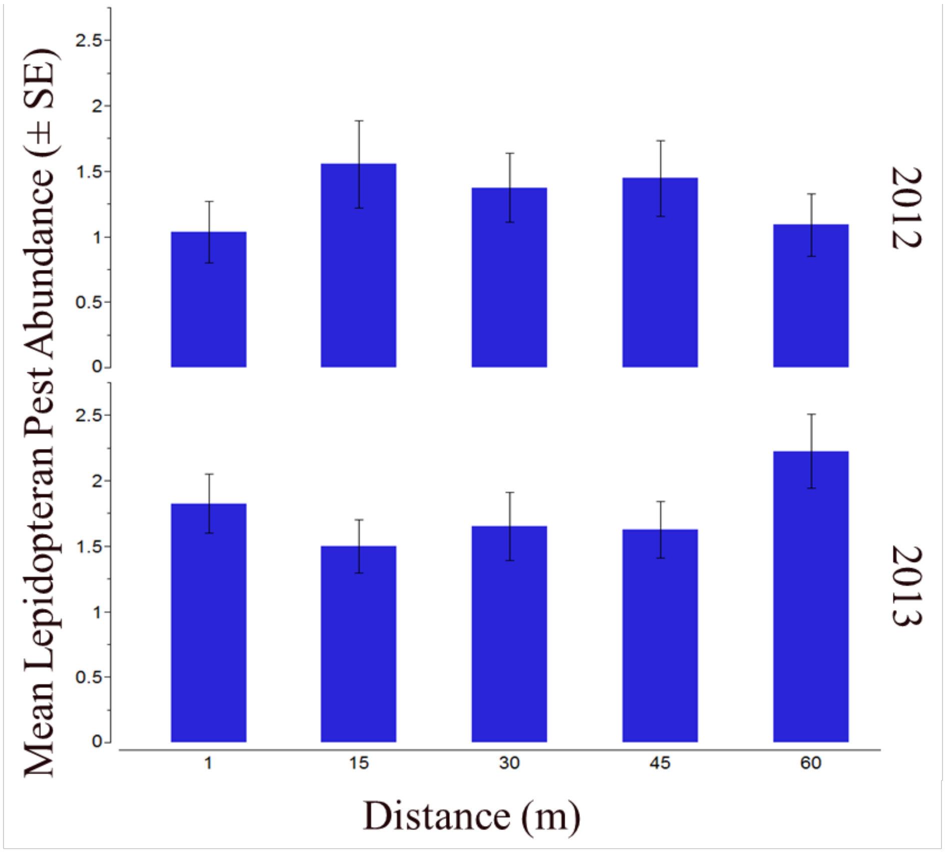


Fig 2. Mean (±SE) density of lepidopteran larvae in collard at various distances from a central buckwheat companion planting at the Virginia Tech Kentland Research Farm in Blacksburg, Virginia in 2012 and 2013.

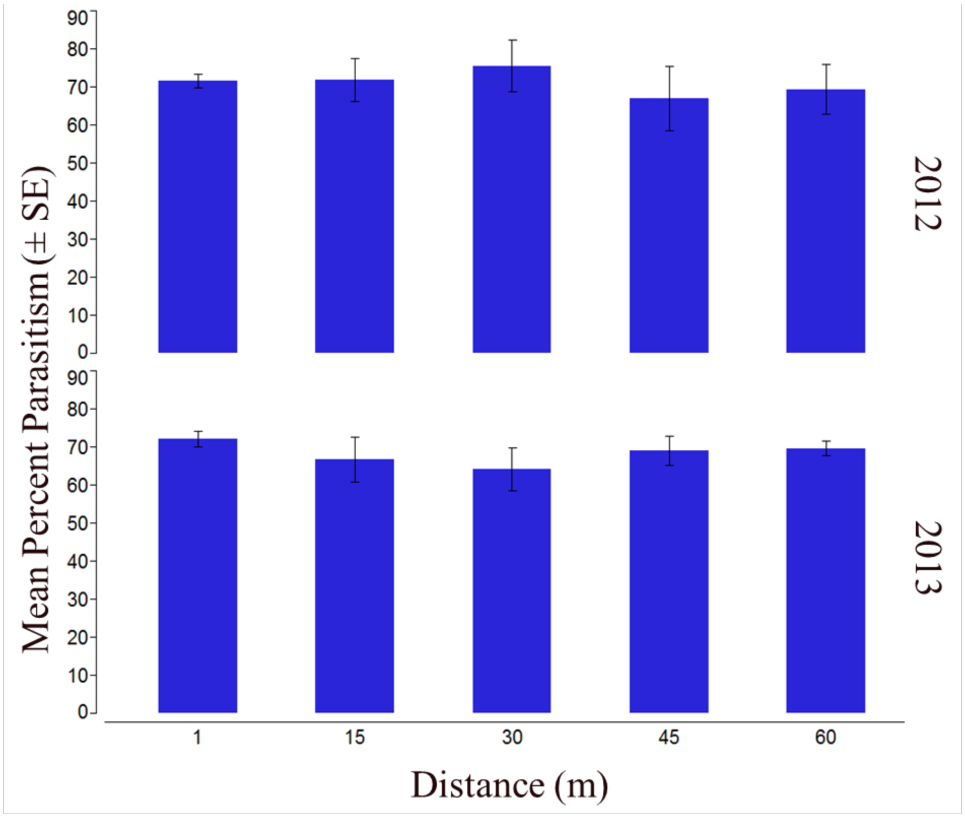


Fig 3. Mean parasitism of *Pieris rapae* larvae by *Cotesia glomerata* in collard at various distances from a central buckwheat companion planting at the Virginia Tech Kentland Research Farm in Blacksburg, Virginia in 2012 and 2013.

INSECT ECOLOGY OF NO-TILL PUMPKIN PRODUCTION IN VIRGINIA

JAMES M. WILSON

Overview:

Virginia production of pumpkins is often difficult to tally, but likely exceeds 2,000 acres, and in 2012 national pumpkin production was valued at $148,908,000. Virginia has seven different pests of pumpkin, and seasonal abundance of them can require costly management. These same pests feed on other cucurbits that are widely grown in Virginia. Pests include striped cucumber beetle *Acalyma* vittatum (F), spotted cucumber beetle *Diabrotica undecimpunctata* (Mannerheim), squash bug *Anasa tristis* (DeGeer), melon aphid *Aphis gossypii* (Glover), squash vine borer *Melitta satyriniformis* (Hubner), melon worm *Diaphania hyalinata* (L), and seed corn maggot *Delia platura* (Meigen). Current pest management practices are broad spectrum insecticide reliant, and could be having deleterious effects on natural enemies and pollinators. Localized surveys have found egg parasitoids of the squash bug. Parasitization rates were in the 89% range on farms where cucurbits had been grown before. Assessing the distribution, and establishment rates of these natural enemies will support the inclusion of conservation biological control efforts in the management of squash bug.

Pumpkin IPM:

To evaluate the effects of an IPM-based approach to pest management versus a conventional insecticide spray regime in no-till pumpkin production, no-till pumpkins were established at three locations in Virginia including: Virginia Tech Kentland Research Farm, Blacksburg, VA; Brann and King Farms in Riner, VA; The Southwest Virginia 4-H Center in Washington County, VA. At each location a Randomized Complete Block Design with 4 reps, (plot size = 3 rows by 20 ft) was planted for the seed treatment tests and the IPM spray tests. ‘Gladiator’ pumpkin was planted at the Riner and Kentland sites and ‘Magic Lantern’ was planted at the Abingdon location. Four treatments were evaluated: untreated control; Farmore® DI 400 seed treatment, which included the insecticide thiamethoxam + 3 fungicides - azoxystrobin, mefenoxam, fludioxonil); Farmore® DI 400 + Standard insecticide spray regime, (roughly every two weeks as part of a fungicide spray); IPM approach – spray insecticides only if pest pressures exceed thresholds. Plots were scouted weekly for densities of cucumber beetles, squash bugs (eggs and nymphs), aphids, and other pests, such as squash beetle and squash vine borer. The results of these experiments, both pest pressure data and mean yields per treatment, are organized by site in table 1 below.

Egg Parasitism in Squash Bug:

The 2013 field season scouting yielded numbers of squash bug nymphs that did not reflect the numbers observed in egg masses. These effected egg masses showed no obvious signs of predation. Egg masses were collected from various field and garden settings in Montgomery county Virginia, and from the Abingdon field site in Washington county Virginia. Egg parasitism was found in 77% of the 61 masses collected, 89% of the 19 egg masses collected at Kentland Farm were parasitized with parasitized eggs per mass averaging 79% at Kentland. Parasitoids reared from these egg masses were found to be a Scelionid (Platygastroidea) wasp. The Scelionids *Gryon pennslyvanicum* (Ashmead), and *Hadronotus ajax* (Girault) have, in the past, been reared from field collected squash bug eggs in Kentucky and North Carolina respectively.

To further evaluate the effect these parasitoids may be having on squash bug populations in Virginia, we plan to survey large and small-scale growers of cucurbits through extension agents and master gardener list serves across the state. Surveys will provide a means to gain squash bug egg masses and allow for the identification of the predominate squash bug egg parasitoid. Knowing the regional abundance and overall distribution of these natural enemies will provide data to further assess the feasibility of utilizing them as conservation biological control agents in cucurbit systems.

Pollination:

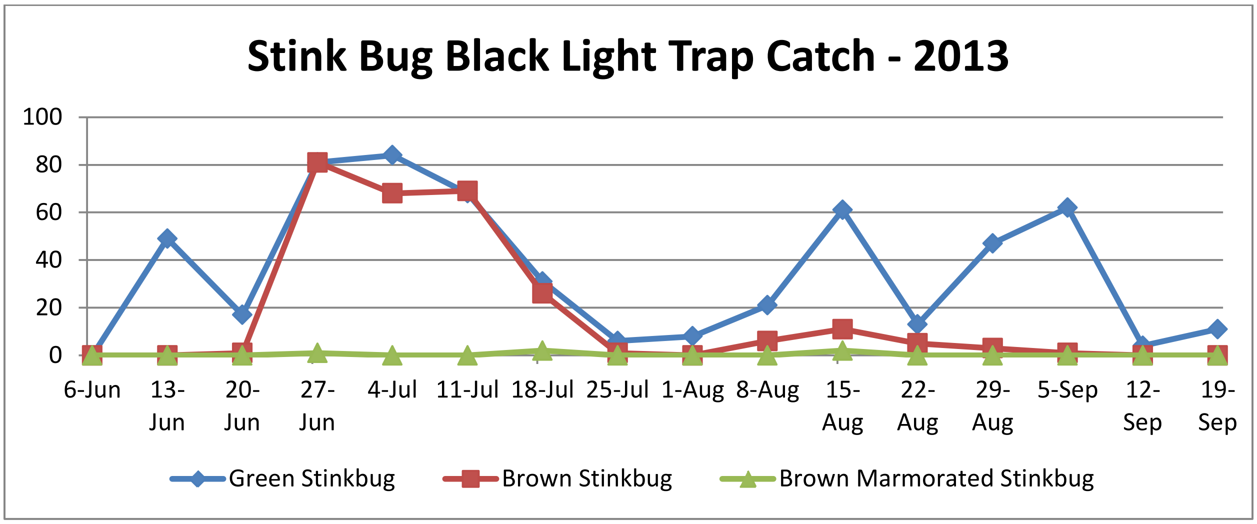
Pumpkin is a pollination dependent crop that does not rely on non-native pollinators but native bees like the squash bee, *Peponapis pruiniosa* (Say) (Hymenoptera: Apidae). In an effort to evaluate non-lethal effects of chemical pest management techniques, we plan to subject colonies of the native bumble bee *Bombus impatiens* (Cresson) to chemical treatments in an isolated setting while observing pollination and foraging behavior. Initial trials will focus on the chemicals used in pumpkin pest control management. Development of a screening protocol for sub-lethal effects of pesticides on native bees would enable growers to use more specific and effective treatments while mitigating the negative effect on the bees that pollinate their crops.

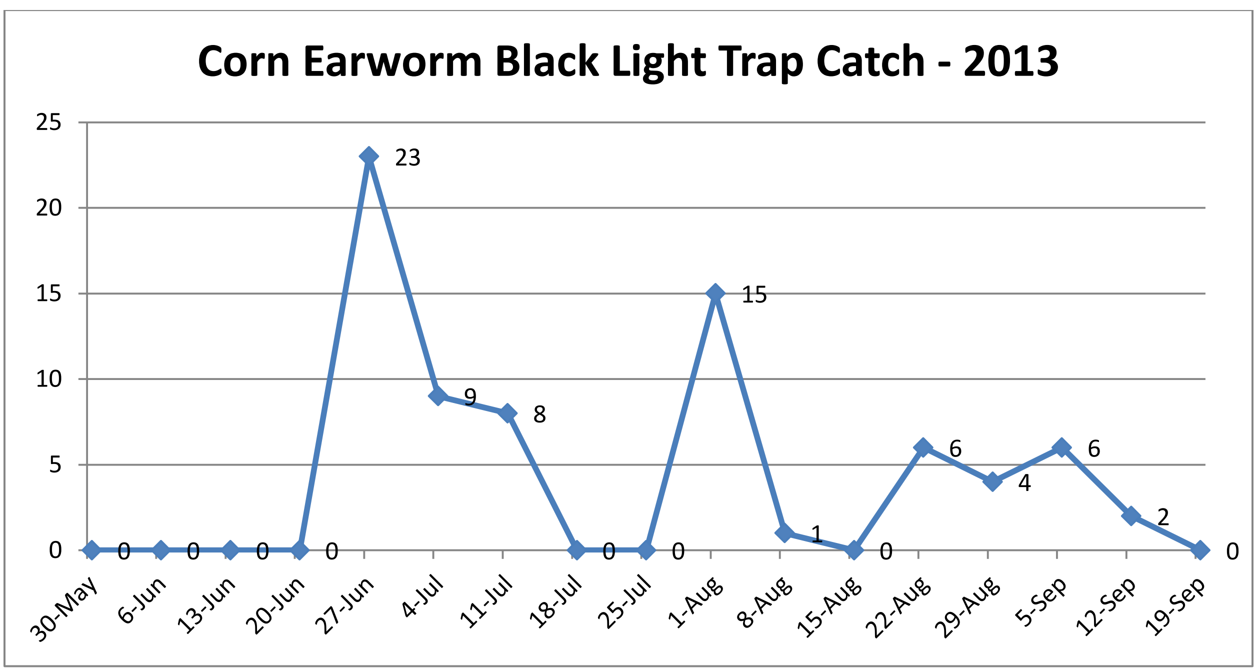
Table 1: Stand count, yield, and cumulative counts of two key insect pests in pumpkin plots under four different pest management regimes in three locations in southwest, VA in 2013.

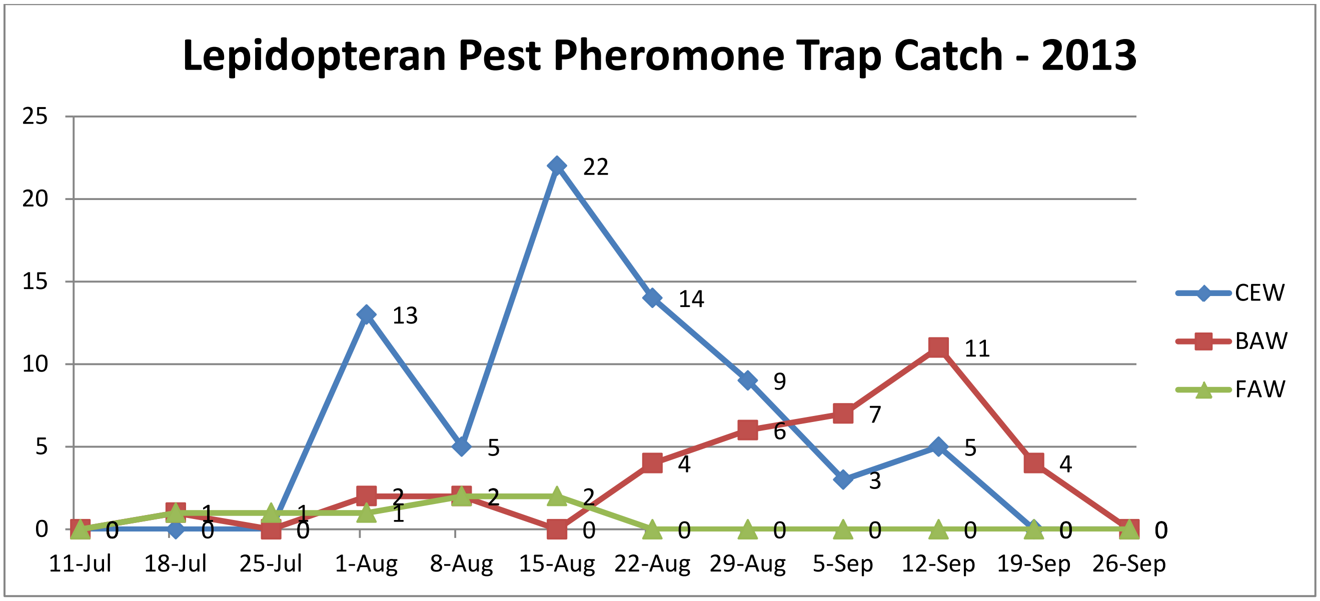
Treatment	Stand Count	Mean Yield (lbs per 0.004 acres)	Cucumber Beetles (cumulative numbers per 5 plants)	Squash Bugs (cumulative numbers per 5 plants)
		Blacksburg, VA		
Untreated Control	89	206 B	16	69
Seed Treat Only	92	274 AB	27	35
IPM	106	254 B	52	23
Conventional Sprays	97	347 A	25	17
		Riner, VA		
Untreated Control	104	477 B	1	0
Seed Treat Only	111	545 A	2	0
IPM	75	545 A	1	0
Conventional Sprays	82	483 AB	1	0
		Abingdon, VA		
Untreated Control	75	550 AB	37	2
Seed Treat Only	90	626 A	48	2
IPM	94	473 B	34	2
Conventional Sprays	86	593 A	15	3

2013 Key Insect Flights (Black Light Trap & Pheromone Traps)

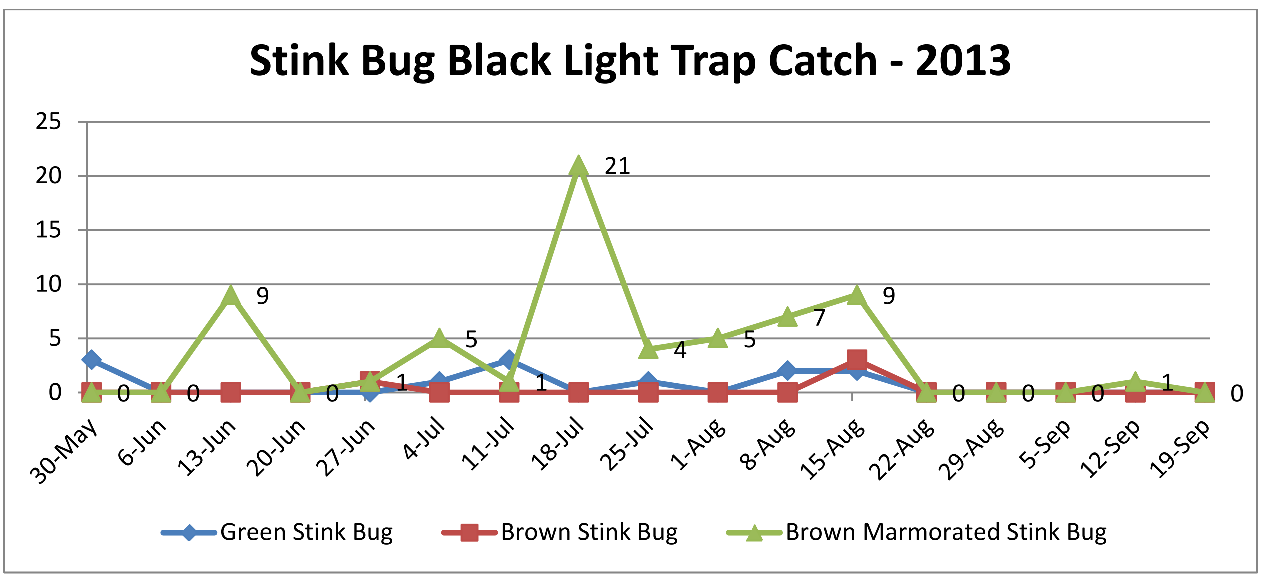
PAINTER, VA

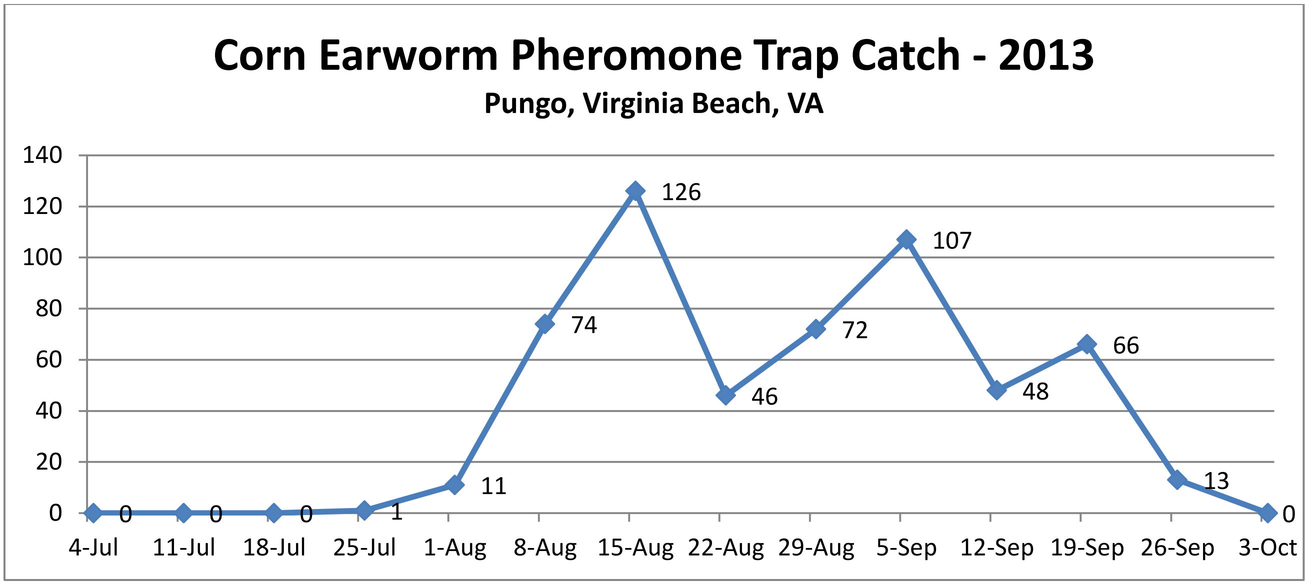






VIRGINIA BEACH, VA





2013 Weather Data for Kentland Research Farm, Blacksburg, VA can be found at the following website:

http://www.vaes.vt.edu/college-farm/weather/2013/weather2013.html

2013 Weather Data
ESAREC, 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	46	41	43.5	0.15		1	47	29	38.0	0		1	48	38	43.0	0	
2	44	34	39.0	0.23		2	35	22	28.5	0		2	43	36	39.5	0	
3	37	29	33.0	0		3	40	32	36.0	0		3	41	30	35.5	0	
4	44	25	34.5	0		4	37	25	31.0	0		4	42	30	36.0	0	
5	43	34	38.5	0		5	48	33	40.5	0		5	46	33	39.5	0	
6	47	31	39.0	0.07		6	47	30	38.5	0		6	47	36	41.5	1.63	
7	47	34	40.5	0		7	45	28	36.5	0		7	46	35	40.5	0.49	
8	54	26	40.0	0		8	46	41	43.5	2.14		8	45	37	41.0	0	
9	63	36	49.5	0		9	42	32	37.0	0		9	52	37	44.5	0	
10	60	42	51.0	0		10	40	26	33.0	0		10	53	25	39.0	0	
11	52	32	42.0	0.06		11	60	33	46.5	0.12		11	59	37	48.0	0	
12	57	46	51.5	0.01		12	60	39	49.5	0		12	60	50	55.0	0.51	
13	53	38	45.5	0		13	52	43	47.5	0.01		13	60	39	49.5	0	
14	65	50	57.5	0.22		14	48	37	42.5	0.1		14	49	34	41.5	0	
15	58	42	50.0	1.22		15	57	32	44.5	0		15	52	31	41.5	0	
16	45	38	41.5	0.48		16	52	34	43.0	0.1		16	57	41	49.0	0.07	
17	48	38	43.0	0.7		17	35	29	32.0	0.19		17	55	37	46.0	0.46	
18	40	32	36.0	0.67		18	40	25	32.5	0		18	45	33	39.0	0.82	
19	51	25	38.0	0		19	56	32	44.0	0.07		19	52	33	42.5	0	
20	59	41	50.0	0		20	54	34	44.0	0.04		20	56	32	44.0	0	
21	56	29	42.5	0		21	39	26	32.5	0		21	53	33	43.0	0	
22	48	26	37.0	0		22	40	28	34.0	0		22	45	30	37.5	0	
23	29	15	22.0	0		23	52	37	44.5	0.62		23	51	27	39.0	0	
24	28	20	24.0	0.02		24	51	40	45.5	0.01		24	51	29	40.0	0	
25	28	14	21.0	0		25	50	32	41.0	0		25	40	32	36.0	0.67	
26	35	17	26.0	0.1	1.5	26	49	27	38.0	0.2		26	49	36	42.5	0.19	
27	36	17	26.5	0		27	57	46	51.5	1.27		27	50	38	44.0	0	
28	45	23	34.0	0.09		28	57	38	47.5	0.01		28	51	38	44.5	0	
29	67	44	55.5	0								29	54	36	45.0	0	
30	69	43	56.0	0								30	61	35	48.0	0	
31	63	47	55.0	0.44								31	60	40	50.0	0.37	
			40.7	4.46	1.50				40.1	4.88	0.00				42.8	5.21	0.00
73-Year Average				3.57						3.20						4.09	
Difference				0.89						1.68						1.12	

Painter, VA

April

	Temperature				
Day	Max.	Min.	Mean	Rain	Snow
1	67	47	57.0	0.03	
2	67	32	49.5	0	
3	52	29	40.5	0	
4	51	31	41.0	0	
5	56	39	47.5	0.9	
6	57	40	48.5	0	
7	61	35	48.0	0	
8	77	55	66.0	0	
9	82	62	72.0	0	
10	85	60	72.5	0	
11	86	62	74.0	0	
12	82	63	72.5	0.12	
13	74	50	62.0	0	
14	69	47	58.0	0	
15	66	53	59.5	0	
16	69	49	59.0	0	
17	78	57	67.5	0	
18	73	56	64.5	0	
19	76	61	68.5	0	
20	73	49	61.0	0.81	
21	55	43	49.0	0	
22	53	35	44.0	0.03	
23	53	46	49.5	0	
24	66	44	55.0	0	
25	65	51	58.0	0	
26	67	38	52.5	0	
27	68	40	54.0	0	
28	64	40	52.0	0	
29	62	54	58.0	1.62	
30	60	54	57.0	0.15	
			57.3	3.66	
73-Year Average				3.13	
Difference				0.53	

May

	Temperature				
Day	Max.	Min.	Mean	Rain	Snow
1	63	55	59.0	0.03	
2	65	48	56.5	0	
3	63	46	54.5	0	
4	62	44	53.0	0	
5	60	44	52.0	0	
6	67	51	59.0	0	
7	68	58	63.0	0.51	
8	69	48	58.5	0	
9	74	57	65.5	0.24	
10	84	58	71.0	0	
11	81	68	74.5	0	
12	75	60	67.5	0.14	
13	68	44	56.0	0	
14	63	39	51.0	0	
15	80	55	67.5	0	
16	88	70	79.0	0	
17	86	63	74.5	0	
18	74	59	66.5	0.18	
19	77	61	69.0	0.06	
20	80	66	73.0	0	
21	80	68	74.0	0	
22	83	69	76.0	0	
23	83	69	76.0	0.27	
24	71	55	63.0	0.22	
25	64	49	56.5	0	
26	69	54	61.5	0	
27	75	47	61.0	0	
28	79	64	71.5	0	
29	85	67	76.0	0	
30	86	69	77.5	0	
31	87	68	77.5	0	
			65.8	1.65	
73-Year Average				3.34	
Difference				-1.69	

June

	Temperature				
Day	Max.	Min.	Mean	Rain	Snow
1	87	71	79.0	0	
2	87	71	79.0	0	
3	85	69	77.0	2.08	
4	75	66	70.5	0.53	
5	76	53	64.5	0	
6	75	58	66.5	0	
7	78	68	73.0	0.94	
8	79	67	73.0	0.87	
9	79	62	70.5	0	
10	82	70	76.0	0.61	
11	83	70	76.5	0.21	
12	88	71	79.5	0	
13	92	70	81.0	0	
14	92	62	77.0	0.65	
15	82	61	71.5	0	
16	85	64	74.5	0	
17	85	70	77.5	0.12	
18	82	69	75.5	0	
19	77	64	70.5	0.7	
20	74	56	65.0	0	
21	76	57	66.5	0	
22	81	60	70.5	0	
23	84	68	76.0	0	
24	87	74	80.5	0	
25	89	74	81.5	0	
26	90	74	82.0	0	
27	90	71	80.5	0	
28	88	74	81.0	0.2	
29	89	71	80.0	0.11	
30	83	73	78.0	0.02	
			75.1	7.04	
73-Year Average				3.78	
Difference				3.26	

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	81	73	77.0	0.14		1	80	71	75.5	0.03		1	87	73	80.0	0	
2	83	73	78.0	0.05		2	87	70	78.0	0.18		2	86	73	79.5	0	
3	84	70	77.0	0.6		3	87	70	82.0	0.77		3	85	74	79.5	0	
4	86	74	80.0	0		4	80	67	83.5	0.02		4	82	64	73.0	0	
5	87	71	79.0	0		5	80	59	75.0	0		5	86	62	74.0	0	
6	89	76	82.5	0		6	76	65	78.5	1.06		6	85	62	73.5	0	
7	89	73	81.0	0		7	82	68	80.0	0.05		7	80	53	66.5	0	
8	88	76	82.0	0.02		8	84	72	77.5	0		8	86	62	74.0	0	
9	88	73	80.5	0		9	89	75	65.5	0		9	86	66	76.0	0	
10	89	77	83.0	0		10	89	78	66.0	0		10	87	67	77.0	0	
11	84	74	79.0	0.94		11	82	68	71.0	0.02		11	90	70	80.0	0	
12	78	72	75.0	0.25		12	85	72	70.5	0		12	89	72	80.5	0	
13	84	69	76.5	0.02		13	87	73	68.0	0		13	84	69	76.5	1.28	
14	86	73	79.5	0		14	86	69	74.0	0.09		14	77	59	68.0	0	
15	90	69	79.5	0		15	75	56	75.0	0		15	74	49	61.5	0	
16	92	76	84.0	0		16	77	55	78.0	0		16	79	61	70.0	0	
17	94	72	83.0	0		17	77	65	77.0	0		17	70	55	62.5	0.01	
18	95	71	83.0	0		18	74	67	69.0	0.77		18	71	50	60.5	0	
19	95	75	85.0	0		19	73	63	66.5	0.06		19	73	47	60.0	0	
20	92	79	85.5	0		20	82	66	66.5	0		20	75	49	62.0	0	
21	89	78	83.5	0		21	84	66	76.5	0		21	78	52	65.0	0	
22	89	73	81.0	0.21		22	86	70	79.5	0.65		22	77	64	70.5	0.54	
23	88	75	81.5	0.01		23	85	69	76.0	0.06		23	73	51	62.0	0	
24	89	72	80.5	0		24	78	60	69.0	0.13		24	68	45	56.5	0	
25	87	67	77.0	0.64		25	77	56	66.5	0		25	75	47	61.0	0	
26	81	65	73.0	0		26	80	53	66.5	0		26	75	56	65.5	0	
27	83	64	73.5	0		27	88	65	76.5	0		27	72	55	63.5	0	
28	84	68	76.0	0		28	88	71	79.5	0		28	70	56	63.0	0	
29	83	69	76.0	0.43		29	81	71	76.0	0.03		29	72	56	64.0	0	
30	84	61	72.5	0		30	82	62	72.0	0		30	74	49	61.5	0	
31	80	64	72.0	0		31	86	68	77.0	0							
			79.2	3.31	0.0				73.9	3.92	0				68.9	1.83	0
73-Year Average				4.56						4.35						4.35	
Difference				-1.25						-0.43						-2.52	

October					
	Temperature				
Day	Max.	Min.	Mean	Rain	Snow
1	79	50	64.5	0	
2	82	57	69.5	0	
3	85	57	71.0	0	
4	85	68	76.5	0	
5	88	62	75.0	0	
6	87	64	75.5	0	
7	82	71	76.5	0	
8	76	59	67.5	0.71	
9	64	58	61.0	0.57	
10	69	60	64.5	0.91	
11	70	66	68.0	1.2	
12	72	66	69.0	0.08	
13	68	64	66.0	0.21	
14	70	61	65.5	0	
15	69	55	62.0	0	
16	73	60	66.5	0	
17	75	60	67.5	0	
18	71	60	65.5	0	
19	66	49	57.5	0	
20	65	52	58.5	0.02	
21	65	40	52.5	0	
22	68	48	58.0	0	
23	64	48	56.0	0.08	
24	57	46	51.5	0	
25	55	36	45.5	0	
26	59	32	45.5	0	
27	63	44	53.5	0	
28	67	39	53.0	0	
29	67	43	55.0	0	
30	67	47	57.0	0	
31	72	55	63.5	0	
			62.5	3.78	0.00

73-Year Average	3.59
Difference	0.19

2013 WEATHER DATA – HRAREC, Virginia Beach, VA

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
Apr	high	avg	low	high	avg	low	sum	
1	72	61	49	93	61	28	0	
2	58	49	40	76	49	21	0	
3	54	48	42	76	54	32	0	
4	50	45	40	89	63	37	0.44	
5	59	51	42	93	68	43	0.48	
6	51	46	40	82	64	46	0	
7	71	56	41	89	59	29	0	
8	80	68	55	83	61	39	0	
9	84	73	62	84	61	37	0	
10	89	78	66	70	52	34	0	
11	85	74	63	73	57	40	0	
12	81	75	69	90	76	62	0.22	Rain
13	70	62	54	87	67	46	0	
14	70	59	48	86	57	28	0	
15	67	63	58	80	63	46	T	
16	74	67	59	80	67	53	0	
17	82	70	58	90	71	51	0	
18	79	71	62	90	68	45	0	
19	84	75	65	87	69	51	0.3	Rain
20	66	58	50	93	68	43	0.4	Rain
21	54	50	45	93	68	42	0	
22	55	50	45	86	76	65	0.02	Rain
23	56	50	44	93	82	71	0	
24	76	60	44	100	73	46	0	
25	64	55	46	86	65	44	0	
26	65	55	44	92	66	40	0	
27	67	58	49	80	56	32	0	
28	67	56	45	87	66	44	0.02	Rain
29	65	61	57	100	94	87	1.31	Fog , Rain
30	64	60	56	93	86	78	0.02	Rain

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
May	high	avg	low	high	avg	high	sum	
1	58	56	51	100	90	31	0.09	Rain
2	63	59	47	93	80	26	0	
3	61	57	45	93	74	35	0	
4	61	56	46	96	84	29	0.02	Rain
5	57	55	46	89	83	28	T	
6	73	64	52	100	79	28	0.03	Fog
7	74	65	53	93	77	26	0.18	Rain
8	75	64	50	93	70	21	0.07	Rain
9	79	68	49	93	65	23	0	
10	87	74	54	84	59	25	0	
11	84	76	59	84	64	33	0.31	Rain
12	70	65	41	93	70	28	0.11	Rain
13	64	60	28	46	38	21	0	
14	66	56	26	77	51	20	T	
15	86	73	43	60	49	31	0	
16	91	81	52	66	47	24	0	
17	77	71	46	78	57	17	0	
18	74	67	52	93	76	26	1.71	Rain
19	78	73	63	93	79	16	T	
20	83	76	65	90	73	32	0.22	Rain
21	83	76	64	90	73	17	0.23	Rain
22	86	77	63	90	69	31	0	
23	77	73	62	93	84	29	0.85	Fog , Rain
24	74	64	35	87	67	35	0.33	Rain
25	67	58	32	56	43	26	0	
26	73	64	33	77	51	22	0	
27	77	65	43	89	61	18	0	
28	84	74	55	78	61	28	0	
29	88	78	61	87	65	29	0	
30	87	77	59	87	67	21	0	
31	90	81	60	84	61	24	0	

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
Jun	high	avg	low	high	avg	low	sum	
1	90	81	71	84	65	46	0	
2	89	80	70	84	62	40	0	
3	80	76	71	90	80	69	0.08	Rain
4	74	67	60	90	68	46	T	Rain
5	77	68	59	90	62	33	0	
6	79	71	63	93	71	48	T	
7	85	78	70	97	81	65	0.74	Rain
8	83	77	70	90	77	63	0	
9	83	75	67	87	73	58	0	
10	85	78	71	93	79	65	1.07	Rain
11	85	78	71	90	69	48	T	Rain
12	92	81	69	79	60	40	0	
13	96	84	71	79	60	40	0.04	Rain
14	72	67	62	84	69	53	T	Rain
15	85	73	61	84	59	34	0	
16	89	79	68	81	61	40	0	
17	86	79	72	84	70	55	0.08	Rain
18	84	76	68	93	79	65	0.3	Rain
19	74	70	65	84	76	68	0	
20	74	69	63	84	69	53	0	
21	78	72	65	90	80	69	0.08	Rain
22	83	75	66	90	78	65	0	
23	89	81	73	93	74	55	0.04	
24	90	82	73	87	70	52	0	
25	93	84	74	87	68	49	0	
26	95	83	71	90	67	44	0.05	Rain
27	94	83	71	90	67	44	0.01	
28	95	85	75	87	64	41	0.02	Rain
29	89	80	71	93	74	55	0.11	Rain
30	85	80	75	82	72	61	T	Rain

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
Jul	high	avg	low	high	avg	low	sum	
1	84	80	76	88	79	69	0.39	Rain
2	88	80	72	93	76	59	1.39	Fog , Rain
3	87	80	73	94	79	63	0.18	Rain
4	90	82	74	94	73	52	0	
5	91	82	73	94	73	52	0	
6	92	83	74	93	69	44	0	
7	92	84	75	82	65	47	0	
8	87	82	76	82	69	55	T	Rain
9	90	83	75	94	73	52	0	
10	92	84	76	88	70	52	0	
11	87	80	73	93	74	55	1.23	Fog , Rain , Thunderstorm
12	82	78	73	93	81	69	0.48	Rain
13	87	80	72	93	78	63	0.11	Rain
14	88	82	76	94	77	59	0	
15	89	81	73	94	75	56	0	
16	92	85	77	79	68	56	0	
17	92	85	77	85	69	52	0	
18	93	84	74	87	70	52	0	
19	94	86	77	85	69	52	0	
20	91	84	77	82	69	56	0	
21	92	84	76	87	70	52	0.03	Rain
22	89	82	74	94	79	63	3.27	Fog , Rain
23	90	83	76	94	73	52	0	
24	93	84	74	87	66	44	0	
25	78	74	69	87	81	74	1.11	Rain
26	83	75	67	90	71	51	0	
27	83	75	66	87	67	47	0	
28	88	80	71	90	73	55	T	Rain
29	83	78	72	94	74	54	0	
30	84	76	67	87	64	40	0	
31	84	78	72	84	66	47	T	

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
Aug	high	avg	low	high	avg	low	sum	
1	83	75	67	93	81	69	0.67	Rain
2	87	78	68	97	74	51	0	
3	89	80	71	94	77	59	0.46	Rain , Thunderstorm
4	82	77	72	93	68	43	0	
5	81	73	65	87	68	49	0	
6	72	70	67	90	79	68	0.53	Rain
7	87	79	71	93	74	55	0	
8	87	80	73	91	75	59	0	
9	93	85	77	88	70	52	0	
10	88	82	75	94	79	63	1.03	Fog , Rain
11	87	81	75	94	80	65	0.43	Rain
12	88	82	75	91	80	68	0	
13	90	84	77	91	75	59	0.01	Rain
14	78	74	70	88	66	43	T	Rain
15	77	73	69	61	53	44	0	
16	76	73	69	84	69	54	T	Rain
17	76	74	71	93	81	69	0.55	Rain
18	77	73	68	100	91	82	0.56	Rain
19	76	72	68	93	83	73	0.01	Rain
20	80	74	68	97	82	67	0	
21	86	78	70	97	83	69	0	
22	89	81	73	93	73	53	0.33	Rain
23	84	78	71	87	73	58	0.24	Rain
24	79	74	68	78	69	60	0	
25	77	70	62	78	64	50	0	
26	82	70	58	93	62	31	0	
27	91	79	66	74	58	41	0	
28	87	81	75	88	73	57	0.18	Rain
29	81	77	73	94	82	69	0.04	Rain
30	82	75	68	90	76	62	0	
31	90	80	69	97	71	44	0	

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
Sep	high	avg	low	high	avg	low	sum	
1	92	83	73	94	73	52	0.12	Rain
2	89	81	72	93	74	55	T	Rain
3	87	79	71	94	78	61	0.23	Rain
4	82	76	69	90	71	51	0	
5	86	77	67	100	79	58	0	Fog
6	79	73	67	82	64	46	0	
7	79	70	60	84	66	47	0	
8	88	76	63	84	58	31	0	
9	83	77	71	87	76	65	0	
10	90	79	68	97	74	51	0	
11	91	81	71	87	67	47	0	
12	92	82	72	87	66	44	0	
13	82	77	72	87	65	43	0.01	
14	72	67	62	73	60	47	0	
15	76	67	57	87	67	46	0	
16	84	74	63	90	74	39	0.03	Rain
17	70	66	61	78	68	58	0	
18	74	66	58	78	63	47	0	
19	74	65	55	93	67	41	0	
20	78	68	57	90	67	43	0	
21	86	73	59	93	71	48	0.05	Rain
22	74	70	65	100	77	53	0.49	Rain
23	68	61	53	65	57	48	0	
24	71	62	52	83	68	53	0	
25	74	64	53	93	67	41	0	
26	75	68	60	90	72	53	0	
27	74	70	65	73	60	46	T	Rain
28	73	69	64	78	70	61	0	
29	74	69	63	87	70	53	0	
30	72	65	57	90	72	53	0	

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
Oct	high	avg	low	high	avg	low	sum	
1	80	67	53	93	68	42	0	
2	81	71	60	90	68	45	0	
3	82	71	60	97	70	43	0	
4	89	79	68	84	62	40	0	
5	87	77	66	93	69	45	0	
6	88	78	68	93	68	42	0	
7	88	76	63	100	75	50	0.68	Rain
8	65	63	60	78	67	56	0.02	Rain
9	65	63	60	100	87	73	2.28	Rain
10	66	64	61	100	100	100	0.68	Fog , Rain
11	68	64	59	100	97	93	0.15	Fog , Rain
12	73	69	65	100	92	84	0.26	Rain
13	72	69	66	100	92	84	0.05	Fog , Rain
14	71	67	62	87	79	70	0	
15	68	65	62	93	89	84	0	
16	70	67	63	93	83	73	0	
17	79	70	60	97	77	56	0	
18	71	64	57	84	66	48	0	
19	68	63	58	93	83	72	0.01	Rain
20	65	56	47	87	63	39	0	
21	68	56	44	93	68	42	0	
22	67	60	52	93	78	62	0	
23	60	56	51	93	74	55	T	
24	57	52	46	71	53	35	0	
25	56	48	39	70	53	35	0	
26	63	50	37	92	61	29	0	
27	66	56	46	80	57	34	0	
28	67	56	44	93	73	52	0	
29	66	58	50	96	72	48	T	Rain
30	74	64	53	100	77	53	0	
31	77	67	56	87	67	46	0	

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
Nov	high	avg	low	high	avg	low	sum	
1	77	72	67	93	79	64	0.37	Rain
2	72	66	59	93	67	40	0.02	Rain
3	60	56	52	64	50	35	0	
4	53	49	44	77	58	38	0	
5	63	58	53	83	72	60	0	
6	70	60	50	90	72	53	0	
7	68	60	52	93	72	51	0.57	Rain
8	57	51	45	56	43	30	0	
9	59	48	37	85	58	30	0	
10	69	57	45	70	48	26	0	
11	55	49	43	83	62	41	0	
12	56	48	39	83	61	39	0	
13	44	37	30	69	53	36	0	
14	59	45	30	78	49	20	0	
15	64	49	33	69	48	27	0	
16	61	57	52	100	81	62	0.02	Rain
17	69	60	55	93	83	73	T	Fog
18	74	66	57	93	59	25	0.03	Rain
19	57	52	46	56	45	33	0	
20	52	48	44	68	59	49	0	
21	61	54	47	96	84	71	T	
22	74	60	46	100	75	49	0.02	Fog , Rain
23	63	52	40	93	68	42	0.03	Rain
24	45	38	30	54	39	23	0	
25	38	33	28	52	46	39	0	
26	67	52	36	93	76	59	0.5	Rain
27	69	54	39	96	81	65	1.01	Rain
28	42	37	31	69	51	32	0	
29	46	37	27	85	65	45	0	
30	47	43	38	83	69	54	0	

2013	Temp. (°F)			Humidity (%)			Precip. (in)	Events
Dec	high	avg	low	high	avg	low	sum	
1	52	44	35	92	76	59	0	Fog
2	54	43	32	96	84	71	0	Fog
3	61	47	33	100	70	39	0	Fog
4	63	56	48	93	76	59	0.05	Rain
5	69	59	49	100	84	68	0	Fog
6	80	64	48	93	74	54	0	
7	49	45	41	93	79	65	0.46	Rain
8	44	41	37	93	77	60	0.37	Rain , Snow
9	47	43	38	100	95	89	0.16	Rain
10	47	41	34	96	88	79	0.93	Rain
11	47	38	28	85	61	37	0	
12	40	33	25	78	63	48	0	
13	49	37	25	81	55	28	0	
14	61	47	33	93	73	53	0.86	Rain
15	60	51	41	96	75	53	0.02	Rain
16	47	41	34	76	63	49	0	
17	61	50	39	85	61	37	T	Rain
18	47	40	32	86	62	38	T	
19	61	45	29	72	47	22	0	
20	69	56	43	86	66	46	0	
21	73	63	53	93	75	57	0	
22	81	70	59	87	71	54	0.01	
23	75	60	45	93	86	78	0.92	Rain
24	45	39	33	89	64	38	0.17	Rain
25	35	32	28	78	60	41	0	
26	47	37	27	92	65	37	T	Rain
27	49	39	28	92	63	34	0	Fog
28	59	44	29	85	55	24	0	
29	66	56	46	93	72	50	0.8	Rain
30	54	46	38	100	75	50	0	
31	50	42	33	65	50	34	0	