

BMSB Response to Insecticides

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Insecticides for control of BMSB

- A lot of insecticide research conducted on BMSB in the last decade (Kuhar & Kamminga 2017)
- Most **pyrethroids** are efficacious and are the most widely used
- **Neonicotinoids** (particularly dinotefuran) also efficacious – regulatory restrictions
- A few remaining OPs and Carbamates such as methomyl, acephate, and chlorpyrifos are also efficacious – but few remaining crops



Kuhar, T. P. and K. Kamminga. 2017. Review of the chemical control research on *Halyomorpha halys* in the USA. J. Pest Sci. DOI 10.1007/s10340-017-0859-7

Heavy reliance on pyrethroids and neonicotinoids

- Insecticide resistance in BMSB
- Need for compounds that are less toxic to beneficial arthropods and thus, more compatible in IPM systems and pollinator protection plans



Collaborative Project: Baseline toxicity levels in BMSB populations to bifenthrin and thiamethoxam



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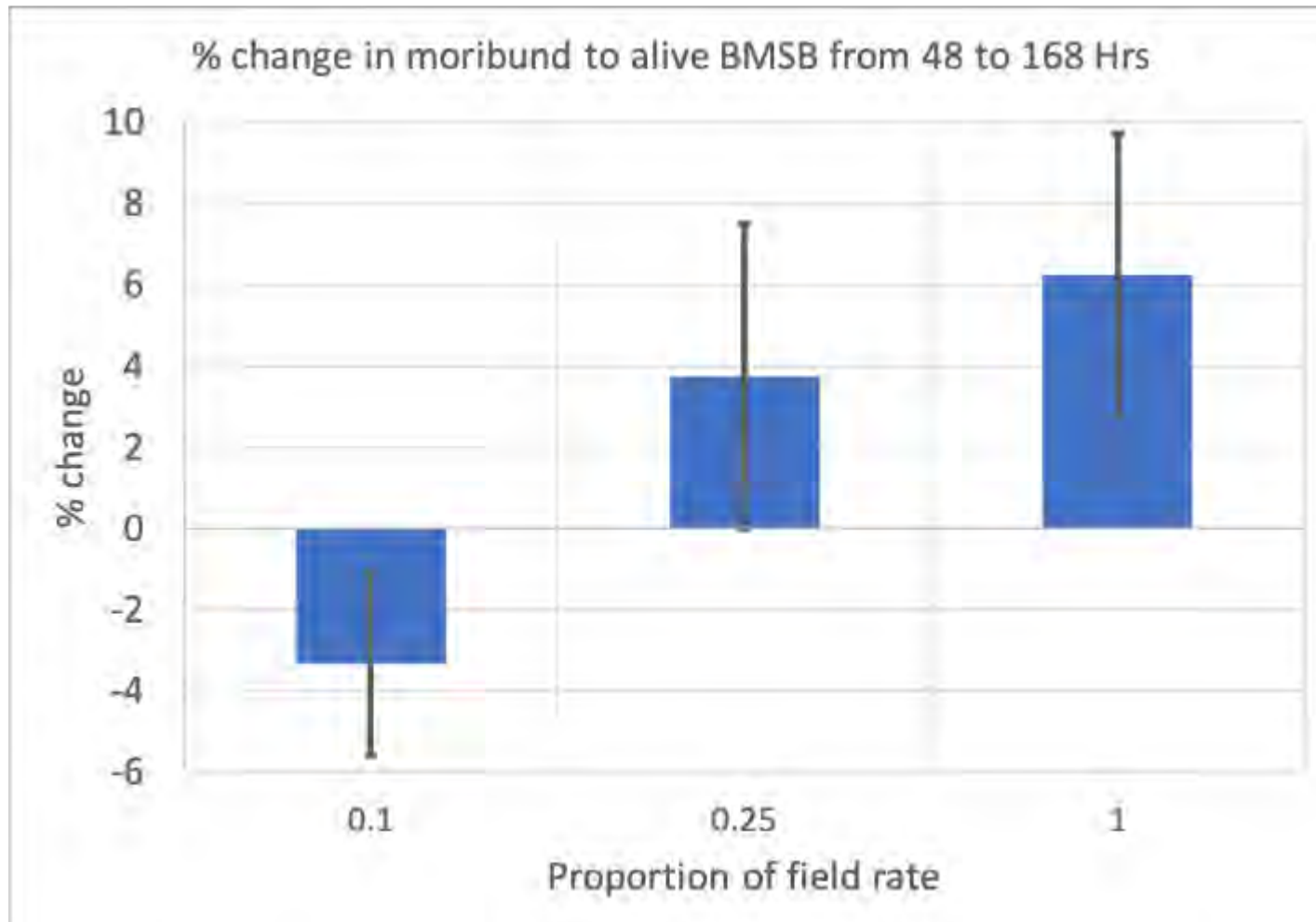


Methods

- BMSB adults collected in the fall from NC, NJ, NY, OH, PA and VA
- Exposed to Brigade 2EC (Bifenthrin) and Actara 50WDG (Thiamethoxam) at 0, 0.1, 0.25, 0.5, and 1X field rate
- Mortality assessed at 24, 48, and 168 hrs
- LD50 probit analysis
- Mortality~sex tested at each concentration



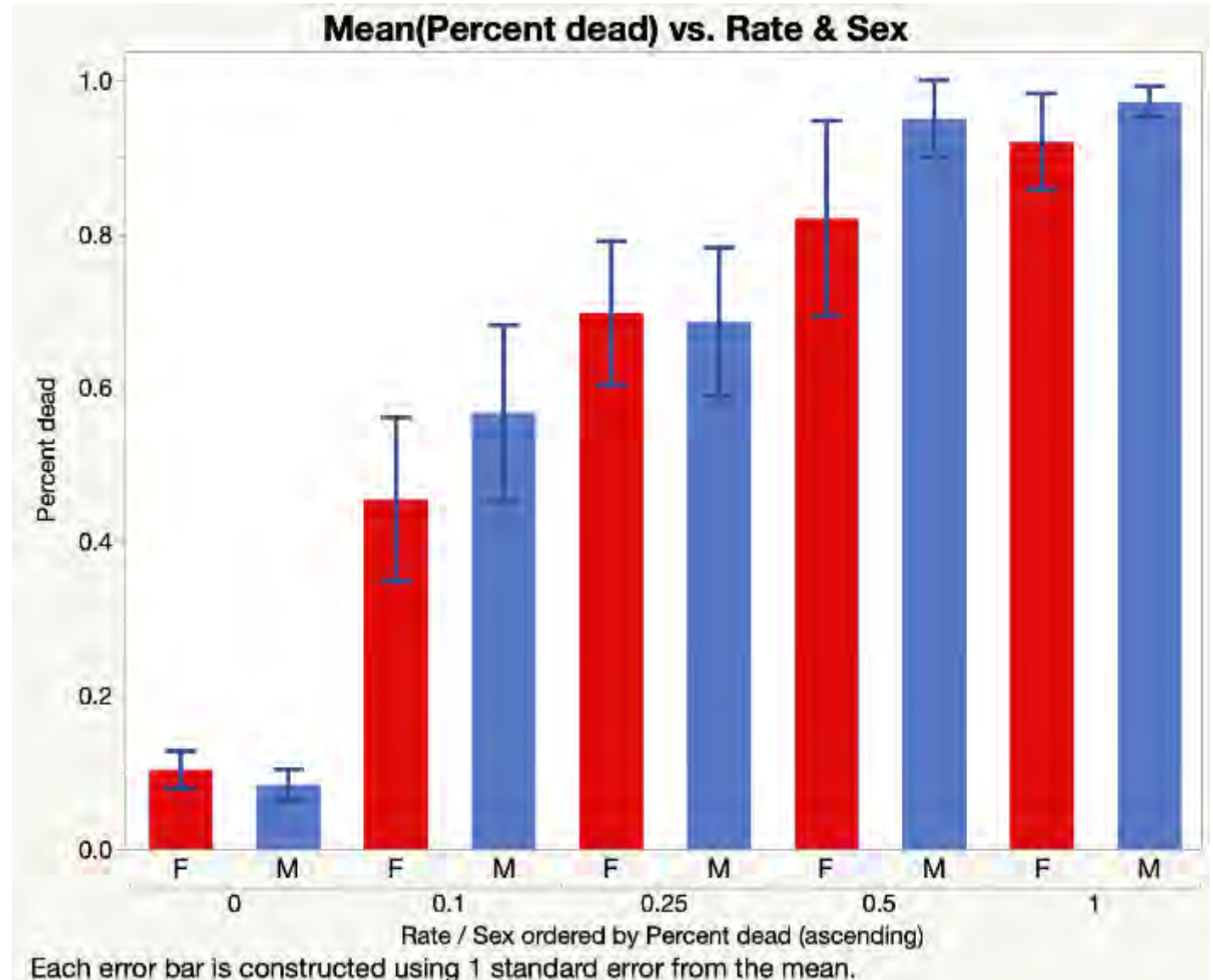
BMSB recovery after exposure



- Minimal full recovery of BMSB with topical exposure
- Using 48 hr dead + moribund to assess mortality is efficient and accurate

Effect of Sex on Bifenthrin Mortality

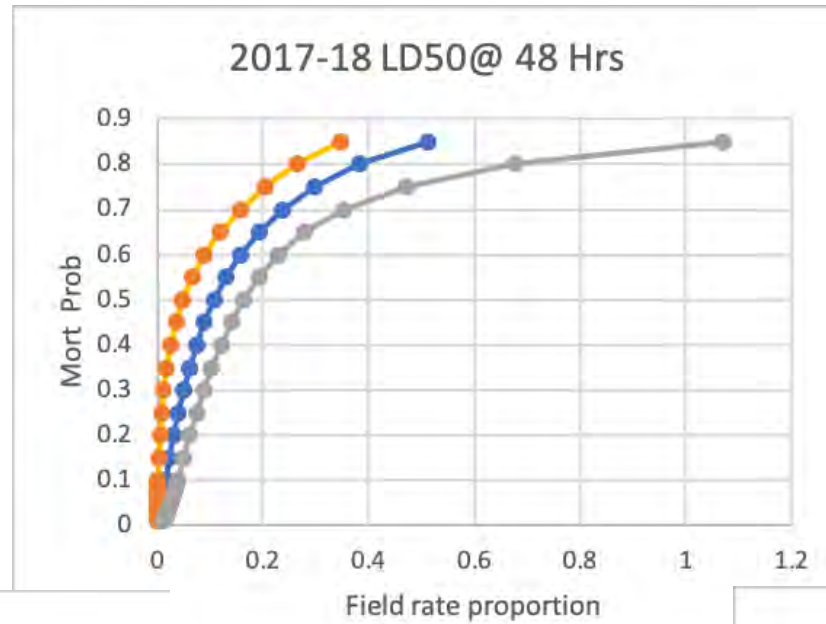
- % dead adults @ 48 Hrs ~ Sex
 - T-test at 0, 0.1, 0.25, 0.5, and 1 proportion of the Bifenthrin field application rate
- 2017+2018 data pooled
- No differences in mortality ~ sex at any concentration



Bifenthrin

2017 LD50
(Prop. Field rate)

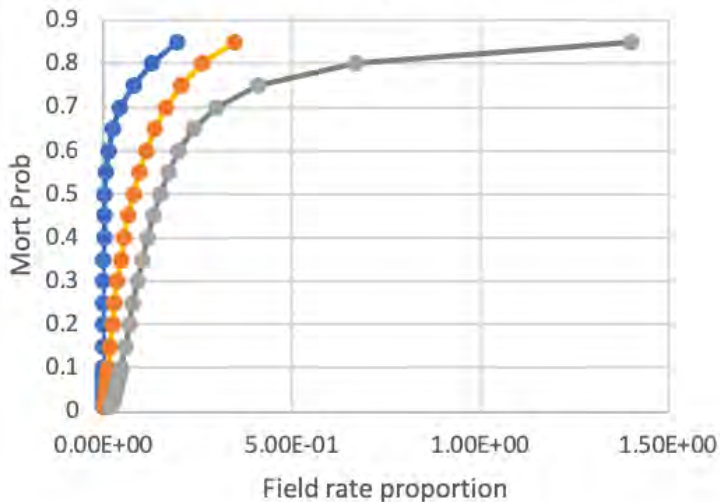
LD50	Low	High
0.08	0.01	0.15



2018 LD50
(Prop. Field rate)

LD50	Low	High
0.15	0.06	0.24

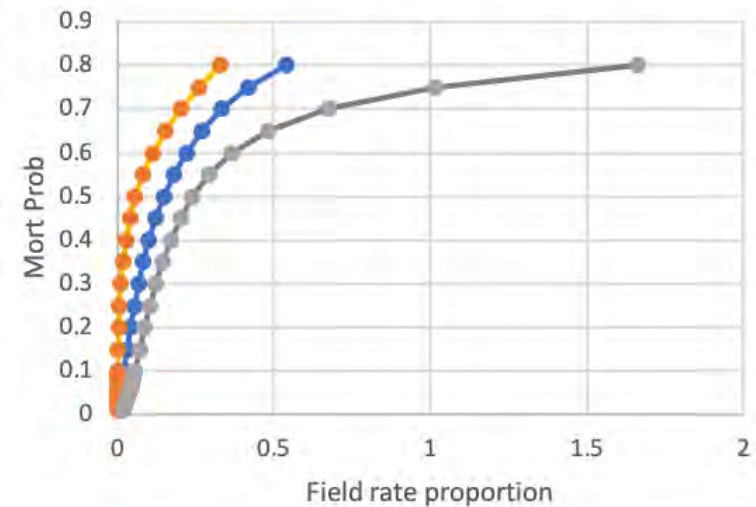
2017 LD50@ 48 Hrs



2017+2018 LD50
(Prop. Field rate)

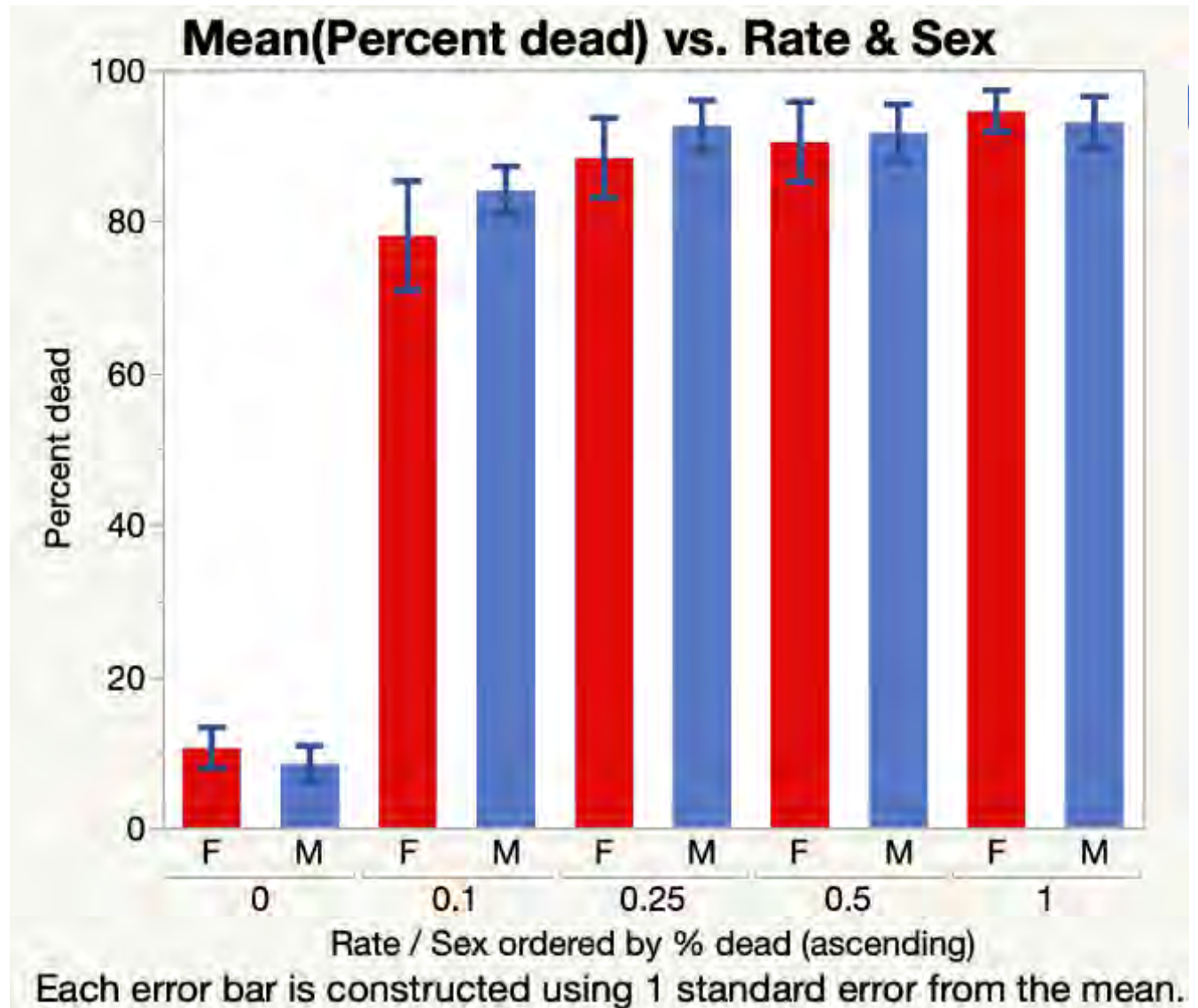
LD50	Low	High
0.11	0.05	0.16

2018 LD50@ 48 Hrs



Effect of Sex on Thiamethoxam Mortality

- % dead adults @ 48 hrs ~ Sex
 - T-test at 0, 0.1, 0.25, 0.5, and 1 proportion of the Thiamethoxam field application rate
- 2017+2018 data pooled
- No differences in mortality ~ sex at any concentration

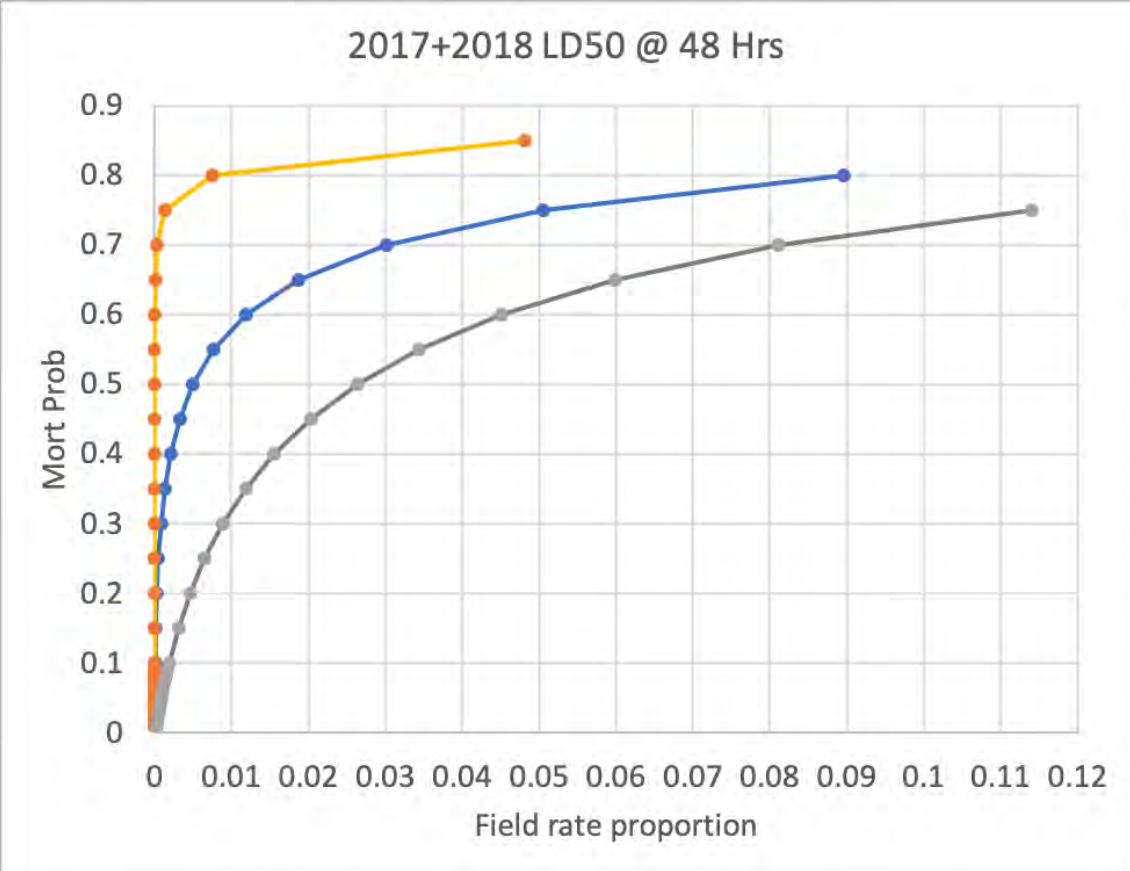


Thiamethoxam

LD50 (Prop. Field rate)	Low	High
0.005	1.12E-06	0.020

Thiamethoxam is highly toxic at field rate.

Insufficient concentrations were tested for 2017 and 2018 LD50 to be made separately



Search for less disruptive insecticides



Sulfoxaflor



- IRAC Group 4C – sulfoximine similar to, but not a neonicotinoid
- **Closer SC** for tree fruit and veggies from **Corteva Agriscience**
Transform 50WG for field crops
- Demonstrated toxicity against several hemipteran pests such as aphids, leafhoppers, and Lygus bugs
- Sulfoxaflor presents a low risk to aquatic and terrestrial organisms and a lower residual toxicity to pollinators, although direct exposure is toxic to bees.

Sulfoxaflor is more toxic to bees than Assail (acetamiprid), but ~10x less toxic than most neonics

Field test on bell Peppers Blacksburg, VA, 2012

(Foliar treatments were applied on 6, 14, 21, and 29 Aug)



Treatment	Rate fl. oz/ A	% stink bug damage		
		16-Aug	23-Aug	5-Sep
UTC		42.5 a	30.0	30.0
Scorpion 3.24 EC (dinotefuran)	5.0	15.0 b	8.8	10.0
Closer 2SC (low rate)	2.0*	12.5 b	18.8	12.5
P-Value from ANOVA		0.0324	ns	ns

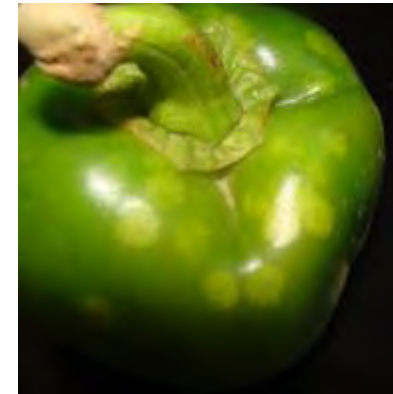
*Note this is a low rate. Can apply up to 5.75
fl oz/A on most crops.

Field tests on bell peppers 2013, Blacksburg, VA (4 weekly sprays)

Treatment	Rate / acre	% stink bug damage to peppers	
		12-Aug	4-Sep
Untreated Control		15.0	7.5
Belay 2.13SC + NIS	6 fl. oz + 0.25% v/v	2.5	7.5
Danitol 2.4EC + NIS	21 fl. oz + 0.25% v/v	3.8	6.3
Closer 2SC + NIS	3 fl. oz + 0.25% v/v	2.5	3.8
Closer 2SC + NIS	5 fl. oz + 0.25% v/v	5.0	2.5

NS

NS





Using 'Confined Field Population' of BMSB as Indicators of Insecticide Efficacy



- Closer SC @ 5.75 fl.oz./A and Bifenthrin EC at 12.8 fl.oz. on 2nd August applied dilute using handgun \geq 250psi @ 75 GPA.
- Placement of BMSB 3rd instar nymphs and adults @ 24hr, 48hr and 72hr post application onto shaded side of fruit, north side of each tree.
- Over top of each insect was placed a 1 oz. screened cup.
- Insects were removed after 7d with container perimeter circled using black marker to isolate BMSB feeding site.



BMSB Feeding and Mortality Comparison on Closer and Bifenthrin Treated Apple.



Harvest Field Means

Trmt	Hr. Post Application	Life Stage	# Feeding Sites	# / fruit Green Dimples	Corking	% Clean
Closer	24h	adult & nymph	0.2	0.3	0.3	71.4
Bifenthrin	24h	adult & nymph	0.2	0.5	0.3	60.0
UTC	24h	adult & nymph	1.4	1.2	1.4	26.7
Closer	48h	adult & nymph	0.4	0.1	0.4	71.4
Bifenthrin	48h	adult & nymph	0.3	0.9	0.4	61.5
UTC	48h	adult & nymph	1.4	1.9	2.1	20.0
Closer	72h	adult & nymph	0.4	0.4	0.6	53.8
Bifenthrin	72h	adult & nymph	0.0	0.6	0.1	64.3
UTC	72h	adult & nymph	1.1	1.4	1.9	23.1

Harvanta 50SL (cyclaniliprole)



- IRAC Group 28

GROUP	28	INSECTICIDE
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 - Anthranilic diamide
 - Ryanodine receptor modulator
- Broad spectrum control
- Highly effective against Lepidopteran, Dipteran, Coleopteran, and many other pests at low use rate
- Long residual activity
- Variable toxicity to beneficials

Summit Agro

Field test on tomatoes 2016 Whitethorne, VA (6 weekly sprays July-Aug)



Treatment	Rate / acre	Total % cumulative stink bug damaged fruit
Untreated check		9.0 a
Zylam (dinotefuran)	6.5 fl. oz	3.3 bc
Actara 25WG (thiameth.)	5.5 oz	2.4 c
Brigade 2EC (bifenthrin)	5.2 fl. oz	1.9 c
Harvanta 50SL (cyclanil.)	11 fl. oz	4.1 abc
P-value from Anova		0.0107

Harvanta providing some control, probably not as good as bifenthrin or thiamethoxam for BMSB.

Beleaf™ (IRAC 9 Insecticide)



- Acts on insect chordotonal organ
- Active ingredient = flonicamid
- Inhibits hemipteran feeding - aphids, whiteflies, plant bugs
- Virtually non-toxic to mammals and beneficial insects

Field tests on bell peppers 2013, Whitethorne, VA (5 weekly sprays July-Aug)

Treatment	Rate / acre	% of fruit with stink bug damage	
		20-Aug	4-Sep
Untreated Control		27.5	23.8 a
Mustang Max (zeta cyperm.)	4 fl. oz	12.5	7.5 bc
Bifenthrin 2EC	6.4 fl. oz	1.3	2.5 c
Beleaf 50 (flonicamid)	2.8 oz	7.5	3.8 bc
Lannate LV (methomyl)	24 fl. oz	1.3	3.8 bc

Beleaf performed quite well at reducing BMSB damage.



Field tests on bell peppers 2015, Blacksburg, VA (4 weekly sprays)

Treatment	Rate / acre	% fruit with stink bug damage	
		13-Aug (3 DAT3)	24-Aug (7 DAT4)
Untreated Control		18.0	31.0 a
Harvanta 50SL	16.4 fl. oz	16.0	13.0 ab
Closer SC	5 fl. oz	13.0	7.0 ab
Beleaf 50SG	2.8 oz	19.0	24.0 ab
Bifenture 2EC	6.4 fl. oz	6.0	2.0 b

Neither Beleaf nor Harvanta reduced BMSB damage, and bifenthrin performed the best in this trial.

SIVANTO

IRAC 4D butenolides

- Active ingredient: flupyradifurone
- MOA – similar to neonics
- control of major sucking insect pests
- has an outstanding safety profile - Virtually non-toxic to beneficial insects



Field test on tomatoes 2018

Whitethorne, VA

(6 weekly sprays July-Sep)



Treatment	Rate / acre	Proportion stink bug damaged fruit	
		24-Aug (8 DAT2)	30-Aug (7 DAT4)
Untreated check		0.29 a	0.33 a
Harvanta 50SL	10.9 fl oz	0.24 ab	0.21 ab
Harvanta 50SL	16.4 fl oz	0.22 ab	0.19 bc
➔ Closer SC	4.5 fl oz	0.08 b	0.07 c
Sivanto Prime	4.5 fl oz	0.32 a	0.25 ab
Sivanto HL	7.0 fl oz	0.16 ab	0.2 b
Beleaf 50SG + NIS	2.4 oz	0.16 ab	0.19 bc

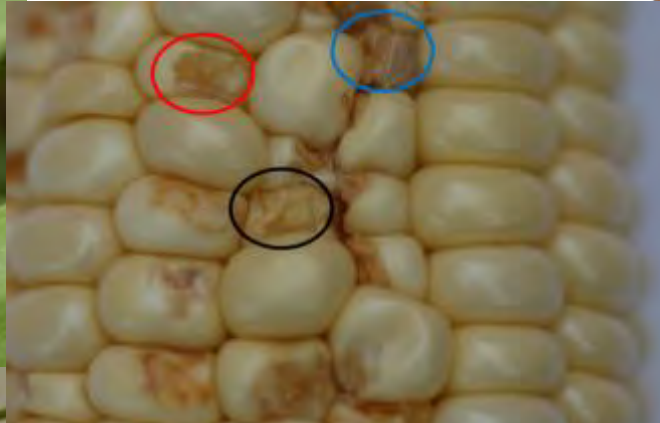
EVALUATION OF INSECTICIDES FOR THE CONTROL OF INSECTS IN SNAP BEANS; Painter, VA – 1 application

Treatment	Rate amt product / acre	Mean no. PLH nymphs / 20 leaves at 6 DAT	% stink bug damaged pods
Untreated check		8.25 a	12.50 a
Closer SC	2 fl oz (Low)	1.00 b	10.50 a
Exirel	13.5 fl oz	0.75 b	13.00 a
Harvanta 50SL	22 fl oz	2.50 b	5.00 ab
Sivanto 200SL	10 fl oz	0.50 b	6.30 ab
Assail 30SG	5.3 oz	1.00 b	7.75 ab
Hero (bif. + zeta)	10.3 fl oz	0.25 b	2.50 b



All trts controlled PLH, but only pyrethroid (Hero) significantly reduced stink bug dmg. Closer rate was low, Harvanta and Sivanto provided a little control.

Insecticide options for organic growers who face the most pest pressure



Field tested a bunch of OMRI-approved insecticides and non provided effective control of BMSB on vegetables.

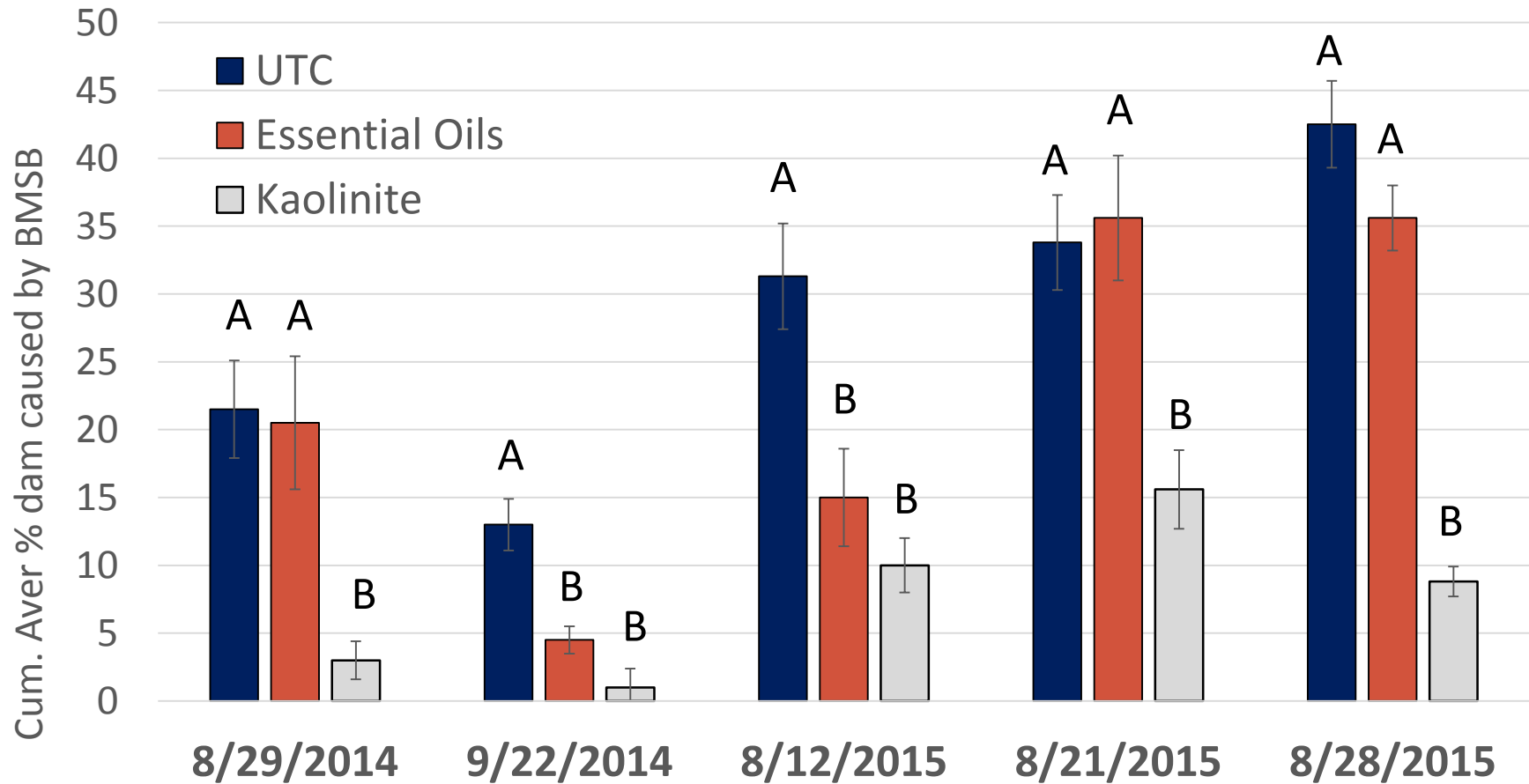
Treatment	Rate (g a.i./ha)	Average % of harvested fruit with stink bug damage \pm SE			
		Pepper		Tomato	
		13-Aug	26-Aug	20-Aug	31-Aug
Water Control	0	47.0 \pm 16.4	47.0 \pm 19.7	65.0 \pm 9.4	65.0 \pm 7.0
Azadirachtin	48.4	22.0 \pm 17.7	46 \pm 2.2	58.0 \pm 4.4	44.0 \pm 5.9
Azadirachtin + Pyrethrins	49.0 + 53.9	19.0 \pm 44.5	33.0 \pm 22.0	60.0 \pm 3.2	49.0 \pm 12.0
Spinosad	175.1	31.0 \pm 26.7	62.0 \pm 18.9	35.0 \pm 4.5	46.0 \pm 17.4
Potassium salts	2861.7	19.0 \pm 9.8	51.0 \pm 7.2	59.0 \pm 12.4	70.0 \pm 8.6
Potassium salts+ Spinosad	2721.1 + 6.8	32.0 \pm 9.8	56.0 \pm 7.4	62.0 \pm 6.6	55.0 \pm 5.9
Pyrethrins	58.1	26.0 \pm 25.6	40.0 \pm 4.7	56.0 \pm 14.3	57.0 \pm 6.4
<i>Burkholderia</i> spp.	14,230.3	41.0 \pm 22.7	56.0 \pm 13.2	59.0 \pm 8.4	58.0 \pm 7.8
Sabadilla Alkloids	33.6	-	-	-	-
P- Value from ANOVA		ns	ns	ns	ns



Kaolin



Kaolin or Essential Oils applied weekly to peppers



In summary

- We have strong baseline toxicity levels for bifenthrin and thiamethoxam on BMSB – as of 2018, 10% of a field-rate concentration of bifenthrin or thiamethoxam (topically-applied) should kill >50% of BMSB adults.
- More IPM-compatible insecticides for BMSB that warrant consideration include:
 - sulfoxaflor (Closer SC),
 - flonicamid (Beleaf 50SG)
 - flupyradifurone (Sivanto). More field testing should be done.
- Kaolin (Surround) is the probably the best option for organic control of BMSB