Update on management of stink bugs

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Feeding injury and damage

Stink Bug Species Reported in CA

Consperse stink bug: *Euschistus conspersus*

Red shouldered stink bug: *Thyanta pallidovirens*

Say's stink bug complex: *Chlorochroa sayi* and *Chlorochroa uhleri*

Southern green stink bug: *Nezara viridula*

Consperse stink bug: ***Euschistus conspersus***

Stink Bugs Recently Reported in California

Halyomorpha halys
Brown marmorated

Euschistus servus
Brown stink bug

Slide adapted from Goodell 2014

Stink Bugs Associated with Fresno Co. Tomatoes from 2013-2016 were Consperse

Photos by E. Hannon, Fresno County Ag Commissioner's Entomologist, 2014

Stink Bug Research (2013-2016)

- Seasonal Population Development
- Pheromone trap evaluation
- Insecticide program comparison

Stink Bug Research

- Seasonal Population Development

Consperse Stink Bug Seasonal Population Development

- **Overwintering:** diapause in protected area

Overwintering Site : Early Nov 2014

Consperse Stink Bug Overwinter under Leaf Litter of permanent Crop

Leaf litter was removed from under the citrus trees with a rake and inspected for stink bug from 4 to 20 Nov 2014.

Consperse Stink Bug Overwinter under Leaf Litter of permanent Crop

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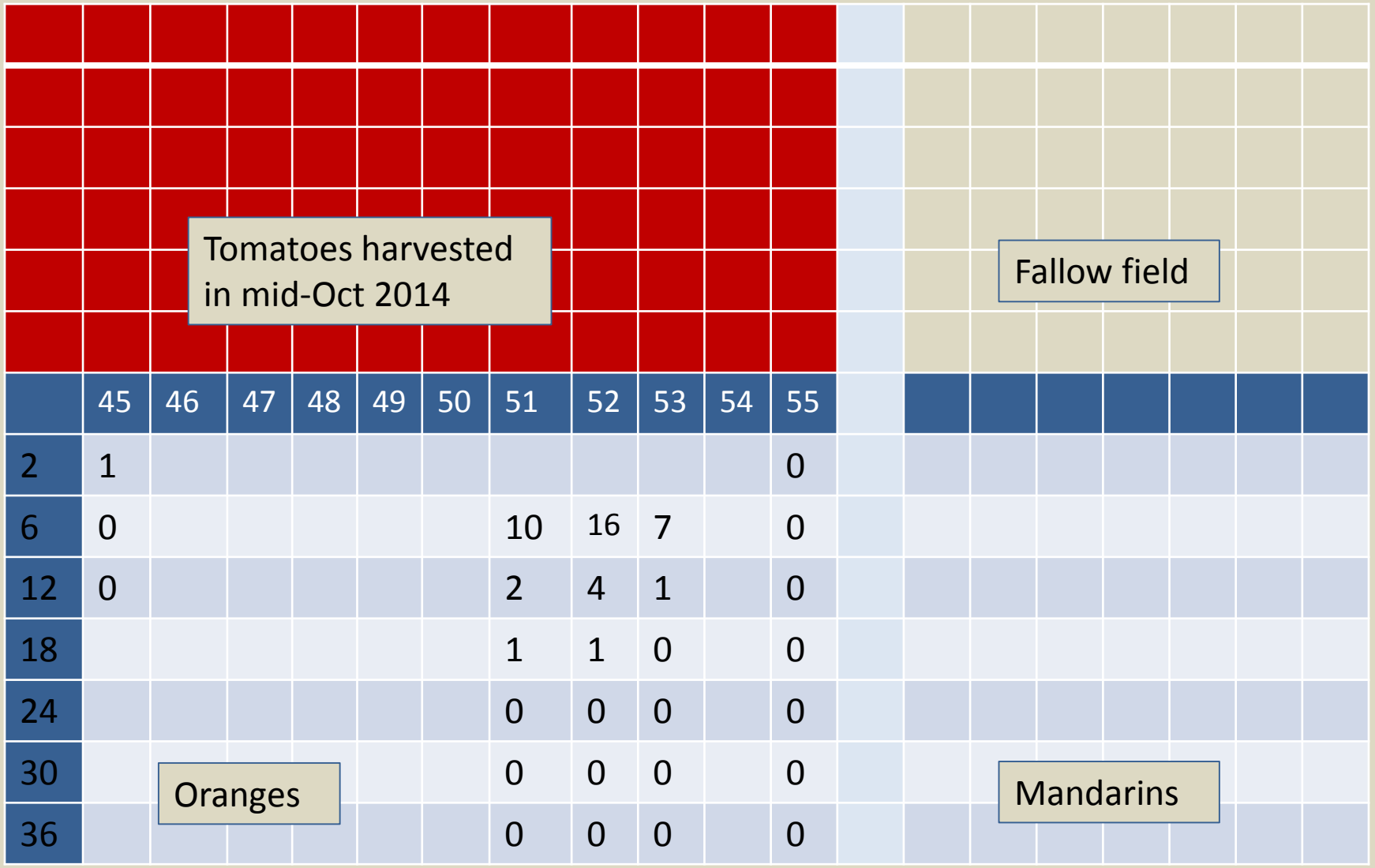
Overwintering site identified



	45	46	47	48	49	50	51	52	53	54	55
2	1										0
6	0						10	16	7		0
12	0						2	4	1		0
18							1	1	0		0
24							0	0	0		0
30							0	0	0		0
36							0	0	0		0

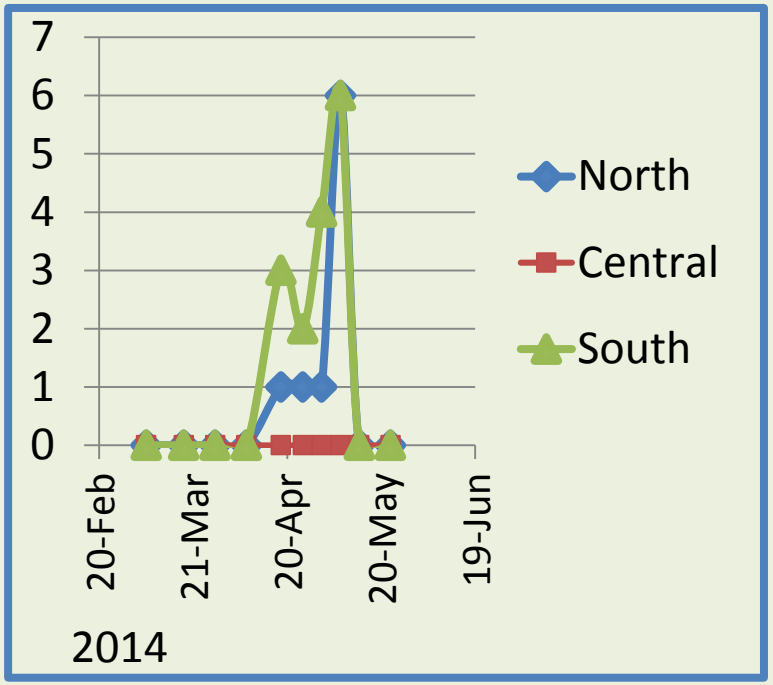
N
↑

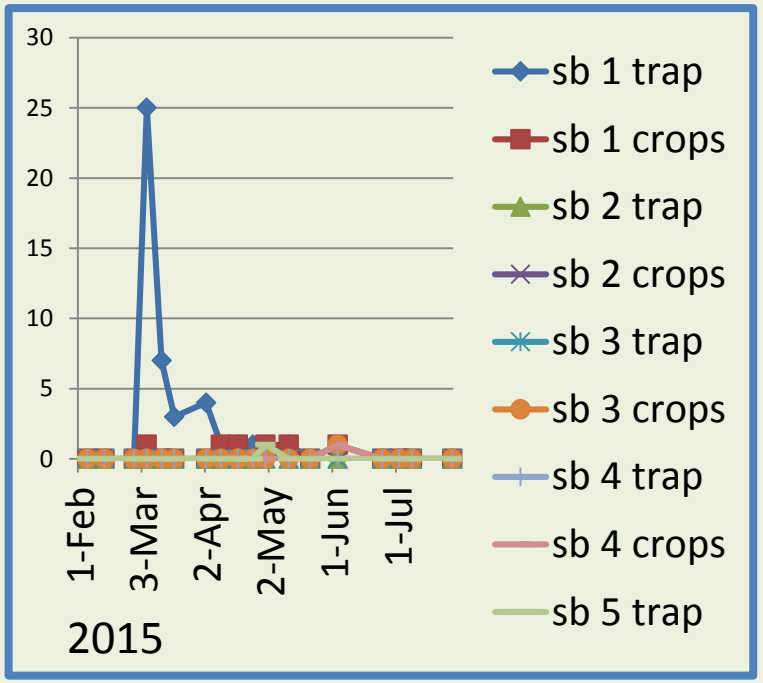
Consperse Stink Bug Seasonal Population Development

- **Overwintering:** diapause in protected area
- **Early- to mid-Spring:** movement from overwintering site and population development on weeds

Detection of Consperse Stink Bug in High Risk Areas, 2015-16

- 2014 trap captures in late Mar
- 2015 trap captures in early Mar
- 2016 first detection was on black mustard on 18 Mar





Plants that Support Consperse Stink Bug

Crop Hosts

- Small grains
- Alfalfa
- Broccoli

Weed Hosts

- Preferred hosts

  Mullein

  Mustard

  Dock

- Possible hosts

  milkweed, mallow, bindweed, thistles, vetch, velvetgrass, beardgrass,

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Stink Bug Research

- Seasonal Population Development
- Pheromone trap evaluation

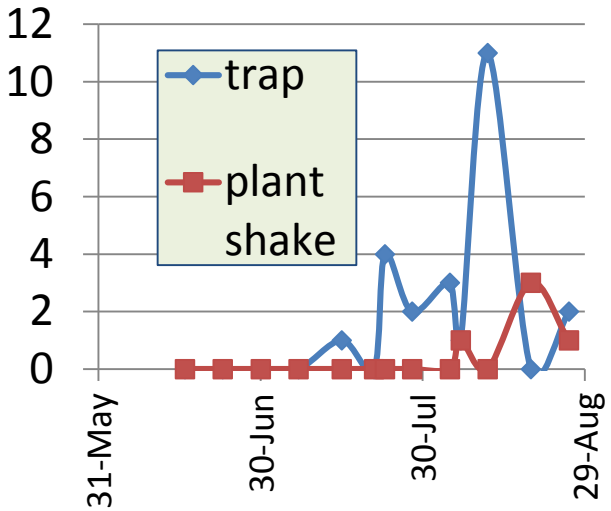
Pheromone baited traps aid in early detection.

Comparison in Tomatoes:

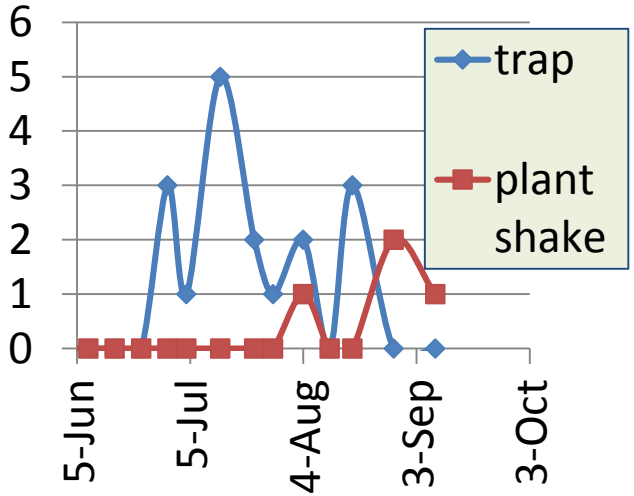
- Live insect trap Sterling International, Inc. with AlphaScents Consperse stink bug lure
- Plant Shake method with 18 x 12 in (45 x 30 cm) tray

Consperse stink bug captures in traps & on tomatoes at UC WSREC, 2014-16

2014



2015



2016: Detection of stinkbugs in tomatoes prior to capture in trap.

Developmental Rates of Consperse Stink Bug are Know and Degree Day Models are Available

53.6° F Developmental Threshold	
Egg development	150 $DD_{>54°}$
1^{st}-3^{rd} instar (small nymph)	408 $DD_{>54°}$
4^{th} – 5^{th} instar (large nymph	386 $DD_{>54°}$
Adult to Egg Laying*	275 $DD_{>54°}$
Total	1219 $DD_{>54°}$

Calculations Are Possible to Predict the Presence of Nymphs from Eggs Laid at First Capture

http://www.ipm.ucdavis.edu/calludt.cgi/DDMODEL?MODEL=CSB&CROP=tomatoes

Monthly $DD_{>54°}$ Accumulation

FIVE_PTS.A (CIMIS #2, Five Points/WSFS USDA)

	2012	2013	2014	2015	2016
Jan	64	30	106	46	29
Feb	83	62	116	159	84
Mar	144	230	227	309	174
Apr	260	338	333	301	264
May	473	463	544	407	435
June	585	654	643	703	524
July	785	824	839	773	735
Aug	838	733	787	770	729
Sept	693	560	664	640	584
Oct	385	310	441	452	366
Nov	154	155	149	93	122
Dec	41	49	55	36	13

Annual Accumulation

year	$DD_{.54}{}^{o}$
2012	4505
2013	4408
2014	4904
2015	4689
2016	4059

http://www.ipm.ucdavis.edu/calludt.cgi/DDMODEL?MODEL=CSB&CROP=tomatoes

Modified from Goodell, Dec 2014

Stink Bug Research

- Seasonal Population Development
- Pheromone trap evaluation
- Insecticide program comparison

Not all pesticides mentioned in this presentation are currently registered in tomatoes.

Carefully read all current labels before writing a pesticide recommendation

Insecticides with Activity against Stink Bug

IRAC #	Trade name	Common Name
> 80% control (adults and nymphs)		
3A	Baythroid	beta cyfluthrin
3A	Ambush, Pounce and others	permethrin
3A+4A	Warrior II + Actara	lambda-cyhalothrin + thiamethoxam
3A	Brigade, Bifenture, Capture, and others	bifenthrin
1B	Dimethoate	dimethoate
4A	Venom	dinotefuron
> 60% control (adults and nymphs)		
3A+4A	Leverage	beta-cyfluthrin + imidacloprid
3A	Warrior II	Lambda-cyhalothrin
4A	Actara	thiamethoxam
4A	Belay	clothianidin
1A	Lannate	methomyl
< 50% control of adults and > 80% control of nymphs		
3A	Hero, Mustang Max	S-cypermethrin

Modified from Zalom

Insecticide Trials 2014-16

Location : West Side Research and Extension Center – Fresno County
Plot size : single 60 inch bed x 75 ft
Untreated buffer between each treated row
Experimental design : 4 Replication
Randomized Complete Block
Plant Dates: 5/21/2014, 5/15/2015, 5/24/2016
Variety: H5608

Application details:
CO_2-powered backpack sprayer
50 gallons per acre
35 psi
3 Teejet 8004 EVS 19-in spacing
8 and 29 Aug 2014
18, 28 Jul, and 18 Aug 2015
25 Aug and 8 Sep 2016

Insecticide Trial Evaluations 2014-16

In-season: Three evaluations of fruit damage and stink bug counts of 4 feet under one side of canopy.

At harvest:

Harvest: 20 ft (6 m) weigh all fruit

Hand sort of 25 to 35 lbs (13.6 to 18.9 kg) of fruit by quality (red, green, sunburn, rot & stink bug damage)

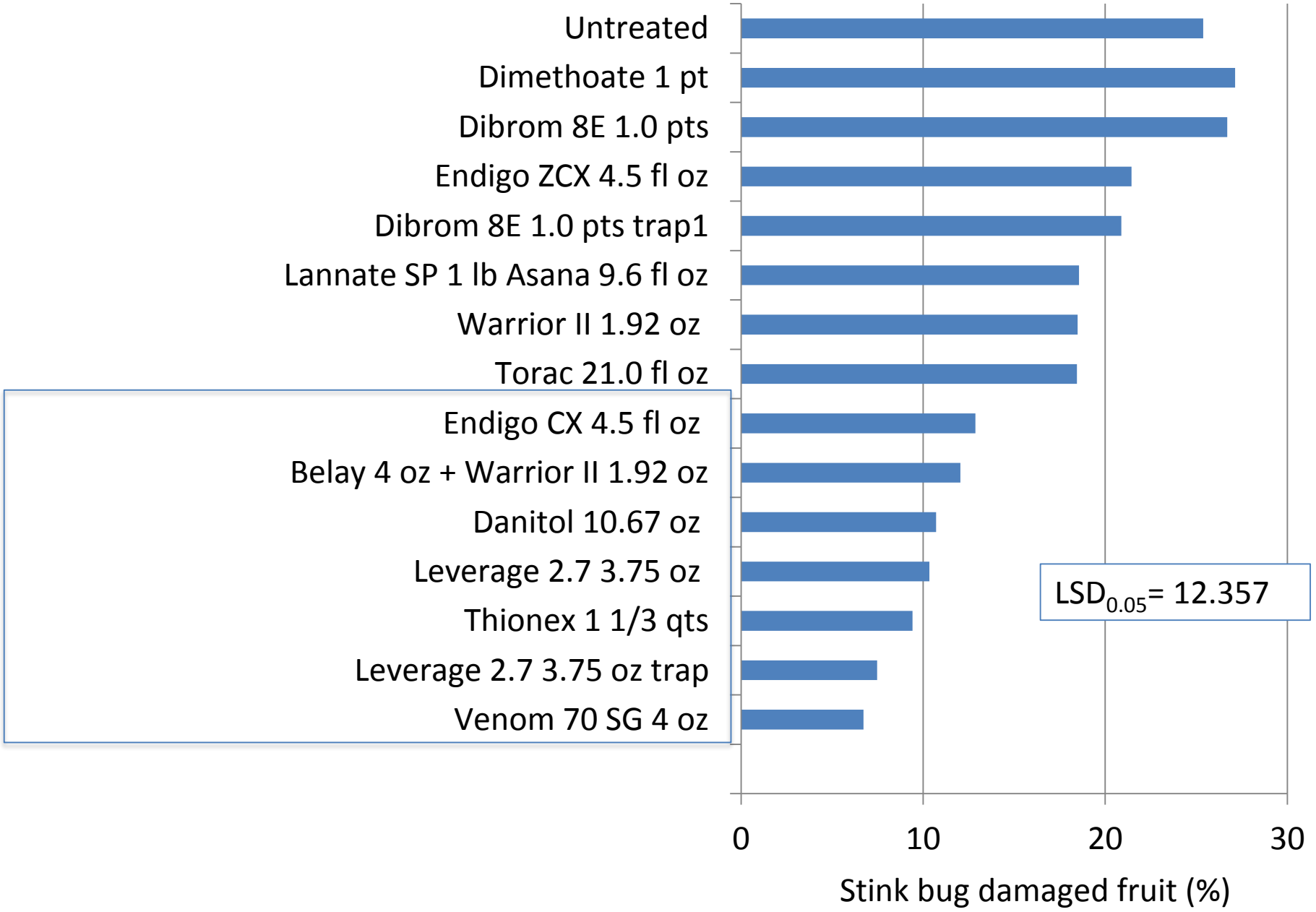
Lab analysis of 50 red fruit at Processing Tomato Advisory Board (PTAB)

Insecticides Selected for 2014 Trials

IRAC #*	Trade name	Common name
1A	Lannate	methomyl
1B	Dibrom 8E	naled
1B	Dimethoate	dimethoate
1B	Thionex	endosulfan
3A	Danitol	fenpopathrin
3A	Warrior II	lambda-cyhalothrin
3A + 4A	Endigo ZCX	lambda-cyhalothrin + thiamethoxam
3A + 4A	Leverage	imidicloprid + beta-cyfluthrin
3A + 28	Voliam Xpress	lambda-cyhalothrin + chlorantraniliprole
4A	Belay	clothianidin
4A	Venom	dinotefuran
21A	Torac	tolfenpyrad
28	Coragen	chlorantraniliprole

* IRAC# mode of action as assigned by the Insecticide Resistance Action Committee

Influence of Insecticide Treatments on Stink Bug Damage, 2014



Insecticides Selected for 2015 Trials

IRAC #*	Trade name	Common name
1B	Dimethoate	dimethoate
3A	Danitol	fenpopathrin
3A	Warrior II	lambda-cyhalothrin
3A	Danitol	fenpropathrin
3A + 4A	Endigo ZCX	lambda-cyhalothrin + thiamethoxam
3A + 4A	Leverage	imidicloprid + beta-cyfluthrin
4A	Belay	clothianidin
4A	Venom	dinotefuran
4C	Sequoia	sulfoxaflor
4D	Silvanto	flupyradifurone
7C	Knack	pyriproxyfen
9C	Beleaf	flonicamid
15	Rimon	novaluron
21A	Torac	tolfenpyrad
28	Exirel	chlorantraniliprole

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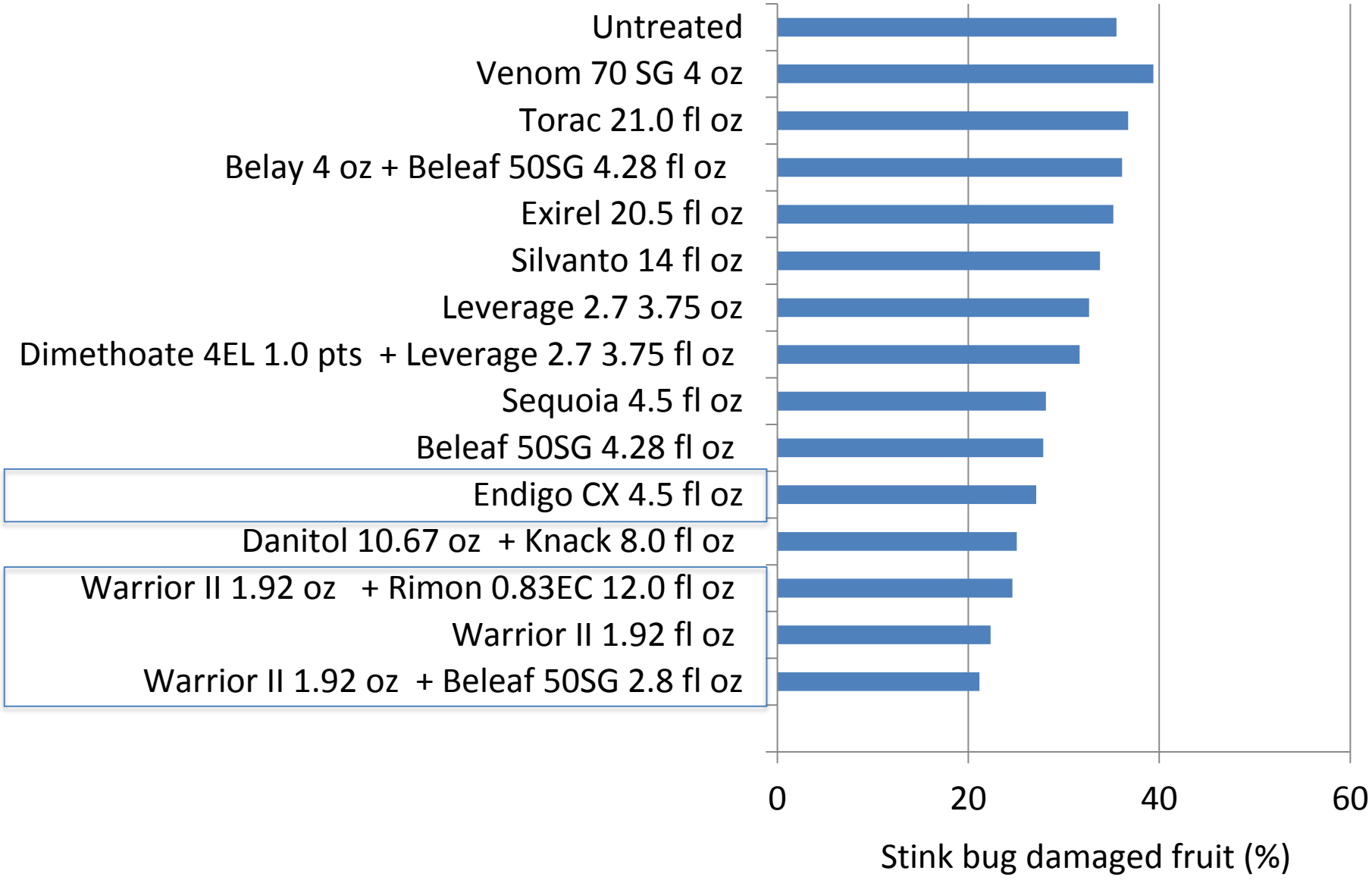

Insecticides Selected for, 2016

IRAC #*	Trade name	Common name
1B	Dimethoate	dimethoate
3A	Danitol	fenpopathrin
3A	Warrior II	lambda-cyhalothrin
3A	Danitol	fenpropathrin
3A + 4A	Brigadier	bifenthrin + imidicloprid
3A + 4A	Endigo ZCX	lambda-cyhalothrin + thiamethoxam
3A + 4A	Leverage	beta-cyfluthrin + imidicloprid
4A	Belay	clothianidin
4A	Venom	dinotefuran
4C	Sequoia	sulfoxaflor
4D	Silvanto	flupyradifurone
7C	Knack	pyriproxyfen
9C	Beleaf	flonicamid
15	Rimon	novaluron
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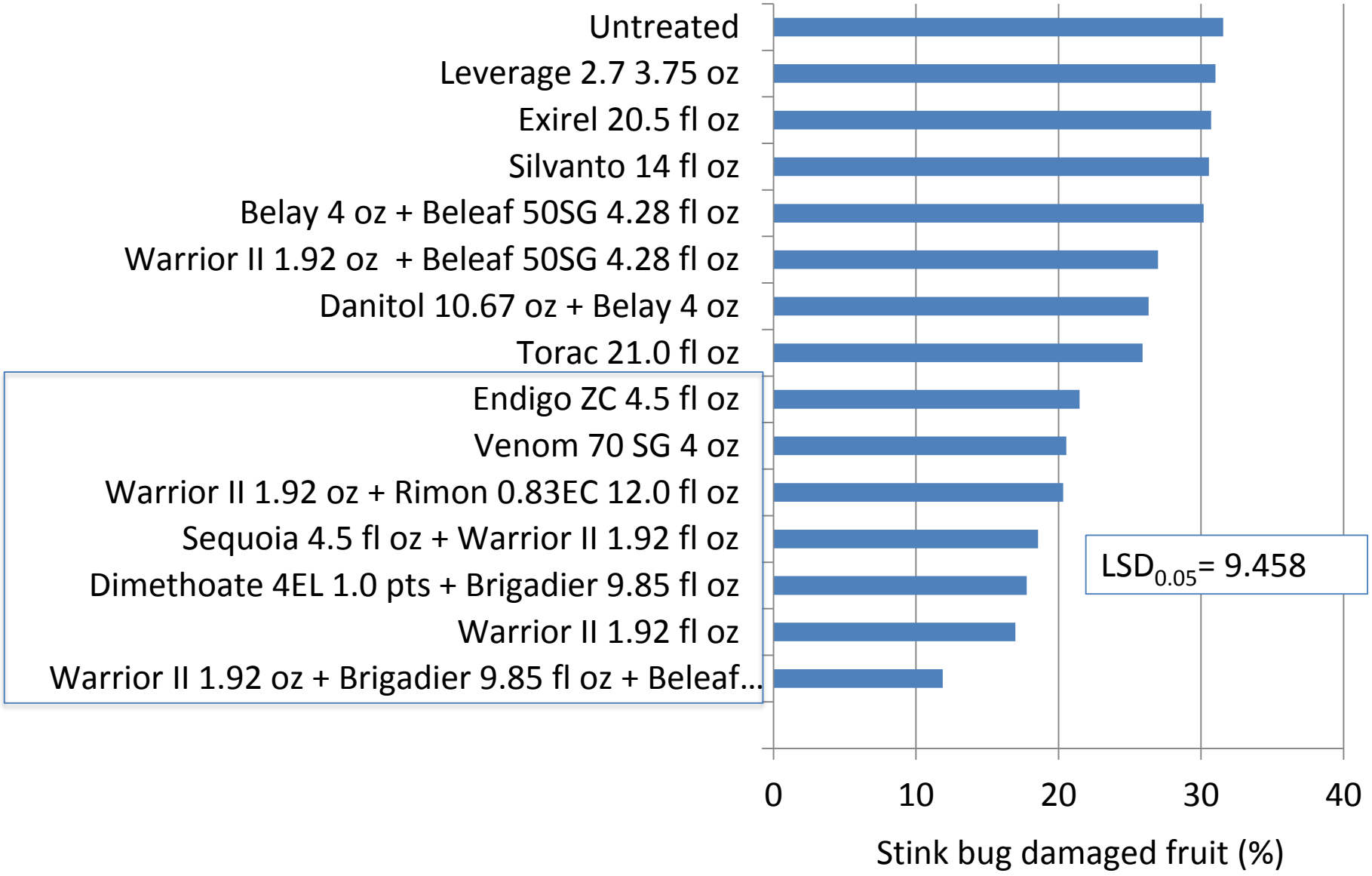


Material Performance Overview

- Warrior II and Endigo provided a level of control over all three seasons
- Venom performed well 2/3 years
- Leverage 1/3 years
- Brigadier provided control applied with dimethoate, but was only tested one year

Comparison of Three Sprayers, 2016

Standard conventional sprayer
40 gallons per acre
50 psi
Three Teejet 8003VS nozzles

Bed drench sprayer
200 gpa

Berm blower sprayer:
40 gallons per acre

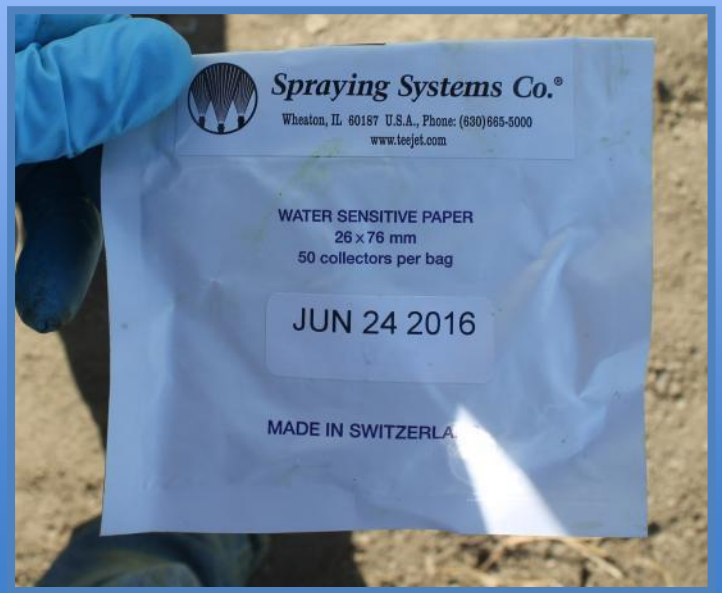
Untreated Control

Application:
Date: 31 Aug
Tank Mix: Warrior II 1.92 fl oz + Brigadier 9.85 fl oz + Beleaf 50SG 4.28 oz

CONDITIONS AT EXPERIMENTAL SITE
Location: West Side Research and Extension Center
Plot size : three 60 inch bed x 130 ft
Experimental design : Five Replication Randomized Complete Block
Plant Date: 24 May 2016
Variety: H5608

Sprayer Comparison Evaluations 2016

Water sensitive paper was used for determination of canopy penetration and coverage



Placed into sprayed area immediately before treating on the soil surface at 3 to 4 inches above the soil surface and at 10 to 12 inches above the soil surface

Sprayer Comparison Evaluations 2016

In-season: On 2 Sep, three evaluations of fruit damage and stink bug counts of 4 feet under one side of canopy.

At harvest:

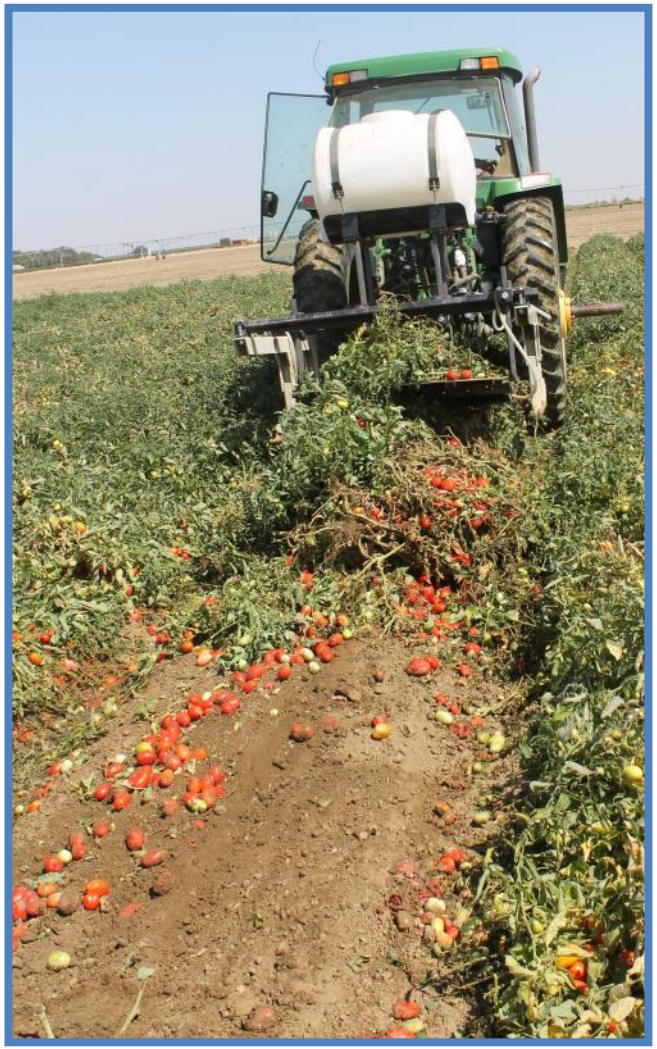
Harvest: 20 ft (6 m) weigh all fruit

Hand sort of 25 to 35 lbs (13.6 to 18.9 kg) of fruit by quality (red, green, sunburn, rot & stink bug damage)

Lab analysis of 50 red fruit at Processing Tomato Advisory Board (PTAB)

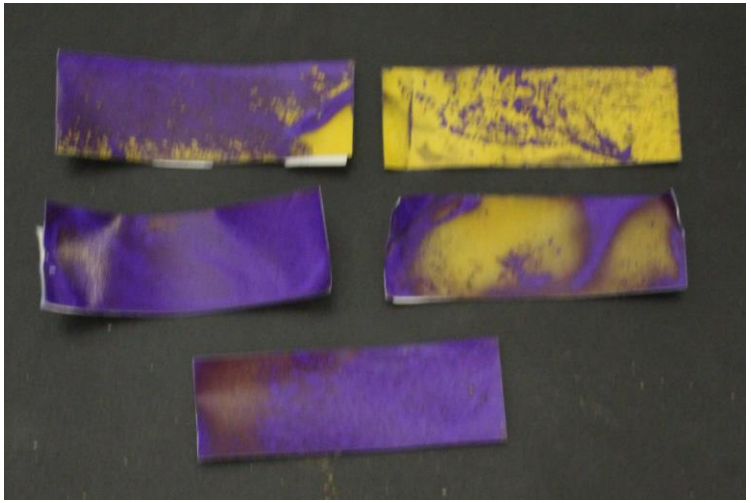
Berm Blower Sprayer (CPS)

Bed Drench Sprayer (UCCE, Kern – Joe Nunez)

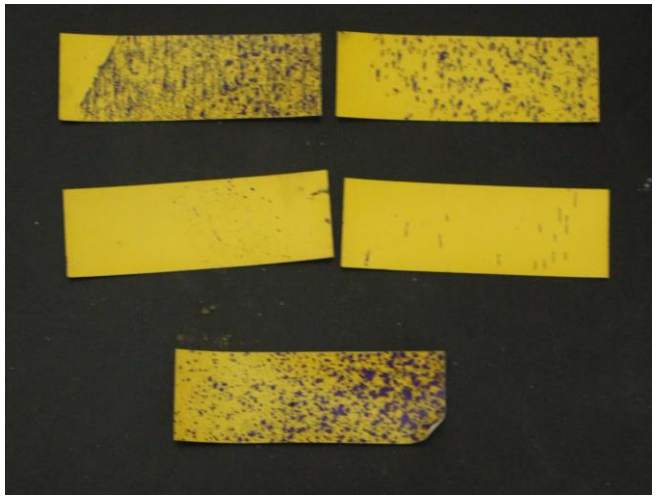


Under the conditions of this study, the plates designed that had successfully lifted the canopies at earlier stages of crop development would drag plants. Likely due to a heavy fruit load and well developed vines. This application was not completed.

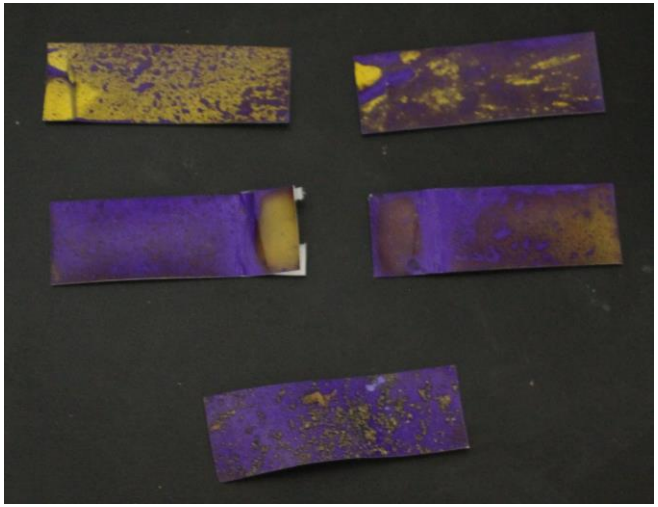
Water Sensitive Cards



Berm Blower Sprayer @ 40 gpa



Conventional standard @ 40 gpa



Berm Blower Sprayer @ 200 gpa
not replicated

Coverage Comparison (3 replications)

Treatment	Upper	Middle	Ground	Average
Standard	2.75	0.82	5.00	2.86
Berm blower	3.43	4.58	7.83	5.28
Probability	0.3753	0.2540	0.1326	0.2317

Rated on a scale of 0-10 based on percentage of card that was darkened. The two cards at the upper and those in the middle were averaged before analysis.

Coverage Comparison (3 replications)

Treatment	Gross yield (tons/ acre)	Red (%)	Green (%)	Sun burn (%)	Rot (%)	Stink bug (%)
Standard	52.867	38.26	9.95	3.16	17.80	30.86
Berm blower	50.501	51.24	7.73	4.04	15.01	21.97
Untreated	52.029	31.22	8.61	2.68	19.26	38.24
$LSD_{0.05}$	NS	8.07	NS	NS	NS	10.92
CV (%)	12.19	14.84	43.92	59.14	23.53	24.66

Fruit quality is based on hand sort of 25-35 lbs fruit and percentage is calculated based on weight per category.

Summary

- Identify and minimize potential overwintering sites or hosts that favor this pest early-spring
- Detection at early stages of infestation
  - Scout edges of the field for stink bugs and damage
  - Pheromone baited traps can be helpful.
- Treatment with lambda-cyhalothrin-containing materials consistently reduced damage; Venom reduced damage 2 of 3 years tests.
- Based on first detection and degree day calculations, apply insecticides to target nymphs
- Maximize coverage deep in the canopy

Acknowledgements

- California Tomato Research Institute
- Daniel Delgado
- Joe Nunez
- Fresno Consultants and Growers
- Ron Avila (CPS)
- Jose Mandajano (CPS)
- Pete Goodell
- Frank Zalom
- Les Ehler
- UC WSREC staff

Questions

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Stink bug efficacy, yield and quality 2014

		Fruit quality (%)				
Treatment	yield (t/a)	reds	greens	sunburn	rot	stink bug
Venom 70 SG 4 oz	39.24	60.83	12.44	10.01	9.99	6.72
Leverage 2.7 3.75 oz trap	40.82	73.46	5.31	4.25	9.52	7.47
Thionex 1 1/3 qts	45.80	74.35	6.54	4.34	5.33	9.41
Leverage 2.7 3.75 oz	40.84	55.88	10.09	9.83	13.86	10.34
Danitol 10.67 oz	37.40	66.04	9.84	4.92	8.49	10.71
Belay 4 oz + Warrior II 1.92 oz	41.80	69.46	5.76	5.36	7.36	12.05
Endigo CX 4.5 fl oz	37.22	59.62	15.77	4.45	7.29	12.87
Torac 21.0 fl oz	41.09	50.05	7.78	13.06	10.66	18.44
Warrior II 1.92 oz	37.00	60.67	8.72	5.73	6.41	18.48
Lannate SP 1 lb Asana 9.6 fl oz	47.52	58.43	14.55	2.46	6.00	18.56
Dibrom 8E 1.0 pts trap1	45.75	46.33	10.55	11.54	10.69	20.89
Endigo ZCX 4.5 fl oz	41.79	57.33	7.84	4.94	8.47	21.44
Dibrom 8E 1.0 pts	37.70	53.13	8.12	2.79	9.26	26.70
Dimethoate 1 pt	40.84	47.82	6.60	11.83	6.62	27.13
Untreated	38.91	52.84	7.02	7.46	7.30	25.38
LSD (P=0.05)^{s}	8.440	15.935	7.305	8.425	6.346	12.357
CV (%)	14.33	18.89	56.04	85.95	52.37	52.64

Unless otherwise specified all applications were made on 8 and 29 Aug. Treatments followed by 'trap' were applied on 18 Jul after 1st capture. Assana was applied on 15 Aug in addition to the Lannate applications on 8 and 29 Aug, H5608 planted 21 May and harvested 15-17 Sep.

Influence of Insecticide Treatments on Yield and Quality, 2015

		Fruit quality (%)[z]				
Treatment[x]	yield (t/a)[w]	reds	greens	Sun burn	rot	stink bug
Warrior II 1.92 oz + Beleaf 50SG 2.8 fl oz	56.51	67.41	8.43	2.01	2.95	21.16
Warrior II 1.92 fl oz	51.11	64.59	6.23	3.41	3.45	22.33
Warrior II 1.92 oz + Rimon 0.83EC 12.0 fl oz	60.75	69.71	6.86	0.62	2.14	24.62
Danitol 10.67 oz + Knack 8.0 fl oz	54.01	66.15	5.67	1.85	1.25	25.08
Endigo CX 4.5 fl oz	53.91	60.57	6.94	1.54	3.85	27.10
Beleaf 50SG 4.28 fl oz	53.37	61.48	7.93	1.85	0.88	27.86
Sequoia 4.5 fl oz	59.68	61.94	5.00	1.53	3.40	28.13
Dimethoate 4EL 1.0 pts + Leverage 2.7 3.75 fl oz	53.80	62.96	5.69	1.67	1.82	31.65
Leverage 2.7 3.75 oz	53.22	57.88	4.83	2.33	2.31	32.64
Silvanto 14 fl oz	48.80	53.47	3.86	2.93	5.96	33.78
Exirel 20.5 fl oz	60.67	51.58	7.37	3.19	2.66	35.20
Belay 4 oz + Beleaf 50SG 4.28 fl oz	54.24	50.59	7.17	2.65	3.48	36.11
Torac 21.0 fl oz	54.42	55.85	5.51	2.40	1.34	36.74
Venom 70 SG 4 oz	53.62	49.44	6.10	2.10	2.99	39.38
Untreated	53.62	49.87	6.32	2.70	5.59	35.52
LSD (P=0.05)[u]	9.967	15.935	3.265	1.950	3.412	19.197
CV (%)	12.61	18.89	36.55	62.50	87.01	44.13

Influence of Insecticide Treatments on Yield and Quality, 2016

		Fruit quality (%)[z]				
Treatment[x]	yield (t/a)[w]	reds	greens	Sun burn	rot	stink bug
Warrior II 1.92 oz + Brigadier 9.85 fl oz + Beleaf 50SG 4.28 fl oz	67.74	63.20	15.32	0.74	8.87	11.87
Warrior II 1.92 fl oz	65.48	54.46	14.75	1.67	12.14	16.98
Dimethoate 4EL 1.0 pts + Brigadier 9.85 fl oz	66.08	55.80	15.19	0.00	11.24	17.76
Sequoia 4.5 fl oz + Warrior II 1.92 fl oz	62.28	54.85	12.23	1.16	13.19	18.57
Warrior II 1.92 oz + Rimon 0.83EC 12.0 fl oz	70.77	53.38	11.16	1.54	13.60	20.32
Venom 70 SG 4 oz	60.53	54.16	14.23	0.75	10.32	20.54
Endigo ZC 4.5 fl oz	64.98	51.39	15.76	1.49	9.88	21.48
Torac 21.0 fl oz	68.61	43.89	17.91	0.05	12.25	25.90
Danitol 10.67 oz + Belay 4 oz	68.83	43.79	14.36	0.87	14.66	26.31
Warrior II 1.92 oz + Beleaf 50SG 4.28 fl oz	58.15	45.29	15.54	0.43	11.75	26.99
Belay 4 oz + Beleaf 50SG 4.28 fl oz	67.80	43.59	11.57	0.83	13.82	30.18
Silvanto 14 fl oz	66.64	39.07	17.83	0.35	12.20	30.55
Exirel 20.5 fl oz	66.61	44.26	14.40	0.58	10.05	30.71
Leverage 2.7 3.75 oz	68.65	40.16	11.90	0.78	16.15	31.01
Untreated	63.37	42.84	16.24	1.28	8.09	31.55
LSD (P=0.05)[u]	6.63	12.96	NS[t]	NS	NS	9.458
CV (%)	7.07	18.89	39.00	127.3	41.23	27.57

H5608 processing tomato plants at UC West Side Research and Extension Center. Foliar applications were made with a backpack sprayer at 50 gpa. All applications were made on 25 Aug and 8 Sep.