Grape Pest Management
Lodi, CA, June 25, 2015

Spider Mite Management Practices for Winegrapes

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Spider Mites

Willamette Spider Mite

Pacific Mite Injury

Pacific Spider Mite

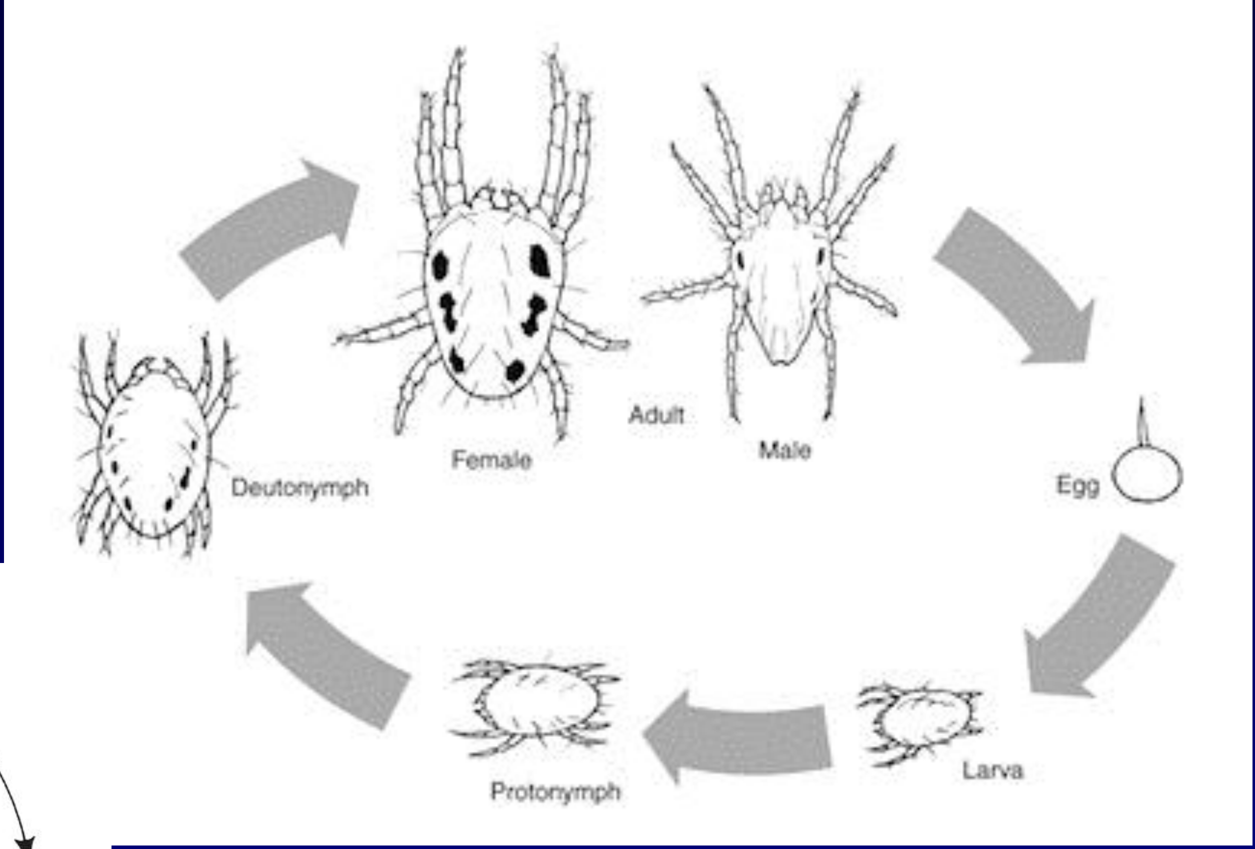
Spider Mites

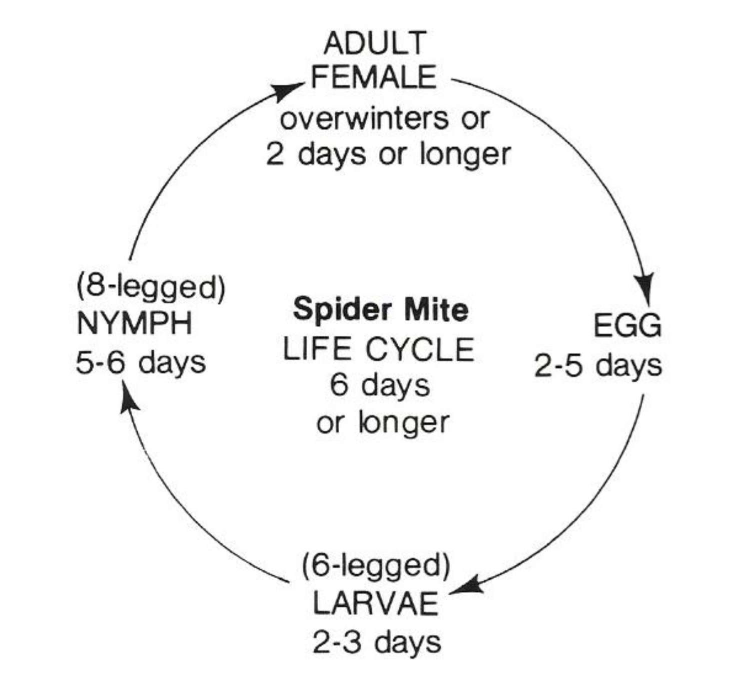
- Mature females overwinter under grapevine bark
- Diapause - daylength and high populations
- Females move to tender young foliage when grape buds break
- Can lay up to 8 eggs daily
- Primarily colonize undersurfaces of leaves

Spider Mites

Life cycle

- Egg
- Larva (6 legs)
- Protonymph
- Deutonymph
- Adult





Development:
Egg to egg-laying
females in 7 to 14 days

Spider Mites

Pacific Spider Mite

Tetranychus pacificus McGregor

- Eggs - spherical and may be laid in webbing
- Newly hatched larva (6 legs) – already has food spots on dorsum
- Adults vary in color from slightly amber to greenish or reddish; usually 2 larger spots forward, 2 rear
- Broad host range
- Usually thought of as the greater problem in warm growing areas

Spider Mites

Pacific Spider Mite

Tetranychus pacificus McGregor

- Prefers the warmer upper canopy (sunny areas)
- Generally does better during the hotter, drier part of the season
- Produces more webbing and tends to aggregate

Damage begins as yellow spots, then dead (necrotic) areas appear on the leaves. High populations can render the leaves nonfunctional with leaf burning and heavy webbing.

Spider Mites

Willamette Spider Mite

Eotetranychus willamettei (McGregor)

- Egg is spherical, slightly smaller than Pacific mite, and has a fine papilla (hair) that tapers at the top
- Newly hatched larva has 6 legs and food spots on its sides
- Adults tend to be yellow with food spots on sides
- Cultivated and wild grapes are the main hosts
- It is typically the species of concern in the coastal valleys and the Sierra Nevada foothills

Spider Mites

Willamette Spider Mite

Eotetranychus willamettei (McGregor)

- Considered an early-season mite
- Prefers the cooler (shady) parts of the plant
- More dispersed over leaf surfaces

Feeding in mid- or late season causes foliage to turn yellowish bronze, and can open canopies.

Damaging at high densities - studies indicate that > 30-50 per leaf reduces brix.

Spider Mites - Monitoring

- Divide vineyard into more than one sampling area
- Randomly select 15 vines to sample
- Select 3 leaves, one from the middle of each of 3 shoots
- Sample south or west facing sides of vines
- Examine for the *presence or absence* of Pacific mite, Willamette mite, and mite predators
- Divide the number of leaves with at least one Pacific mite by the total number of leaves sampled (45) to calculate the percent of leaves infested by Pacific mite

Pacific Spider Mite - Injury

- Light - < 50% infested leaves; no bronzing or burning of the foliage
- Moderate - 50-65% infested leaves; foliage shows little or no burn but some bronzing
- Heavy - 65-75% infested leaves; considerable bronzing of foliage and some leaf and shoot tip burning. Webbing on shoot tips
- > 75% infested leaves - extensive webbing and severe burning of shoots

Injury varies somewhat by cultivar; those with less vigorous vegetative growth (e.g. Zinfandel) tend to be particularly sensitive to damage by spider mites.

Distribution and abundance of Pacific and Willamette mite seem to be changing over the last decade+. Why?

- pesticide use (can disrupt mites)
- irrigation practices that can promote water stress
- large-scale planting of wine varieties in new areas
- changes in insecticide and fungicide use patterns
- *What about newer products?*

Distribution and abundance of Pacific and Willamette mite seem to be changing over the last decade+
Why?

- pesticide use
- irrigation practices that promote water stress
- large-scale planting of wine varieties in new areas
- changes in insecticide and fungicide use patterns
- *What about newer products?*

Do they effect six-spotted thrips, lacewings, hemipterans, predaceous beetles, or predator mites?

What about their effects on spider mite development?

Spider Mites - Chemicals

- Pesticide use has a major impact on spider mites - use selective products
- Be aware that unintended impacts on spider mites is possible whenever introducing a new chemical into the vineyard
- General predators such as six-spotted thrips, lacewings, hemipterans and predaceous beetles can be affected, not just predator mites (e.g. spinosyns affect thrips, buprofezin affects lady beetles, neonics affect hemiperans)
- Older products such as carbaryl were known to increase spider mite reproduction in addition to killing mite predators

Spider Mites - Cultural Controls

- Correct areas with poor irrigation - dusty and water-stressed conditions favor spider mite outbreaks
- Overhead sprinklers reduce mite abundance
- Summer cover crops (or no till) help to control dust and reduce heat
- Delay turning under a fall-winter cover crop until early June - can be a source of alternate prey for mite predators

Each of a suite of practices can contribute to reduced mite abundance - use what is practical.

Grape Acaricide Use –
San Joaquin and Sacramento Counties, 2013

Product	Active ingredient	Acres treated	IRAC #
Agri-Mek*	Abamectin	69727	6
Onager	Hexythiazox	4912	10A
Apollo	Clofentazine	16	10A
Zeal	Etoxazole	3779	10B
Vendex	Fenbutatin oxide	0	12B
Omite	Propargite	756	12C
Kanemite	Acequinocyl	0	20B
Fujimite	Fenpyroximate	1920	21
Nexter*	Pyridaben	5	21
Envidor	Spirodiclofen	317	23
Sultan**	Cyflumetofen	0	25A
Acramite	Bifenazate	12792	unc
various	Paraffinic oils	??	unc
various	Botanical oils	??	unc
Kelthane	Dicofol	0	unc

* Agri-mek
Abacus
Abba
Epi-mek
Reaper

Resistance management?

** Not registered for use in California

Acaricide Efficacy - Methods

- applications made with an Echo mister/duster air assist sprayer
- 72 gallons per acre volume - conventional treatments
- 150 gallons per acre volume - organic treatments
- water buffered to pH 6.5

Sampling -

- 5 leaves from the center 3 vines of each plot
- mite-brushed and counted under microscope

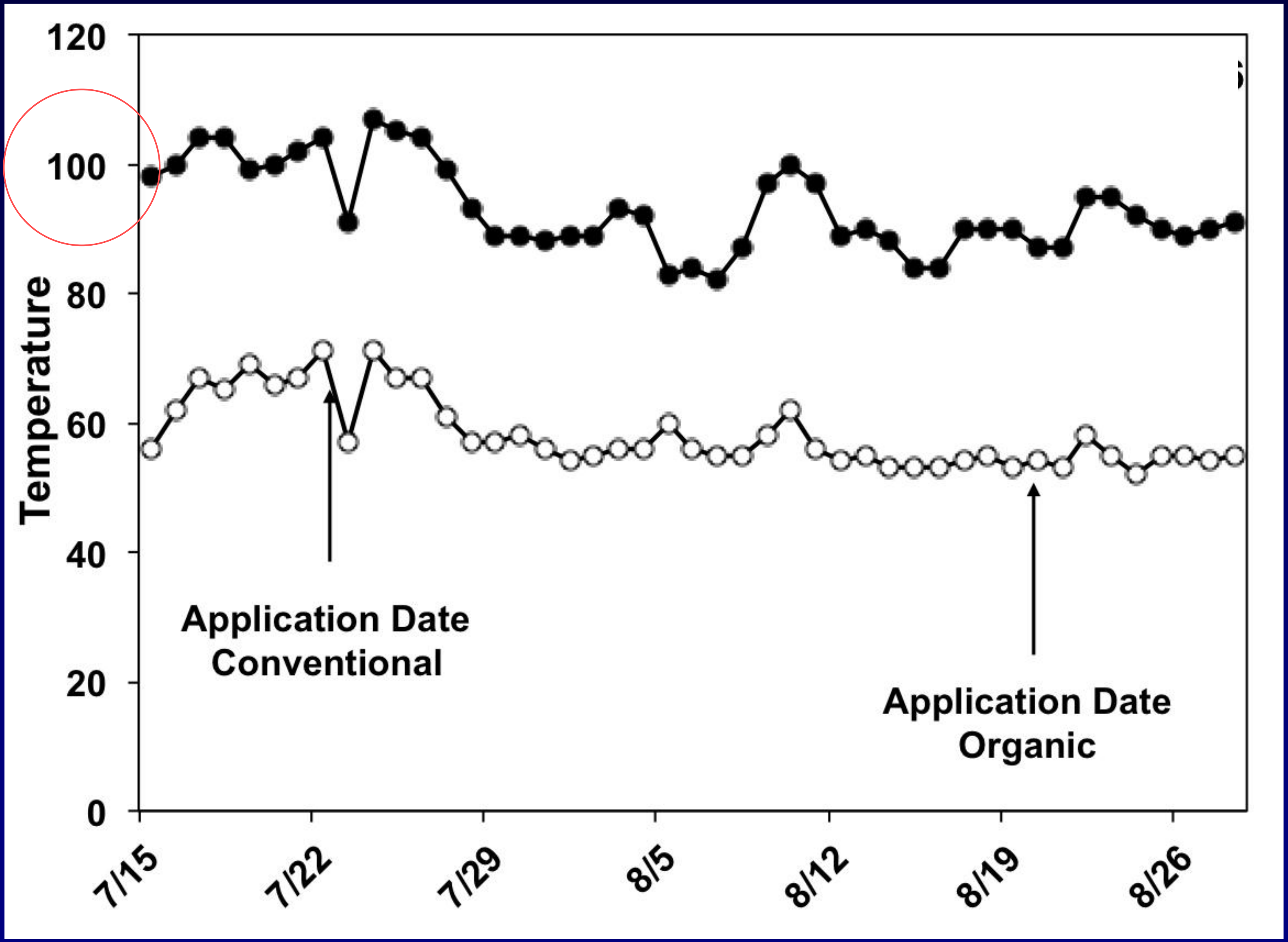
Nikki Nicola and Corin Pease

Location and design

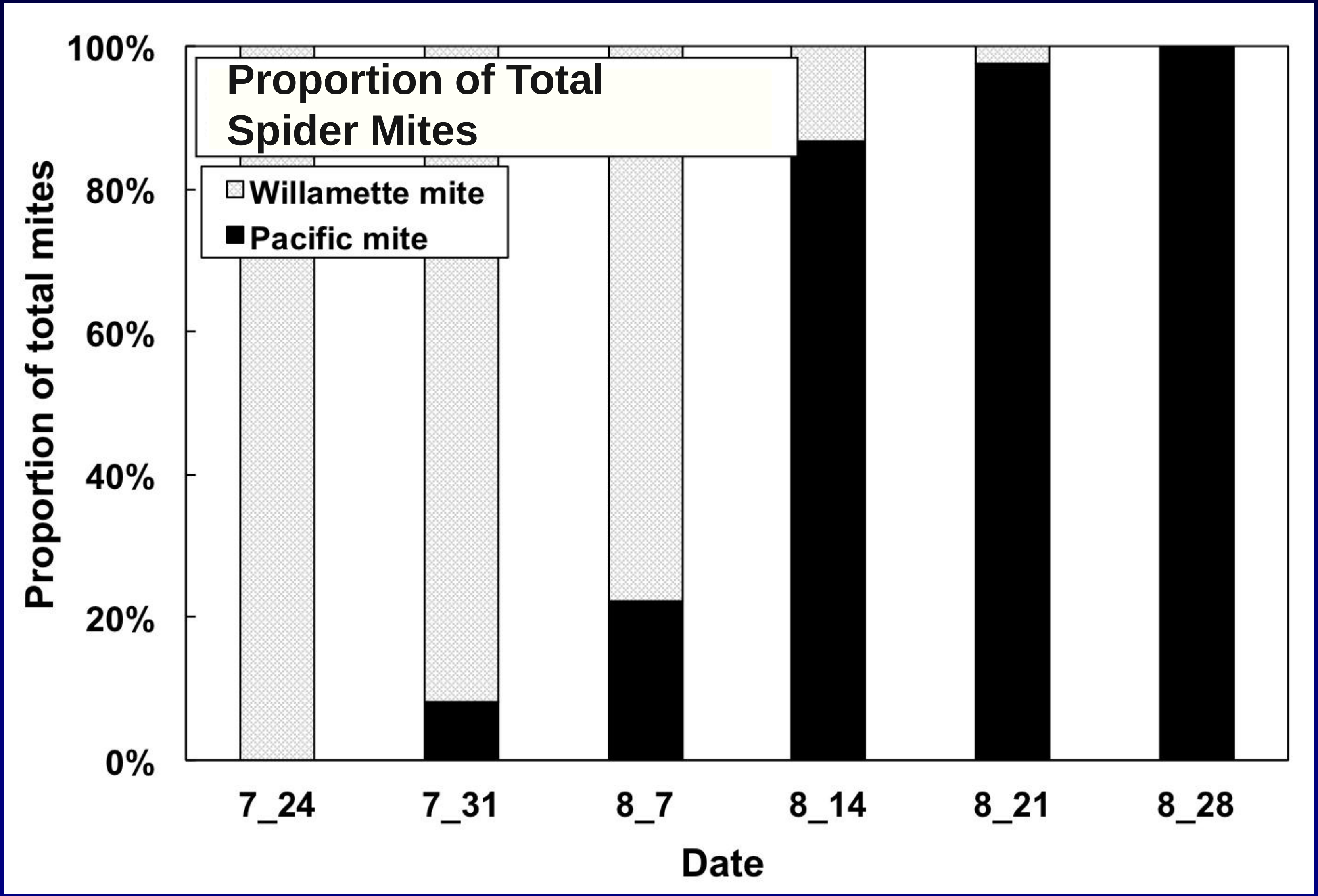
- 96 acre mature cabernet sauvignon grape vineyard
- East of Lodi, San Joaquin Co.
- vines drip irrigated
- 4 replicates for each treatment and untreated control
- each treatment replicate was 5 vines in size.
- treatments arranged in a completely randomized design

Special thanks to Steve Quashnick, Wilbur-Ellis Co.

Daily maximum and minimum temperatures (ºF) at Lodi during the period of the experiment.



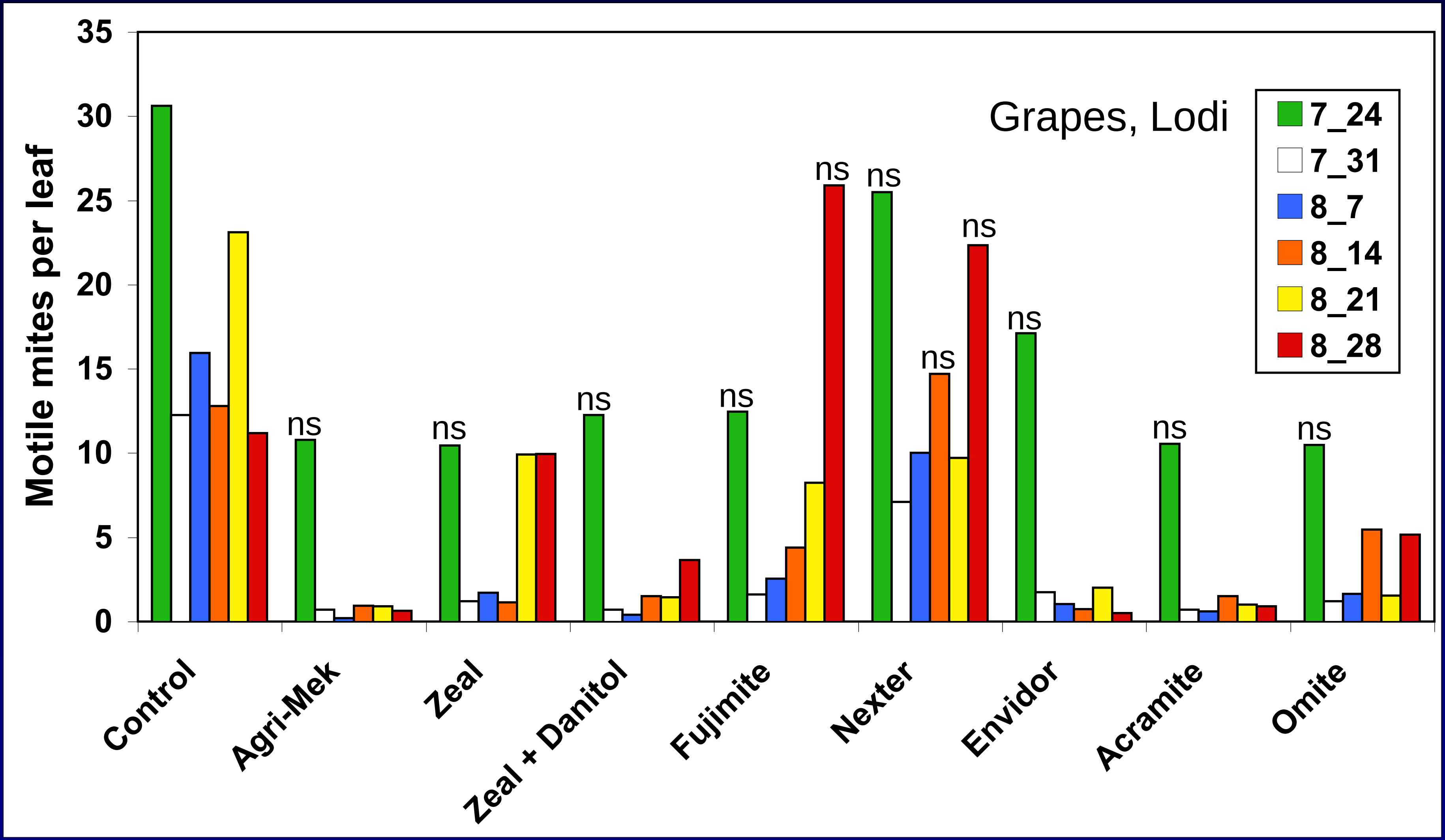
Proportion of Willamette and Pacific spider mites among all spider mites present in untreated control plots



Conventional acaricide study at Lodi - treatments applied to cabernet sauvignon grape vines

Product	Active ingredient	Rate per acre
Agri-Mek 0.83EC	Abamectin	16 oz
Zeal	Etoxazole	3 oz.
Zeal + Danitol (V-10141)	Etoxazole + Fenpropathrin	18 oz
Fujimite 5EC	Fenpyroximate	2 pts.
Nexter	Pyridaben	10.67 oz.
Envidor 2SC	Spirodiclofen	18 oz.
Acramite 50WS	Bifenazate	1 lb.
Omite 30WP	Propargite	8 lb.
Untreated	Untreated	--

Comparison of acaricides applied on July 20 to cabernet sauvignon grape vines near Lodi

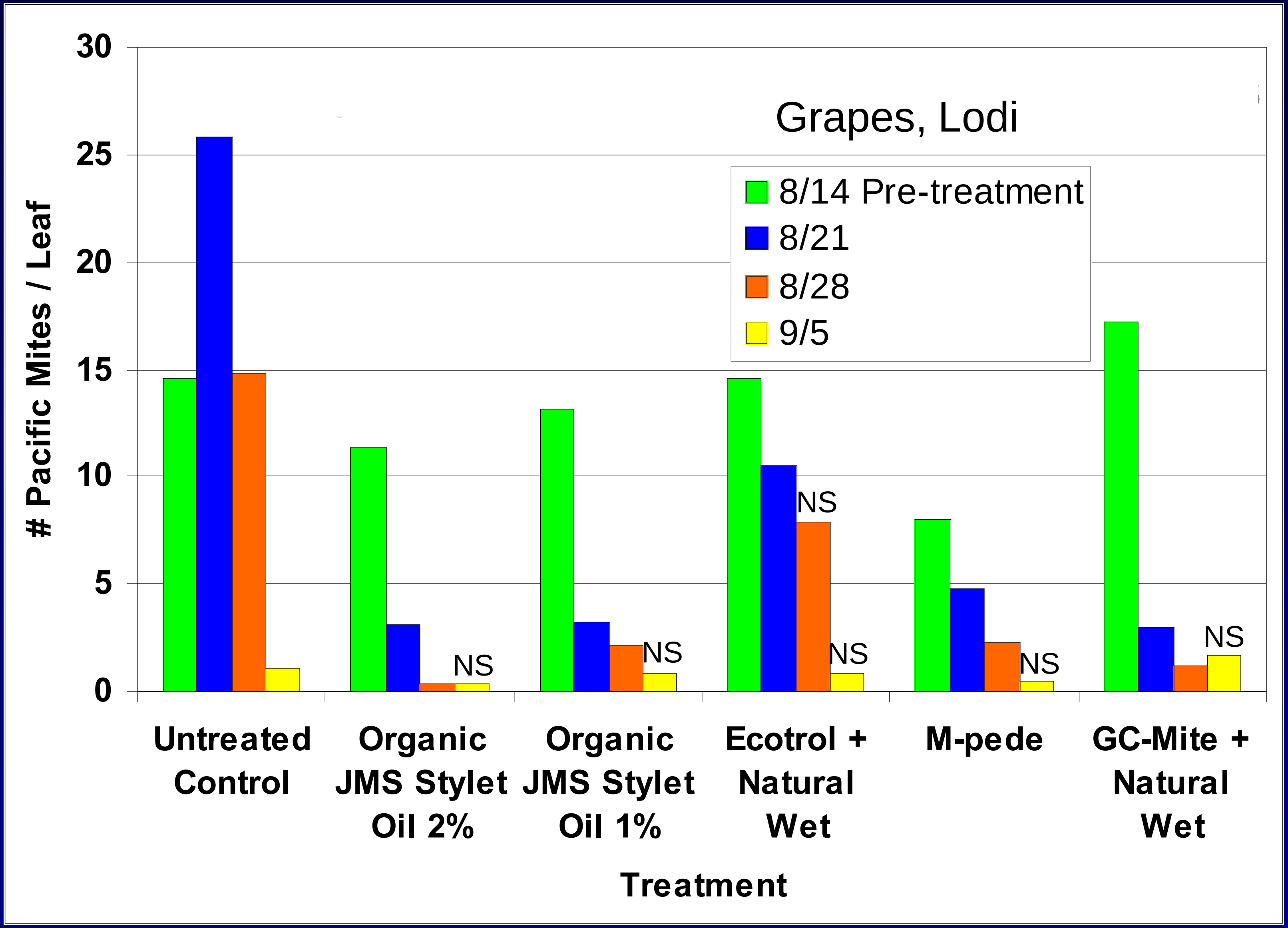


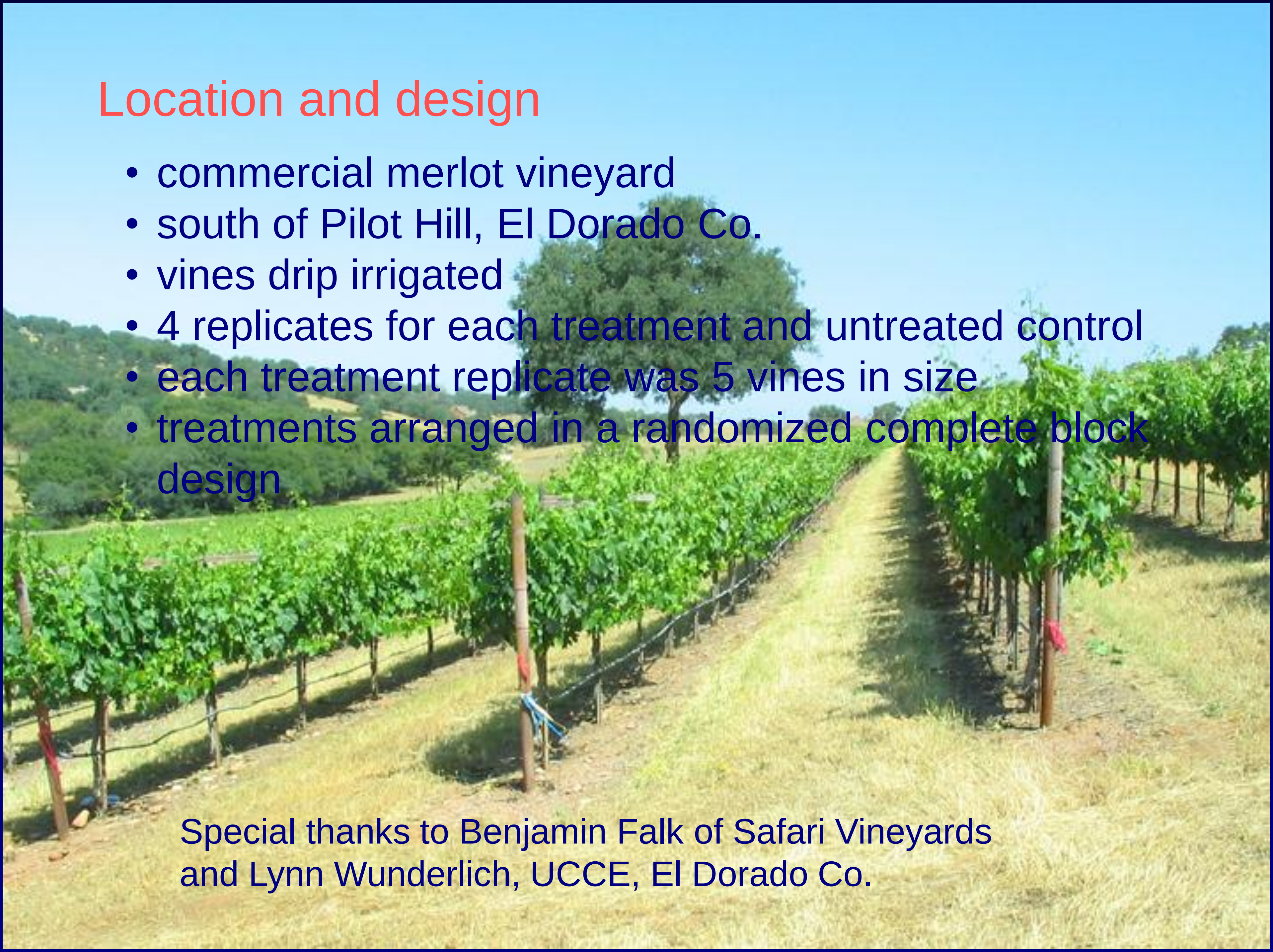
Treatments are significantly (P<0.05) different from untreated except for those indicated by 'ns'.

Organic acaricide study - treatments applied to cabernet sauvignon grape vines near Lodi

Treatment	Active ingredient	Rate
Untreated Control	na	na
Organic JMS Stylet Oil	Paraffinic Oil	2% v/v
Organic JMS Stylet Oil	Paraffinic Oil	1% v/v
Ecotrol + Natural Wet	Rosemary Oil + Saponin	0.75 qts + 0.125% v/v
M-pede	Potassium salts of fatty acids	2% v/v
GC-Mite + Natural Wet	Cottonseed, Clove and Garlic oil + Saponin	1% v/v + 0.125% v/v

Comparison of organic acaricides applied on August 19 to cabernet sauvignon grape vines near Lodi



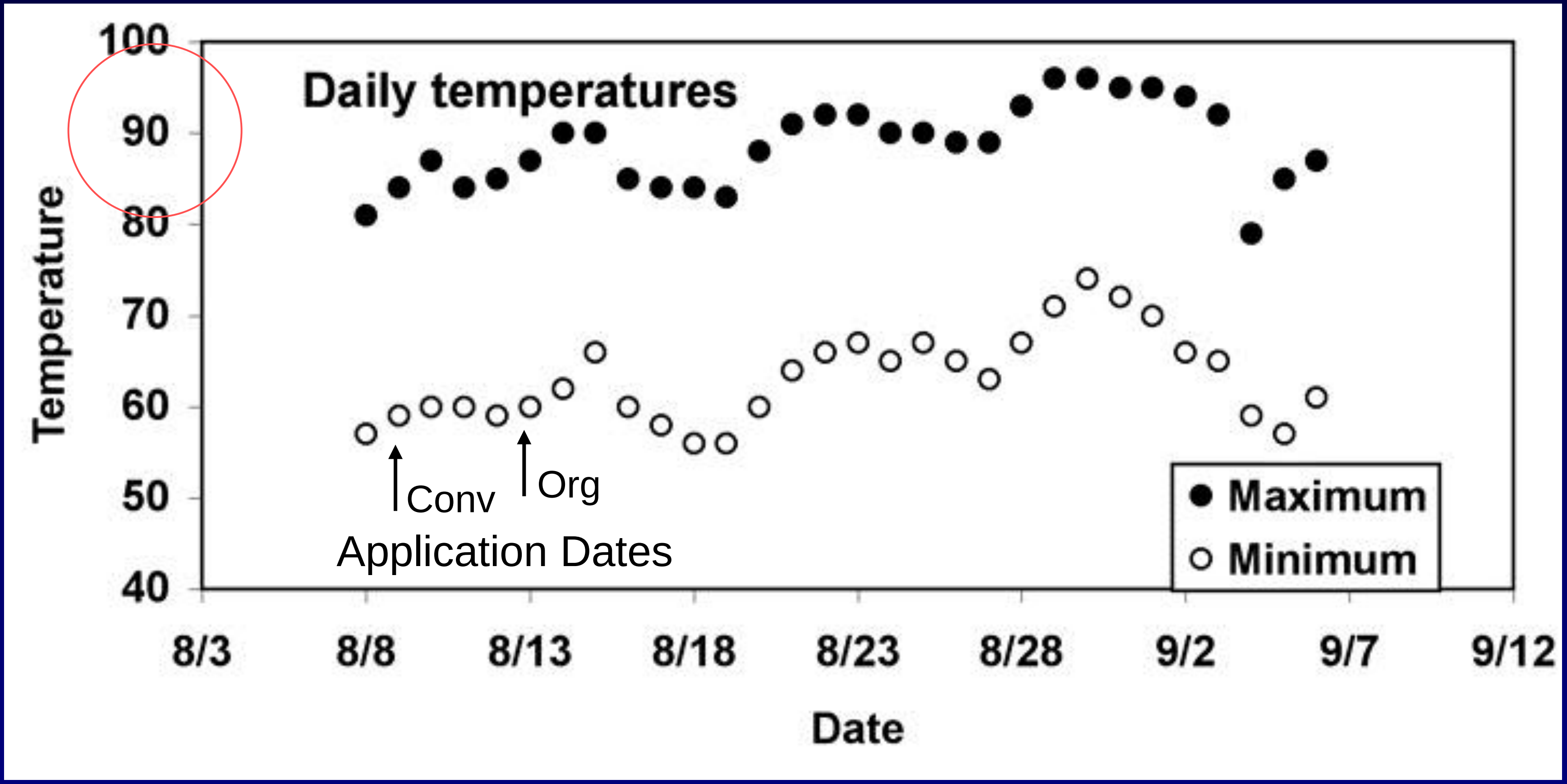


Location and design

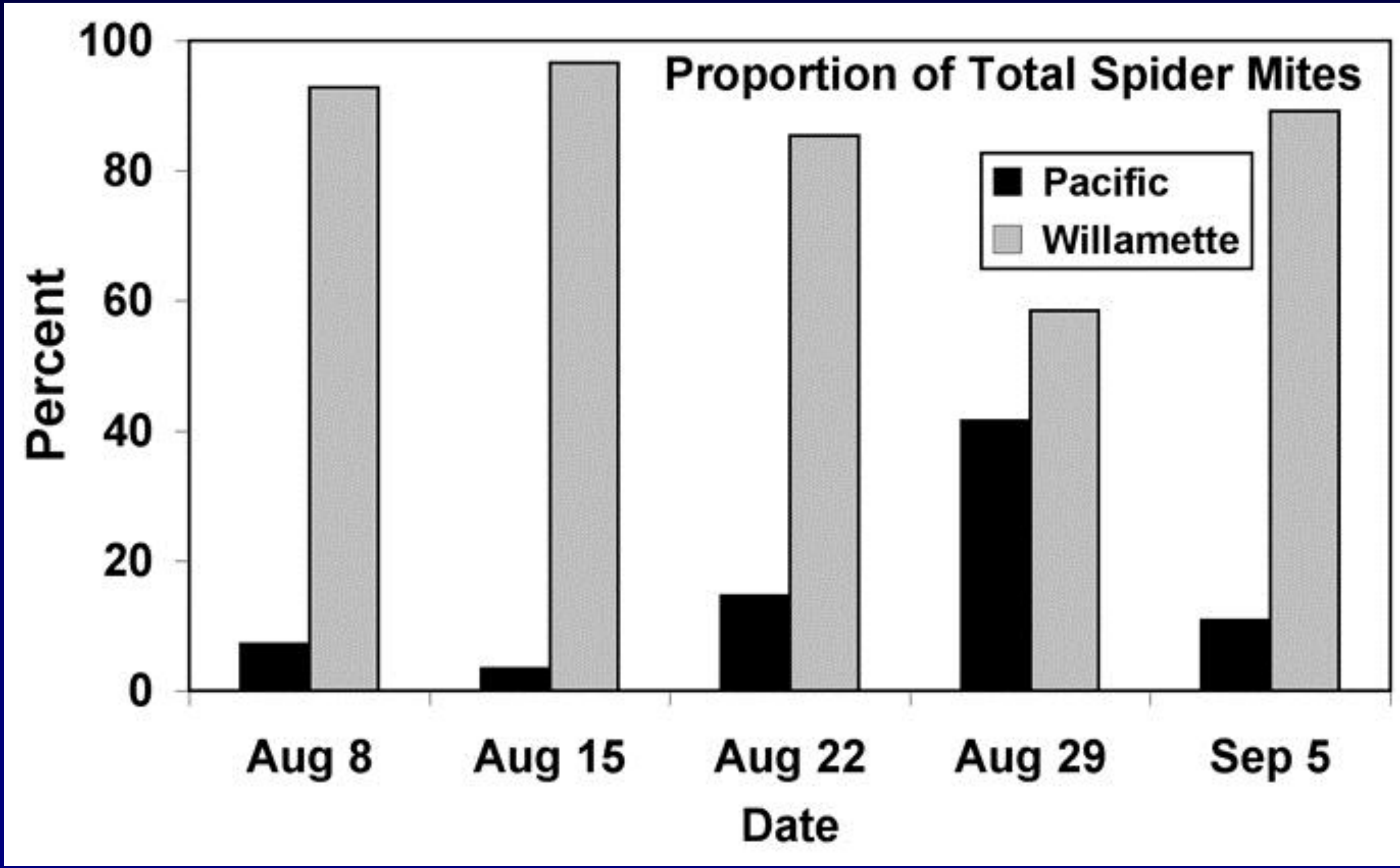
- commercial merlot vineyard
- south of Pilot Hill, El Dorado Co.
- vines drip irrigated
- 4 replicates for each treatment and untreated control
- each treatment replicate was 5 vines in size
- treatments arranged in a randomized complete block design

Special thanks to Benjamin Falk of Safari Vineyards
and Lynn Wunderlich, UCCE, El Dorado Co.

Daily maximum and minimum temperatures (ºF) at Pilot Hill during the period of the experiment.



Proportion of Willamette and Pacific spider mites among all spider mites present in untreated control plots.

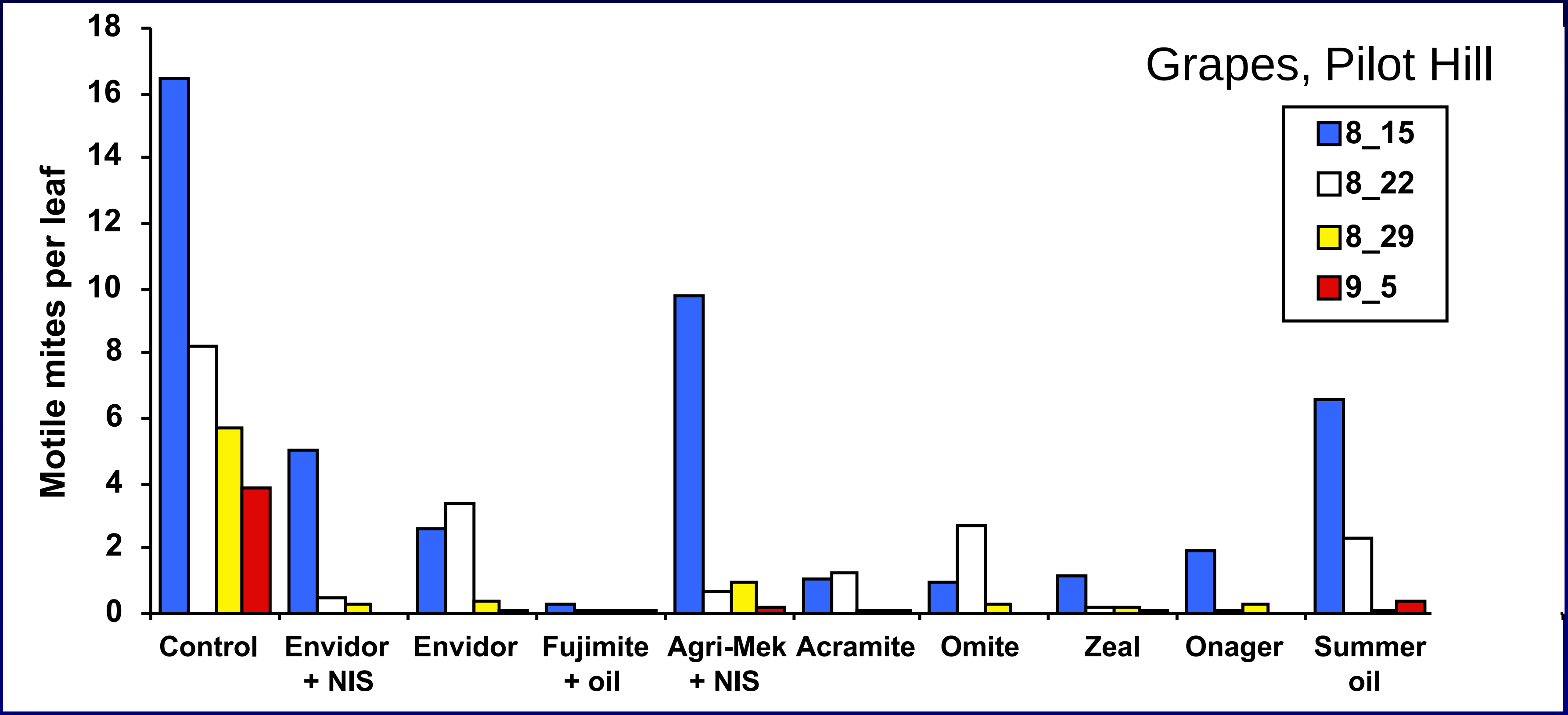


Pretreatment count (August 8) = 67.4 mites per leaf

Conventional acaricide study in El Dorado Co. - treatments applied to merlot grape vines

Product	Active ingredient	Rate per acre
Agri-mek + Dyne-amic	Abamectin + surfactant	12 oz + 0.25% v/v
Zeal	Etoxazole	3 oz.
Fujimite + summer oil	Fenpyroximate	2 pts. + 1% v/v
Onager	Hexythiazox	19.2 oz.
Envidor	Spirodiclofen	18 oz.
Envidor + Bond	Spirodiclofen + surfactant	18 oz. + 0.25% v/v
Acramite	Bifenazate	1 lb.
Omite	Propargite	8 lb.
Orchex 796	Summer oil	1% v/v
Untreated	Untreated	--

Comparison of acaricides applied on August 9 to merlot grape vines in El Dorado Co.

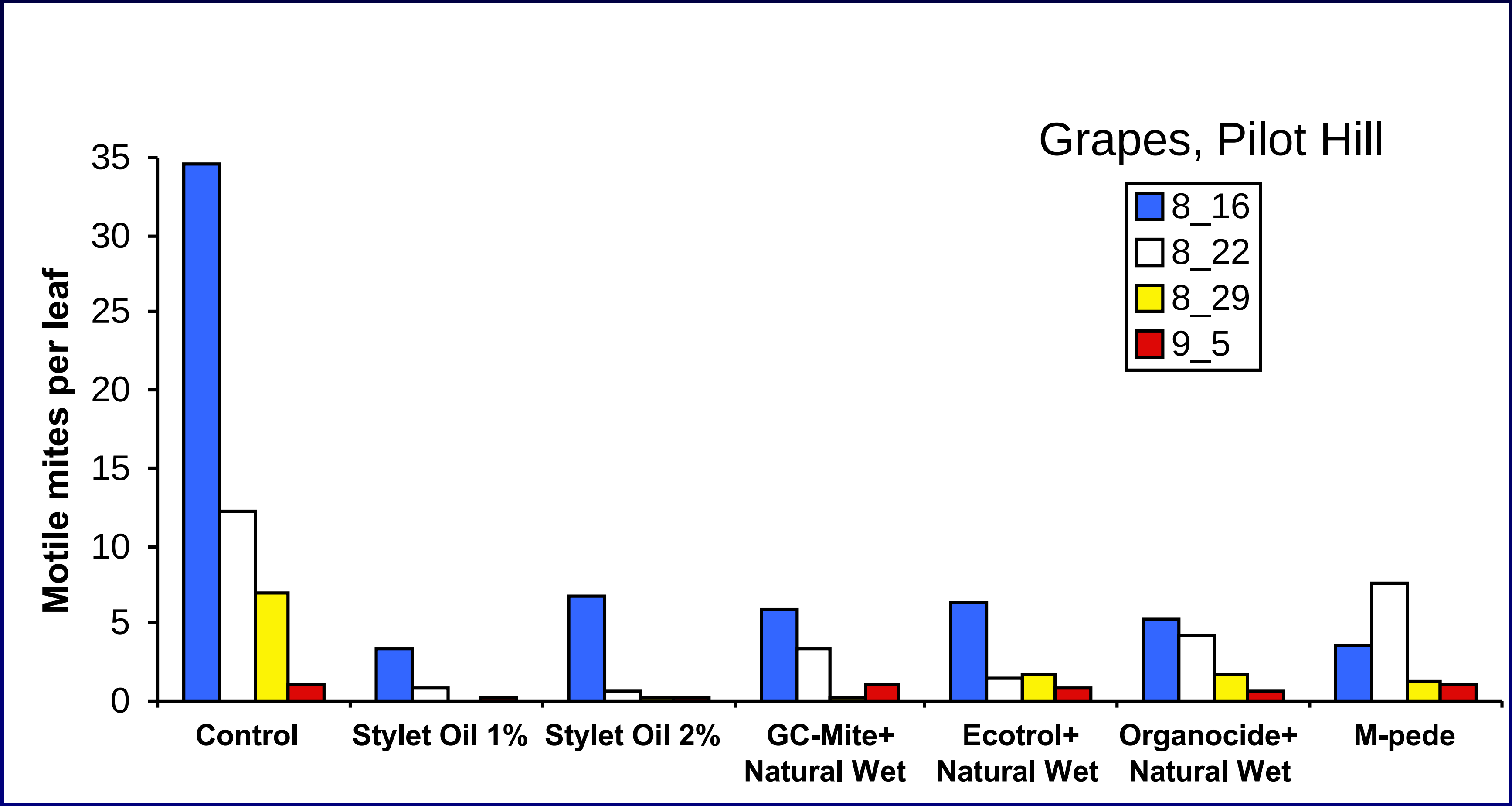


Treatments are significantly (*P*<0.05) different from untreated except for August 22 sampling date, *F*=1.9719, df = 10,42, *P*=0.0710.

Organic acaricide study - treatments applied on August 13 to merlot grape vines in El Dorado Co.

Product	Active ingredient	Rate per acre
Untreated	na	na
Organic JMS Stylet Oil 1%	Parafinic Oil	1% v/v
Organic JMS Stylet Oil 2%	Parafinic Oil	2% v/v
GC-Mite + Natural Wet	Cottonseed, Clove and Garlic Oil + Saponin	1% v/v + 0.125% v/v
Ecotrol + Natural Wet	Rosemary Oil + Saponin	4 pts/acre + 0.125% v/v
Organocide + Natural Wet	Sesame Oil + Saponin	2 oz./gal + 0.125% v/v
M-pede	Potassium salts of fatty acids	2% v/v

Comparison of organic acaricides applied on August 13 to merlot grape vines in El Dorado Co.



Treatments are significantly (*P*<0.05) different from untreated except for September 5 sampling date and those labeled ns.

Biological Control of Mites on Winegrapes

overwinter on vines

Phytoseiid mites

Lady beetles

Lacewings

Predatory bugs

Six-spotted thrips

general predators must recolonize each year

Predaceous Mites on Winegrapes

Typhlodromus pyri Scheuten - north coast
Euseius quetzali McMurtry - north coast, central valley
Amblyseius andersoni Chant - north coast
Typhlodromus caudiglans Schuster - north coast
Metaseiulus johnsoni (Mahr) - north coast
Neoseiulus fallacis (Garman) - Lodi
Euseius stipulatus (Athias-Henriot) - central coast
Metaseiulus mcgregori (Chant) - central valley, Lodi
Galendromus occidentalis (Nesbitt) - central valley, north coast
Neoseiulus californicus (McGregor) - central valley and coast
Euseius tularensis Congdon - central valley

Predaceous mites on winegrapes

- Adult females are typically narrowly oval
- Most are shiny white to slightly yellow or reddish
- Tend to move much more quickly than do spider mites

- Eggs are elliptical and perhaps 3 to 4 times larger than the spherical eggs of spider mites
- Overwinter primarily under the buds of grapevines as mated, adult females

Sampling and decision rules in "Grape Pest Management"

Mite predators on winegrapes

- Record number of leaves with any predator (not just predator mites) at the same time you are counting the number of leaves with spider mites
- Determine predator-to-prey distribution ratio
- When the ratio is greater than 1:2, spider mite populations will predictably decrease, regardless of the number of pest mites per leaf
- Ratio of 1:10 to 1:2 is good
- <1:30 is not good for control by predators
- 30% of leaves with six-spotted thrips is good

Pesticide Toxicity Measurements

Acute toxicity - percent mortality
LD50 or LC50 - dose response
Sublethal effects - fecundity, fertility,
immature development
Total effects -
Persistence -
Behavioral modification -

Predator mite bioassays - analysis

Mortality, fecundity and fertility analyzed by ANOVA with means separated by LSD ($p < 0.05$)

Total effects of pesticides - *E*

E (%) = 100% - (100% - M) x R

Where

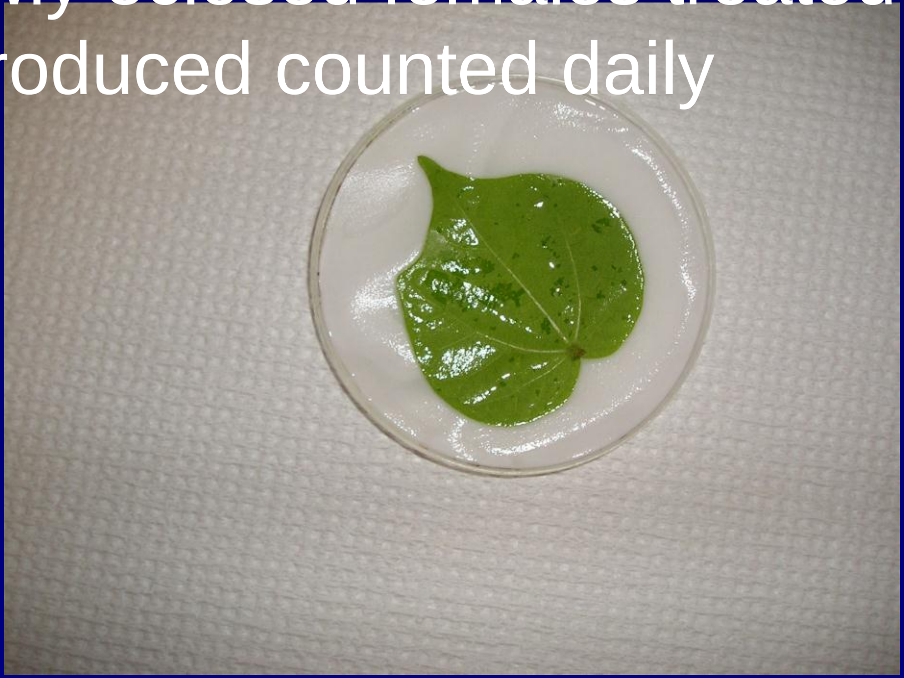
M = Abbott corrected mortality (Abbott, 1925)

R = reproduction per treated female (eggs/female x % fertility) / reproduction per untreated female

Predator mite bioassays - direct contact

Methods

- 30 adult *G. occidentalis* sprayed
- 1 female per leaf + spider mite eggs and actives
- 20 reps of each treatment and control
- Evaluate mortality, fecundity and fertility @ 72 hrs
- Separate cohort of newly eclosed females treated and number of eggs produced counted daily



Predator mite bioassays - direct contact

G. occidentalis survival, fecundity and fertility after treatment of adult females with label rates of five different acaricides.

Active ingredient	Contact spray			
	% Survival	Total eggs/ female	Fertility (% hatch)	*E*
Control	100±0a	12.4±0.8a	100±0a	-
Acequinocyl	100±0a	9.2±0.6b	96.0±4.9a	28.5
Bifenazate	100±0a	9.4±0.5b	92.3±3.4a	30.2
Etoxazole	98.3±2.2a	9.4±0.7b	0±0b	100
Spiromesifen	98.3±2.2a	8.6±0.5b	96.1±4.0a	34.0
Fenpyroximate	0±0b	0±0c	0±0b	100

Means followed by the same letter are significantly different at $p<0.05$ by LSD.

Predator mite bioassays - residues

Methods

- Leaf discs air-dried after spraying
- 1 female per leaf + spider mite eggs and actives
- 20 reps of each treatment and control
- Evaluate mortality, fecundity and fertility @ 72 hrs
- Separate cohort of newly eclosed females treated and number of eggs produced counted daily

Predator mite bioassays - residues

G. occidentalis survival, fecundity and fertility after treatment of leaves with label rates of five different acaricides.

	Surface residue			
Active ingredient	% Survival	Eggs laid	Fertility	*E*
Control	98.3±2.2a	11.2±1.0a	100±0a	-
Acequinocyl	93.4±3.0a	9.6±0.5a	92.2±4.9a	25.1
Bifenazate	95.1±2.7a	9.6±0.9a	96.0±4.0a	20.1
Etoxazole	93.4±3.0a	9.0±0.5a	0±0b	100
Spiromesifen	91.7±3.2a	5.0±0.7b	92.6±4.3a	61.7
Fenpyroximate	0±0b	0±0c	0±0b	100

Means followed by the same letter are significantly different at $p<0.05$ by LSD.

IOBC Classifications - (Sterk et al., 1999)

Leaf surface residues

Acequinocyl
Bifenazate

Harmless (class 1)

Spiromesifen

Slightly harmful (class 2)

Etoxazole
Fenpyroximate

Harmful (class 4)

Direct contact spray

Acequinocyl
Bifenazate
Spiromesifen

Harmless (class 1)

Etoxazole
Fenpyroximate

Harmful (class 4)

Predator mite bioassays - persistence

Active ingredient, trade name, formulation and concentration.

Active ingredient	Product	% a.i. and formulation	Concentration (ppm)
Fenpyroximate	Fujimite	5 SC	62.5
Etoxazole	Zeal	72 WP	80.9
Acequinocyl	Kanemite	15 SC	181.5
Bifenazate	Acramite	50 WS	200.7
Spiromesifen	Oberon	23 SC	142.6
Abamectin	Agrimek	15 EC	93.0

Amount of solution applied was 10.6±0.53 μl/cm2.
The chemicals evaluated were mixed with distilled water

Predator mite bioassays - persistence

Methods

- Acaricides applied in the field to runoff
- Five 20 mm leaf disks per Petri dish arena
- 3 adult female *G. occidentalis* per disk + spider mite eggs and actives
- 5 replicates
- Evaluate mortality and fecundity after 3 days (fertility after 6 days)
- Procedures repeated with treated leaflets at 3, 6, 10, 14, 17, 24, 30 and 37 days after application

IOBC Persistence - female mortality

Treatment	Mean ± SD % mortality Days after treatment 3	6	10	>14	IOBC
Control	0 a	0 a	0 a	0 a	A
Bifenazate	0 a	0 a	0 a	0 a	A
Etoxazole	26.4±6.6b	0 a	0 a	0 a	A
Spiromesifen	0 a	0 a	0 a	0 a	A
Abamectin	33.0±10.4b	0 a	0 a	0 a	A
Fenpyroximate	100c	100b	100b	0 a	B
Acequinocyl	100c	0 a	0 a	0 a	A

Within columns means (±SD) followed by the same letter do not differ significantly at *p*=0.05 by LSD.

IOBC categories: A = short lived (<5 d), B = slightly persistent (5-15 d), C = moderately persistent (16-30 d), D = persistent (>30 d).

E (%) = 100% - (100% - M) x R

IOBC Persistence - fecundity

	Days after treatment							
Treatment	3	6	10	14	17	24	30	37
Control	2.3a	2.4a	2.1a	2.3a	2.0ab	2.4a	2.2a	2.3a
Bifenazate	0.0c	0.8d	1.0c	2.4a	2.3a	2.3a	2.1a	2.4a
Etoxazole	1.9ab	0.9cd	1.5b	2.2a	2.3a	2.4a	2.2a	2.3a
Spiromesifen	0.2c	1.2bc	1.4bc	2.2a	2.1ab	2.2a	2.3a	2.2a
Abamectin	1.4b	2.4a	2.2a	2.2a	2.1ab	2.3a	2.2a	2.2a
Fenpyroximate	0.0c	0.0e	0.1d	0.3c	0.2c	0.4b	0.5a	0.7a
Acequinocyl	1.5b	1.6b	1.5b	1.8b	1.9b	2.4a	2.3a	2.3a

Within columns means (±SD) followed by the same letter do not differ significantly at *p*=0.05 by LSD.

IOBC Persistence - fertility

Treatment	Days after treatment							
	3	6	10	14	17	24	30	37
Control	100.0a	99.0a	100.0a	99.1a	100.0a	99.0a	100.0a	99.0a
Bifenazate	0.0c	100.0a	100.0a	99.0a	44.4b	99.0a	100.0a	98.1a
Etoxazole	0.0c	0.0d	0.0b	0.0b	0.0c	0.0b	0.0b	0.0b
Spiromesifen	0.0c	65.3c	100.0a	98.0a	99.1a	99.0a	100.0a	99.0a
Abamectin	99.1a	98.2a	100.0a	100.0a	99.1a	100.0a	100.0a	98.0a
Fenpyroximate	0.0c	0.0d	12.0b	0.0b	0.0c	0.0b	0.0b	2.6b
Acequinocyl	77.8b	78.2b	97.4a	97.8a	99.0a	99.2a	99.2a	99.0a

Within columns means (±SD) followed by the same letter do not differ significantly at *p*=0.05 by LSD.

IOBC Persistence - total effects

Total effects (*E*) of acaricide residues on *G. occidentalis* 72 h after exposure to treated leaves on the indicated days after application

Treatment	Days after treatment								IOBC[a]
	3	6	10	14	17	24	30	37	
Bifenazate	100	67	52	0	0	0	0	0	B
Etoxazole	100	100	100	100	100	100	100	100	D
Spiromesifen	100	67	33	0	0	0	0	0	B
Abamectin	60	0	0	0	0	0	0	0	A
Fenpyroximate	100	100	100	100	100	100	100	100	D
Acequinocyl	100	48	30	23	6	0	0	0	B

IOBC persistence categories: A = short lived (<5 d), B = slightly persistent (5-15 d), C = moderately persistent (16-30 d), D = persistent (>30 d).

E (%) = 100% - (100% - M) x R

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Etoxazole	100	100	100	100	100	100	100	100	D
Spiromesifen	100	67	33	0	0	0	0	0	B
Abamectin	60	0	0	0	0	0	0	0	A
Fenpyroximate	100	100	100	100	100	100	100	100	D
Acequinocyl	100	48	30	23	6	0	0	0	B

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E (%) = 100% - (100% - M) x R

Fertility

Female survival

Integrating Control of Leafhoppers and Spider Mites with Powdery Mildew Treatment in an Organic Vineyard

Dual function products for organic production

Products evaluated:

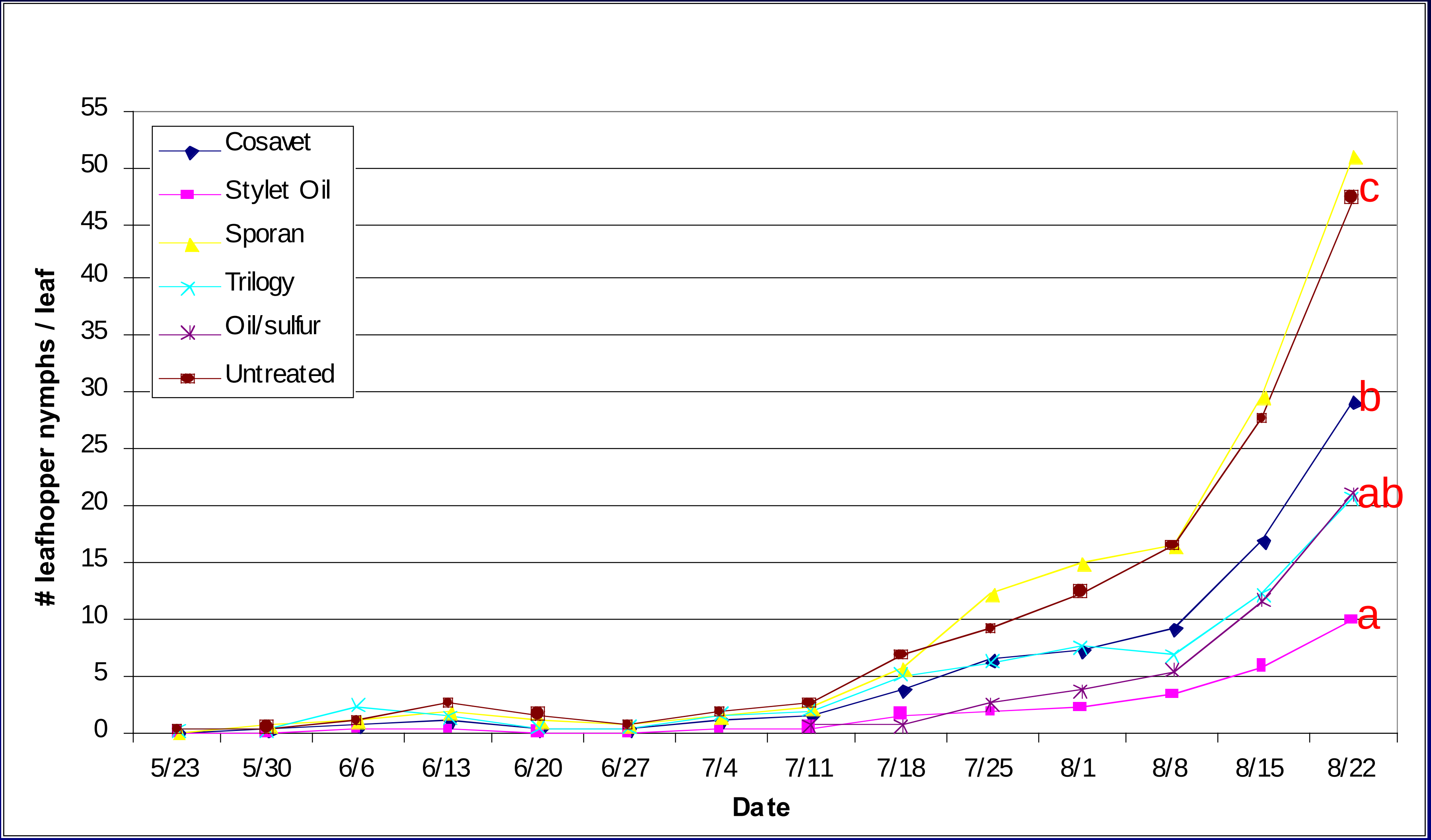
- Untreated
- Cosavet- micronized sulfur
- JMS Organic Stylet Oil – paraffinic oil
  - Sub-plot treatment Stylet oil > Cosavet
- Trilogy- neem oil
- Sporan- rosemary, clove and thyme oil

Treatments applied at a volume of 100 gpa

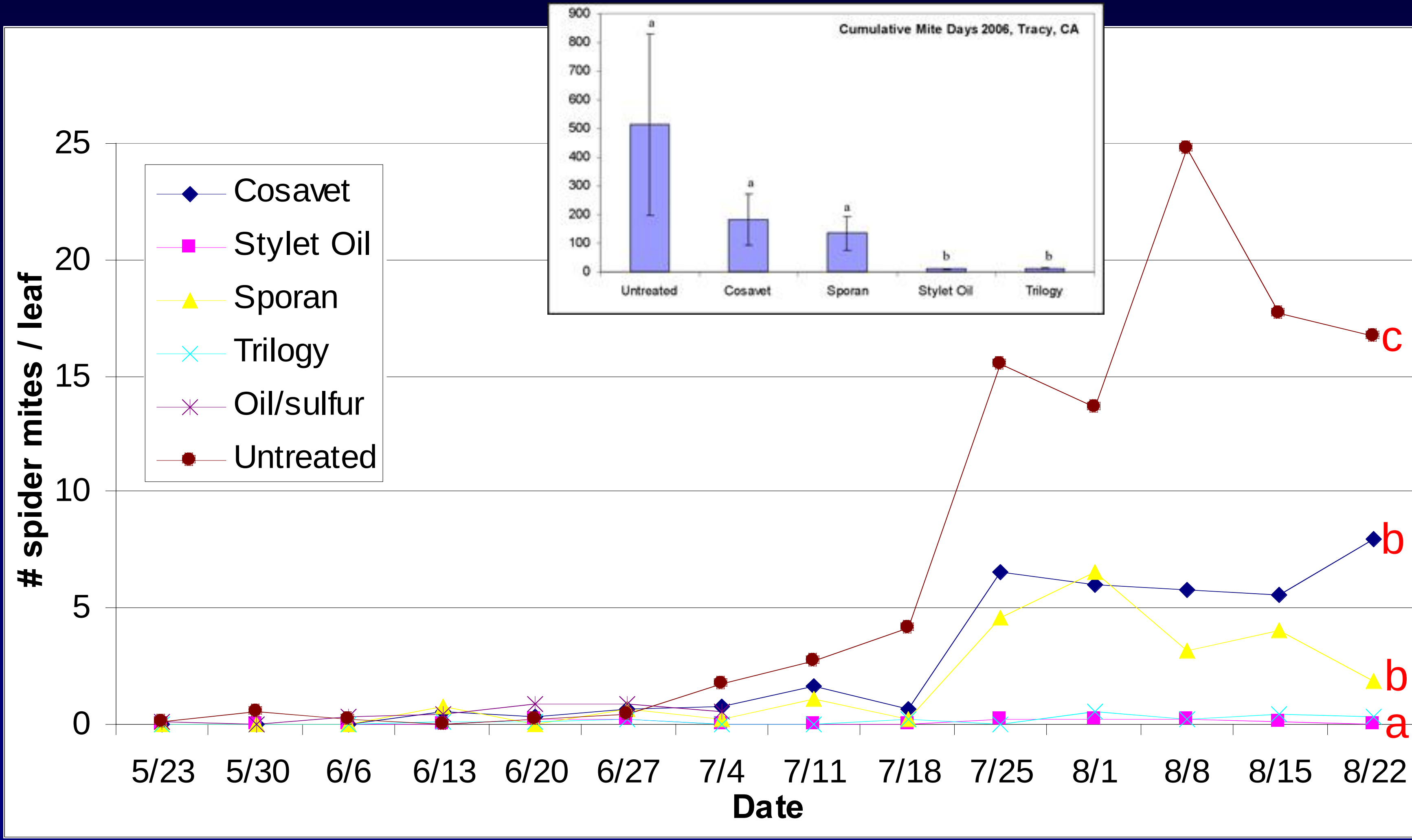
Methods

- Fantasy seedless organic table grapes, Tracy
- 15-vine main-plots, 4 replicates
- Treatments applied every 10 to 14 days, prebloom to veraison
- Leafhoppers: 12 leaf turns per plot
- Mites: 5 leaf samples per plot
- Powdery Mildew: 20 bunches examined per plot

Leafhopper nymph densities, 2006



Willamette spider mite densities, 2006



Powdery mildew - results

Mean ± SEM powdery mildew incidence and severity in main plots, 2006

	Powdery Mildew	
	Incidence [a]	Severity [b]
Treatment	Mean ± SEM	Mean ± SEM
Untreated	0.99 ± 0.01 a	0.84 ± 0.05 a
Cosavet	0.96 ± 0.02 a	0.20 ± 0.02 bc
Stylet Oil	0.83 ± 0.01 b	0.10 ± 0.00 d
Sporan	0.99 ± 0.01 a	0.32 ± 0.02 b
Trilogy	0.94 ± 0.03 ab	0.16 ± 0.01 cd

[a] Proportion of grape bunches with powdery mildew infection

[b] Proportion of grape berries with powdery mildew infection

Means followed by the same letter are not significantly different (Tukey's HSD, $p < 0.05$)

Means were arcsine transformed prior to analysis, means presented here are untransformed.

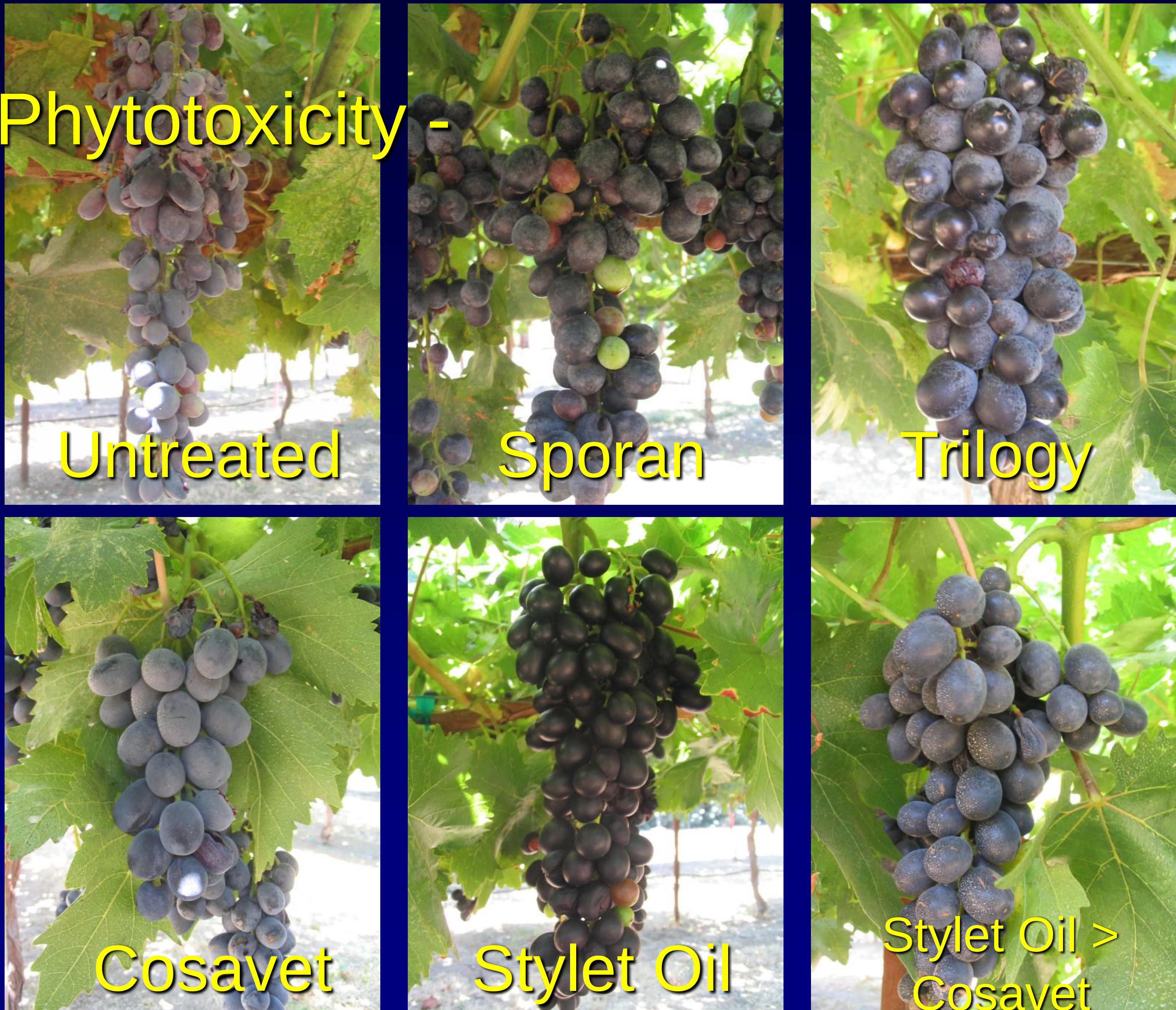
Powdery mildew - results

Mean ± SEM powdery mildew incidence and severity in stylet oil sub-plots, 2006

	Powdery Mildew							
	Incidence [a]				Severity [b]			
Subplot Treatments	Mean	±	SEM		Mean	±	SEM	
Stylet Oil	0.83	±	0.01	a	0.10	±	0.00	a
Stylet Oil then Cosavet [c]	0.85	±	0.04	a	0.10	±	0.01	a

[a] Proportion of grape bunches with powdery mildew infection
[b] Proportion of grape berries with powdery mildew infection
[c] Stylet Oil applied 5/17-6/26, Cosavet applied 7/10-8/7
Means followed by the same letter are not significantly different (Tukey's HSD, $p < 0.05$)
Means were arcsine transformed prior to analysis, means presented here are untransformed.

Phytotoxicity -



Grape Pest Management
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Spider Mite Management Practices for Winegrapes

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