5th National IPM Symposium:
IPM in Support of Environmental Issues: Delivering to Improve Water and Air Quality

Management practices at the farm level to mitigate off-site movement of pesticides

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Pesticides and Surface Water Quality:

sources

- Drift from aerial or air blast sprayers
- Improper mixing and loading practices
- Leaching from disposal sites
- Stormwater runoff
- Irrigation tail water runoff
- Urban (runoff and disposal)

Pesticides and Surface Water Quality:
mitigation practices

- **Proper pesticide handling**
- **Alternative pest management**
- **Alternative site management**

Goals:

Reduce amount of the toxic pesticide

Reduce its offsite movement

prevent runoff

improve infiltration

IPM and Water Quality

an example -

Alternatives to Organophosphate Dormant Sprays in Orchards

The concern with OP dormant sprays -

Organophosphate insecticides, especially diazinon and chlorpyrifos, have been routinely detected in the Sacramento and San Joaquin River watersheds coincident with storm events which follow their application to dormant orchards, and have contributed to the Sacramento and San Joaquin Rivers being placed on the Clean Water Act 303(d) list of impaired waterways.

Runoff following a rainfall event
Artois, Glenn County, CA

Why use dormant sprays?

Target pest species -

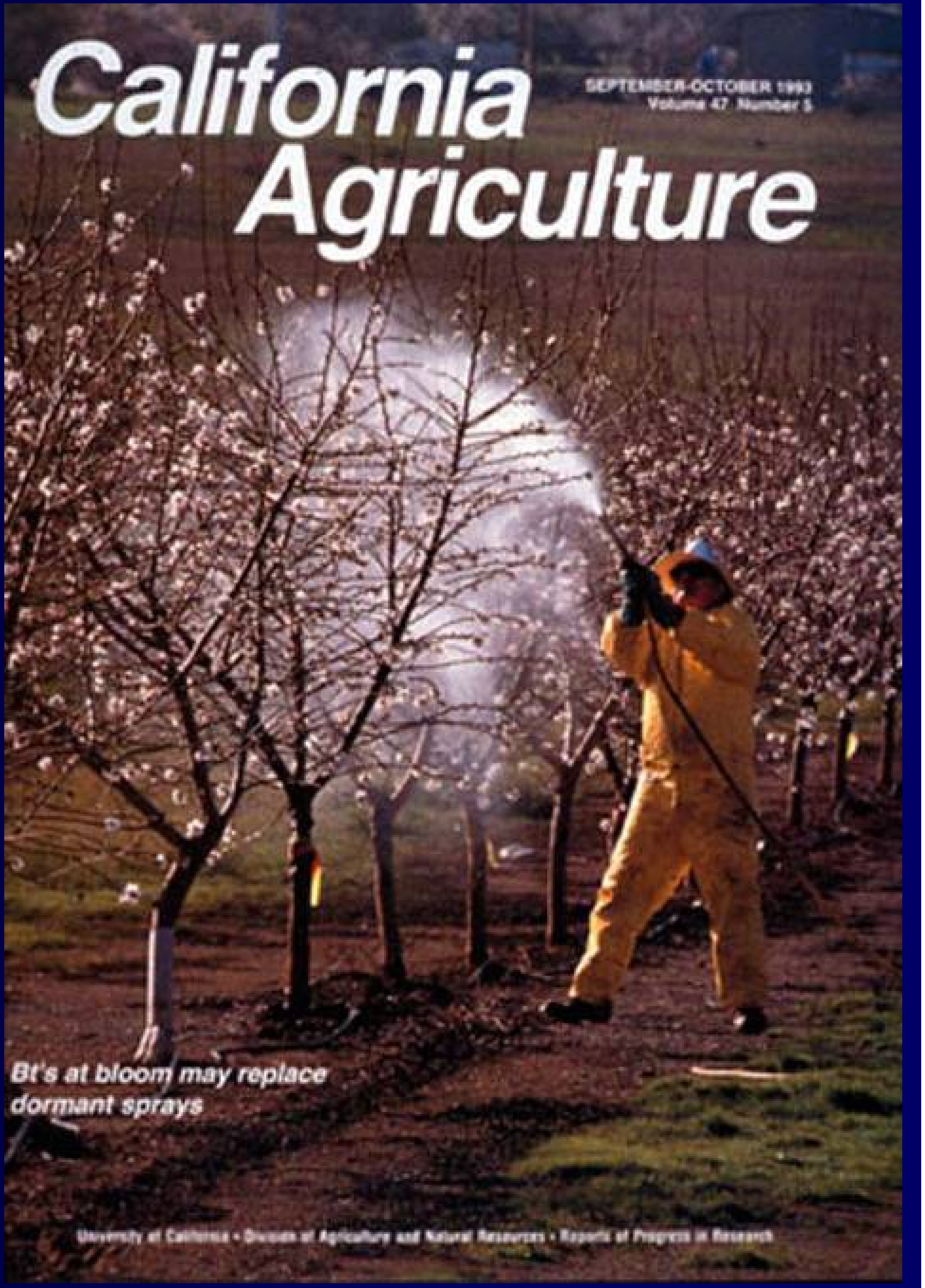
Why use OP dormant sprays?

Beneficial when compared to in-season sprays -

- **Life stages synchronized**
- **Fewer sprays - cheaper and easier**
- **Less worker exposure**
- **Less concern for biocontrol agents**
- **Fewer nontarget vertebrates active**
- **No food residues**

Widespread adoption - >90% of stone fruit and almond growers in 1980's and 1990's + pome fruit and walnut growers

IPM research and extension effort on dormant spray alternatives and mitigation measures began in 1990.



* Alternative pest management practices

Monitoring with -

- **No dormant spray, in-season treatments as needed**
- **Alternate treatment timing**
- **Alternate conventional pesticides (i.e. pyrethroids)**
- **Alternative pesticides - narrow pest spectrum**

Spinosad - peach twig borer

Bt bloom sprays - peach twig borer

Oil - San Jose scale, mite eggs

Insect Growth Regulators - peach twig borer, San Jose scale, aphids

Pheromone mating disruption - peach twig borer

Almond, Peach and Prune Pest Management Alliances

among identified priorities -

Monitoring techniques

OP and carbamate alternatives

For almonds: side-by-side comparisons of grower practices vs "softer" or alternative practices at 3 sites - 50 to 120 acres in size - in Butte, Stanislaus and Kern Co.; field days, newsletters, handholding.

* Alternative site management practices

- Earlier treatment timing
- Orchard floor management
- Buffer strips
- Post treatment sprinkling
- Berms/ catch basins

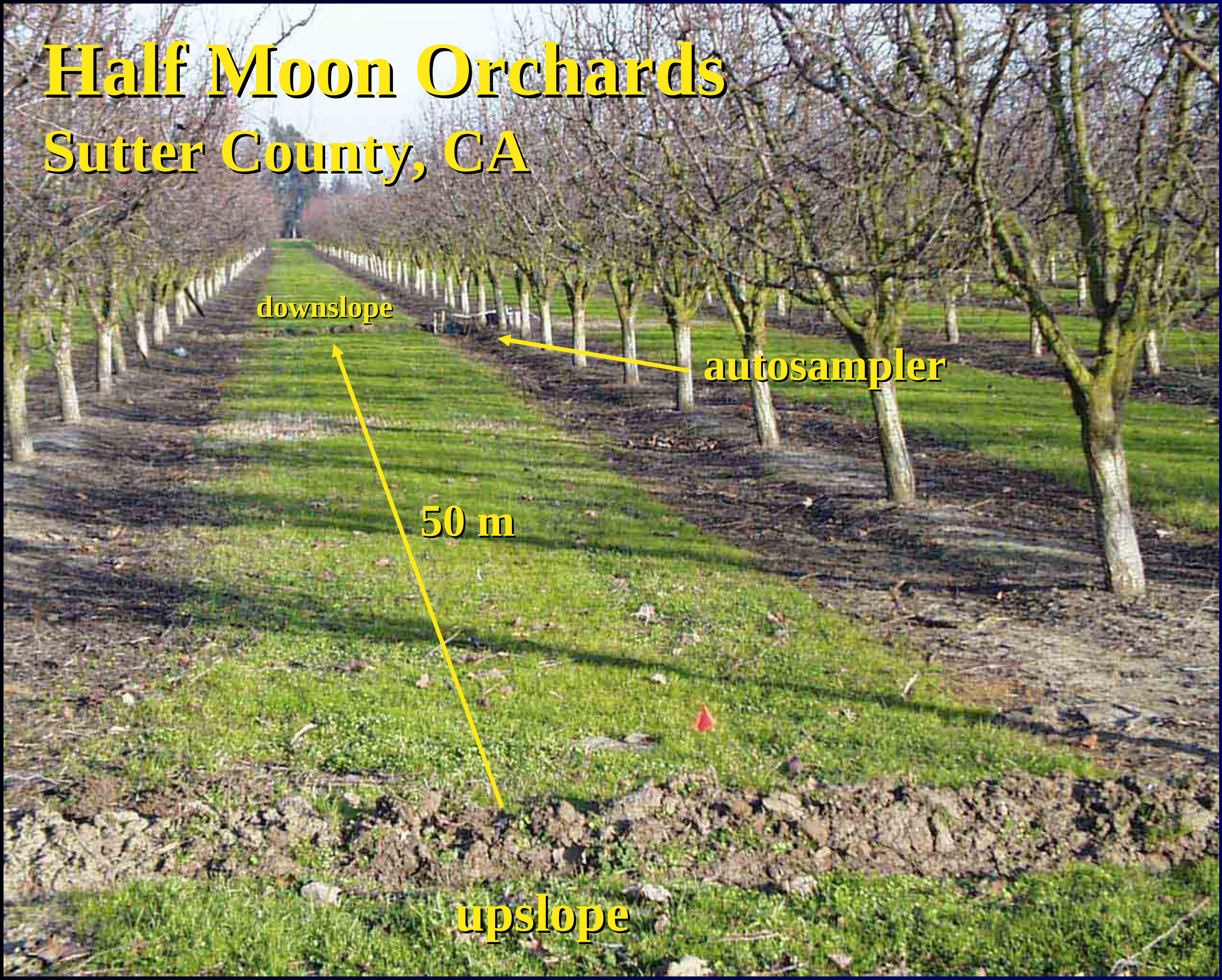
Cover crop

Buffer strip

* Alternative site management practices

Our approach -

Microplot studies and modeling:
focus on methods to improve infiltration
Larger field plots in commercial orchards:
evaluating management practices
through estimation of total load and
bioassays of nontarget aquatic species



Half Moon Orchards
Sutter County, CA
downslope
autosampler
50 m
upslope


Autosampler
direction of water flow
pump

Autosampler

flow meter

Samples and Bioassay

- **Runoff is collected in washed glass bottles and returned to UC Davis, divided and frozen at -20°C.**
- **Samples subjected to chemical residue analysis using GC and bioassays.**

Ceriodaphnia dubia

* Alternative site management practices

- Earlier treatment timing ☆
- Orchard floor management
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Cover crop


Buffer strip

Earlier treatment timing?

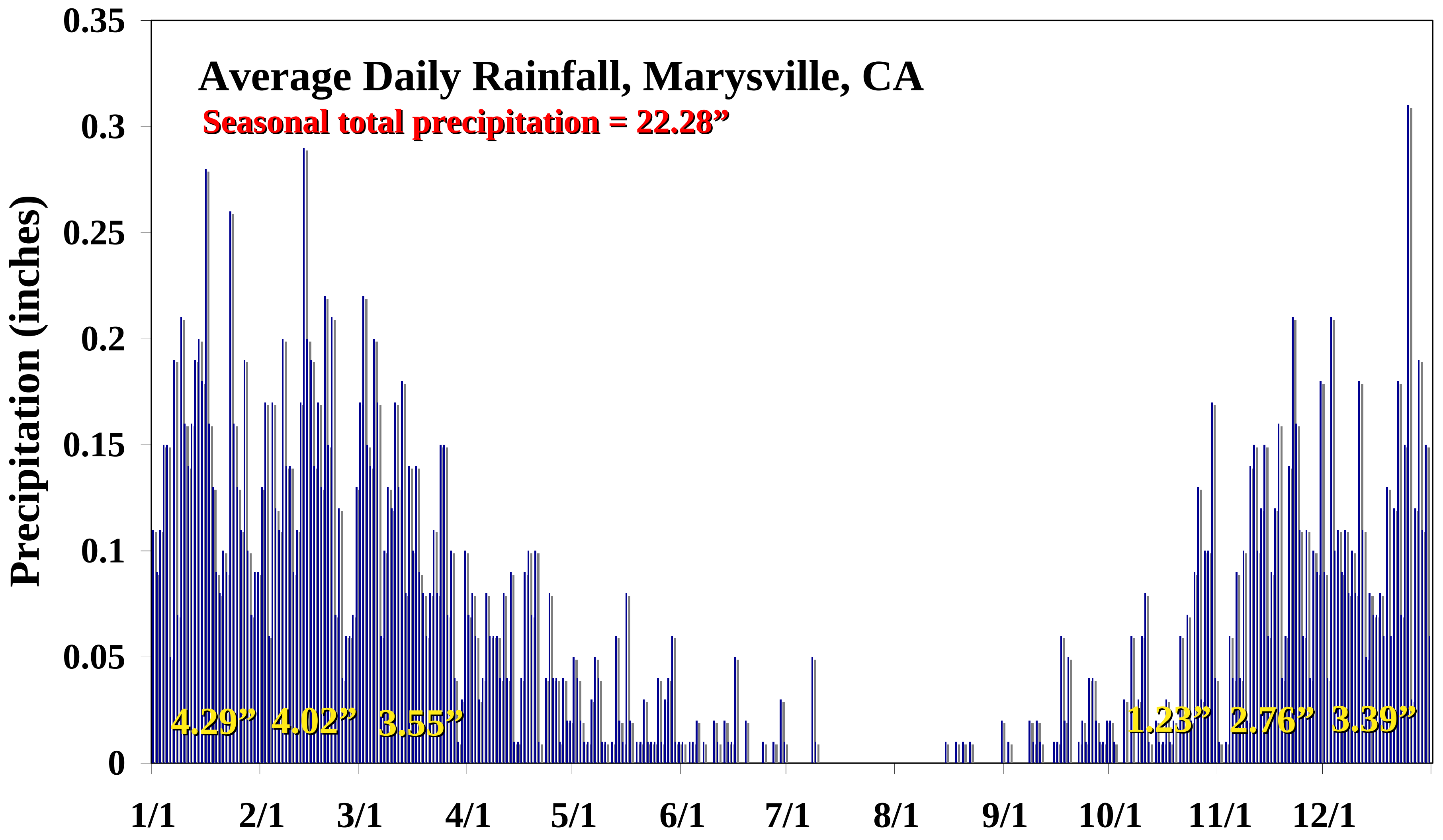
Hypothesis:

- Pesticide application timing influences the amount of residual pesticide that moves off-site with subsequent rain events.

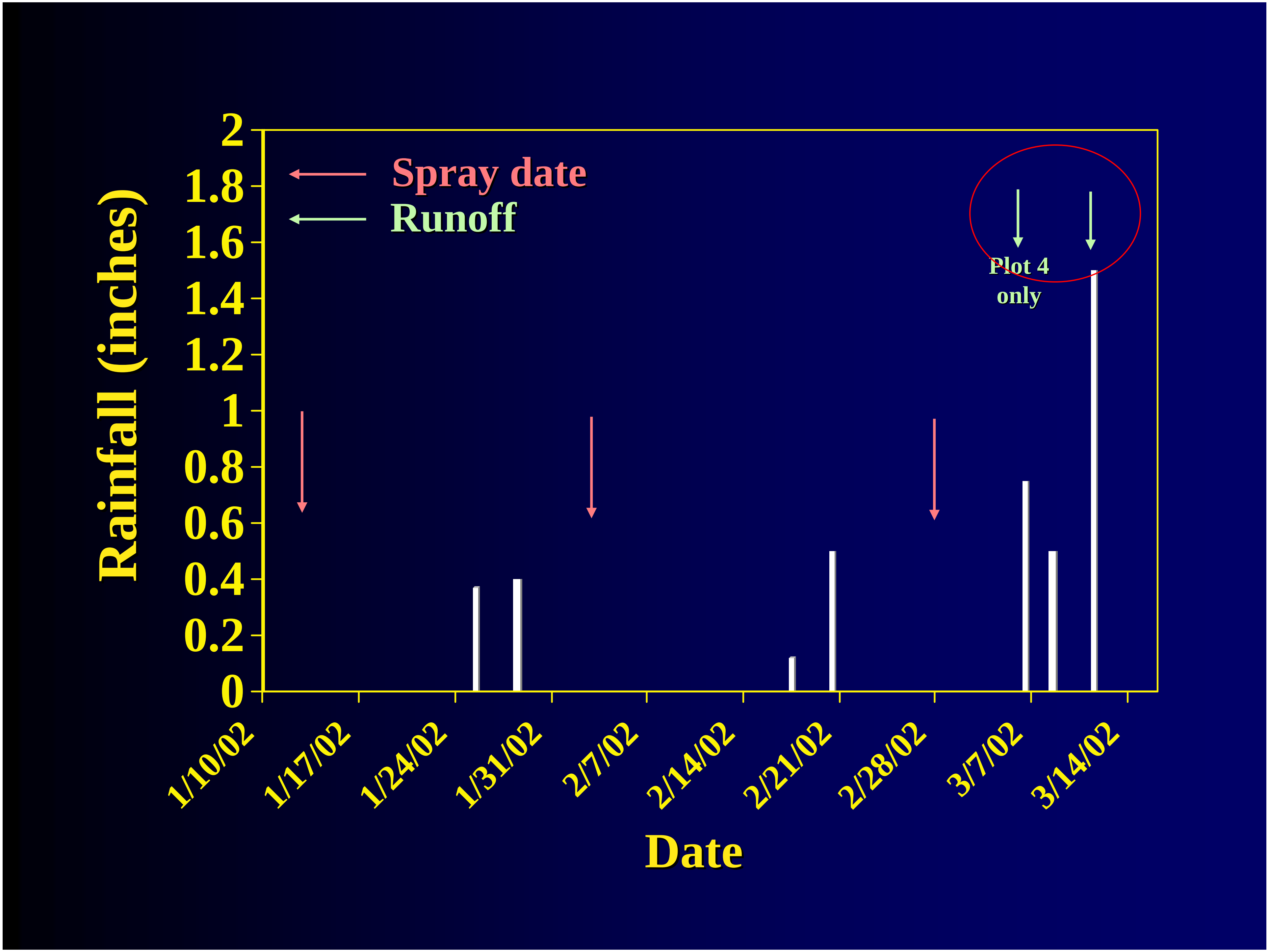
Assumptions -

- Drier soils late Fall and early Winter are more conducive to water infiltration.
- Storm events are more frequent in January and February, so there is less time between application and storm event for pesticide residues to decline naturally.

Study site - west of Yuba City/Marysville, CA




Diazinon - 4 lbs./ac. in 100 gal./ac.
Applied with commercial airblast sprayer
Treatment dates -
Jan. 12
Feb. 2
Feb. 22
3 replicates of 10 rows X 100 trees



Spray date
Runoff
Plot 4 only
Rainfall (inches)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/10/02
1/17/02
1/24/02
1/31/02
2/7/02
2/14/02
2/21/02
2/28/02
3/7/02
3/14/02
Date

Percent diazinon concentration in runoff samples from plots with different treatment timings, and associated NOEC and LOEC to *Ceriodaphnia dubia*.

Treatment	Plot	Date	Conc. ppb	NOEC*	LOEC*
Early**	3	3/11	3.12	<5.0	5.0
Early **	3	3/11	2.97	5.0	10.0
Early	6	3/11	5.57	<5.0	5.0
Early	9	3/11	2.72	10.0	20.0
Mid	2	3/11	9.44	2.5	5.0
Mid	5	3/11	13.47	2.5	5.0
Mid	8	----	----		
Late	1	3/11	32.02	0.625	1.25
Late	4	3/7	91.39	0.25	0.5
Late	4	3/11	34.91	0.625	1.25
Late	7	3/11	27.03	0.625	1.25

* NOEC = no effect concentration, LOEC = lowest effect concentration.

** These plots were within the same treatment replicate.

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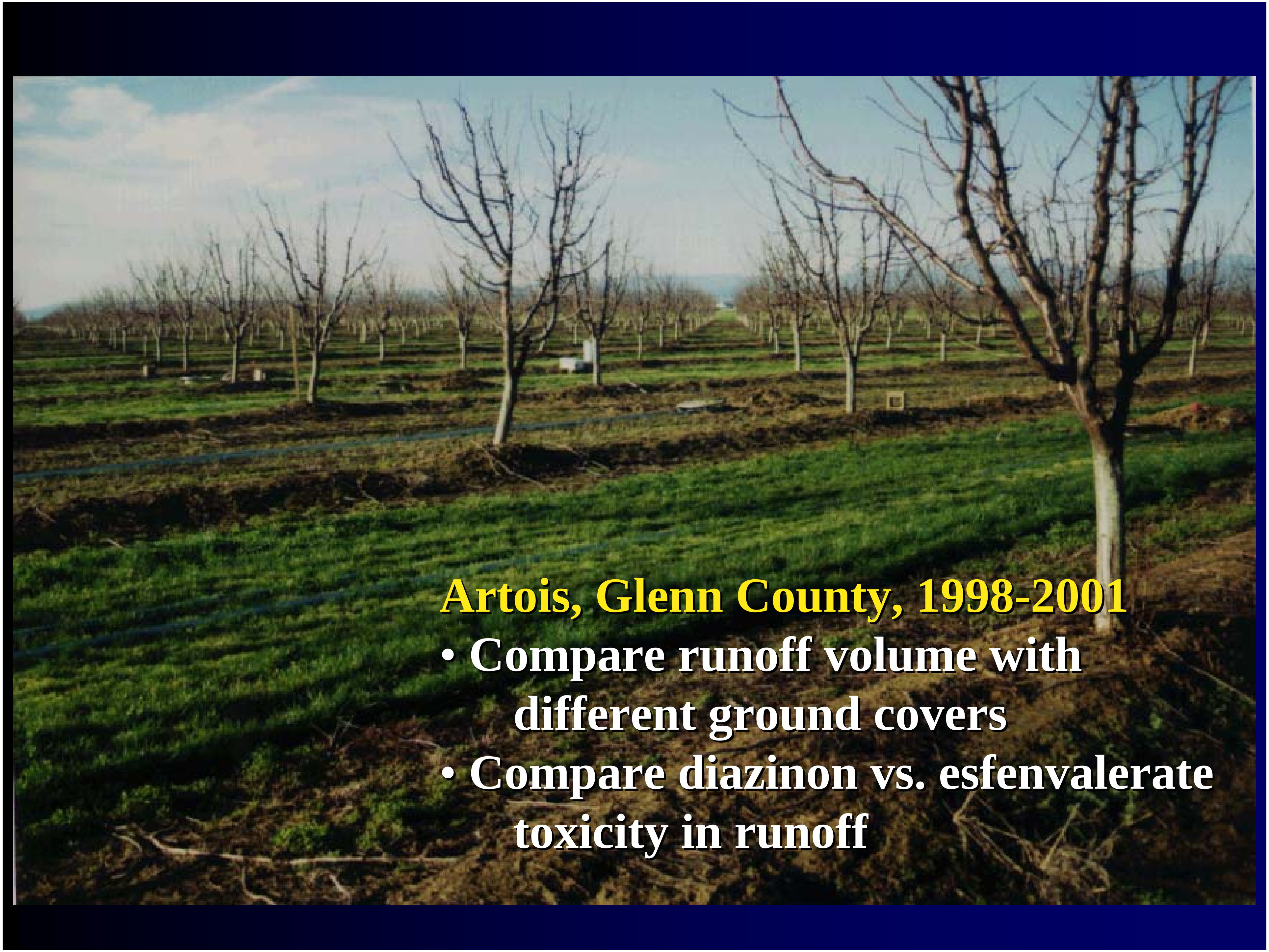
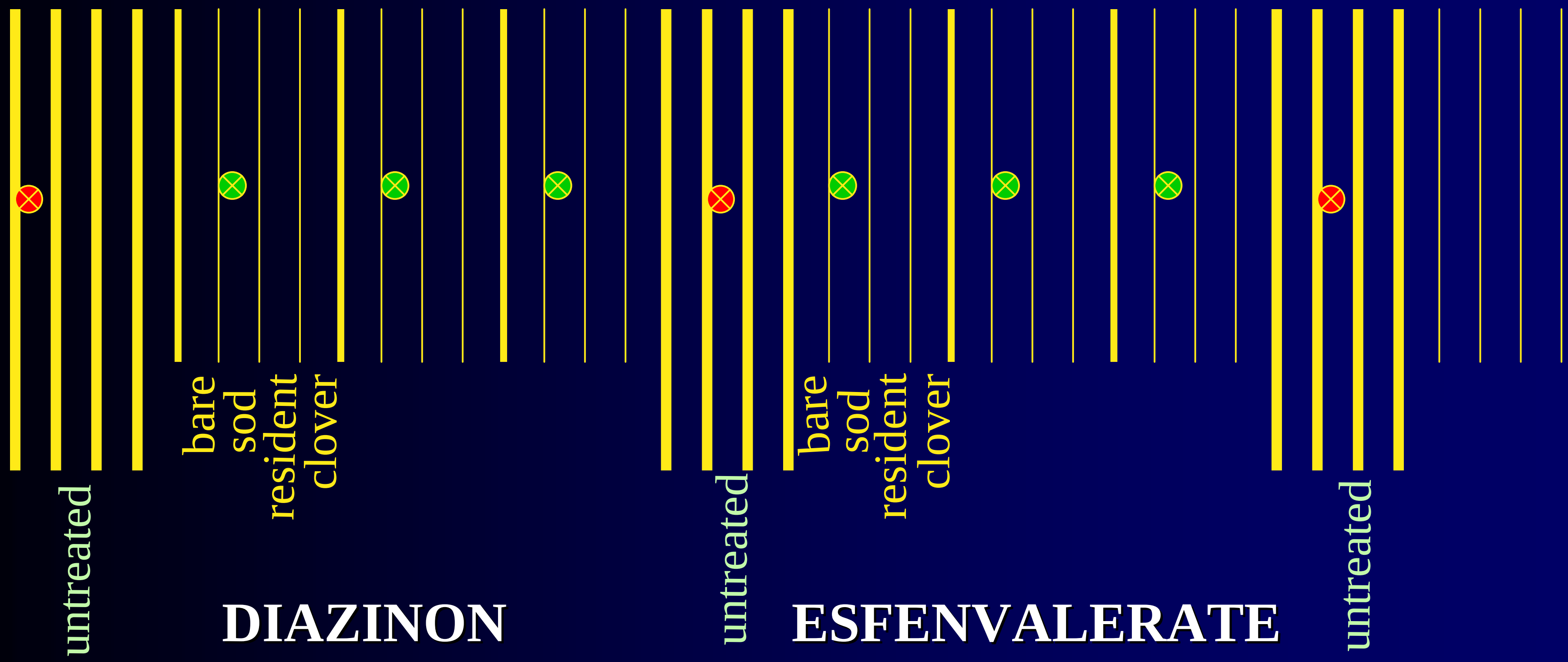

Artois, Glenn County, 1998-2001
• Compare runoff volume with different ground covers
• Compare diazinon vs. esfenvalerate toxicity in runoff

Ground Covers

Planted in Fall, 1998

Runoff and Orchard Floor Vegetation Study, Artois



Autosamplers - measures runoff volume and collects samples from organophosphate treated plots for bioassays and residue analysis.
Glass jars - collects samples of composite runoff from organophosphate and pyrethroid treated plots.

Runoff volume (l) from rows with different orchard ground covers, and runoff as percent of bare ground treatment, 2001 (n=3) .

Type of groundcover	Water runoff (l) and % of bare ground treatment						
	Total	1/25	1/26	1/29	2/18	2/20	2/23
Non-tillage clover	46056 (61%)	6137 (81%)	5298 (68%)	359 (143%)	255 a (16%)	1380 a (44%)	1924 a (41%)
Perennial sod mix	52769 (70%)	6528 (87%)	5664 (72%)	202 (80%)	763 a (47%)	1791 a (57%)	2643 a (56%)
Resident vegetation	46668 (62%)	5758 (76%)	5714 (73%)	328 (130%)	389 a (24%)	1466 a (46%)	1908 a (40%)
Bare ground	75474 (100%)	7535 (100%)	7846 (100%)	252 (100%)	1635 b (100%)	3156 b (100%)	4734 b (100%)
$LSD_{0.05}$[1]	NS	NS	NS	NS	730	1086	1540

[1] Means followed by the same letter are not significantly different by Fisher's Protected LSD at *P*<0.05.

Insecticide concentrations measured from runoff samples taken in rows with different orchard floor vegetation covers, and results of bioassays of runoff samples on *Pimephales promelas*[1] and *Ceriodaphnia dubia*[2], Artois. 2001.

	Concentration (µg/l)		Fathead minnow mean ± SE	Water flea % by volume	
Treatment	Diazin.	Esfenv.	mortality (%)	NOEC	LOEC
Lab Control (DIEPAMH)	nd	nd	0.0±0.0	--	--
Diazinon Bare Ground	210.4	nd	2.5±3.0	0.06	0.13
Diazinon Sod	135.9	nd	7.5±8.0	0.13	0.25
Diazinon Resident Veg.	155.2	nd	26.8±11.0	0.13	0.25
Diazinon Clover	118.2	nd	5.0±3.0	0.13	0.25
Esfenvalerate Bare Ground	3.6	nd	100.0±0.0	2.50	5.00
Esfenvalerate Sod	6.3	nd	100.0±0.0	2.50	5.00
Esfenvalerate Resident Veg.	3.9	nd	97.8±2.0	1.25	2.50
Esfenvalerate Clover	2.9	nd	93.0±4.0	5.00	10.00

[1] Source = Aquatox, Hot Springs, AK

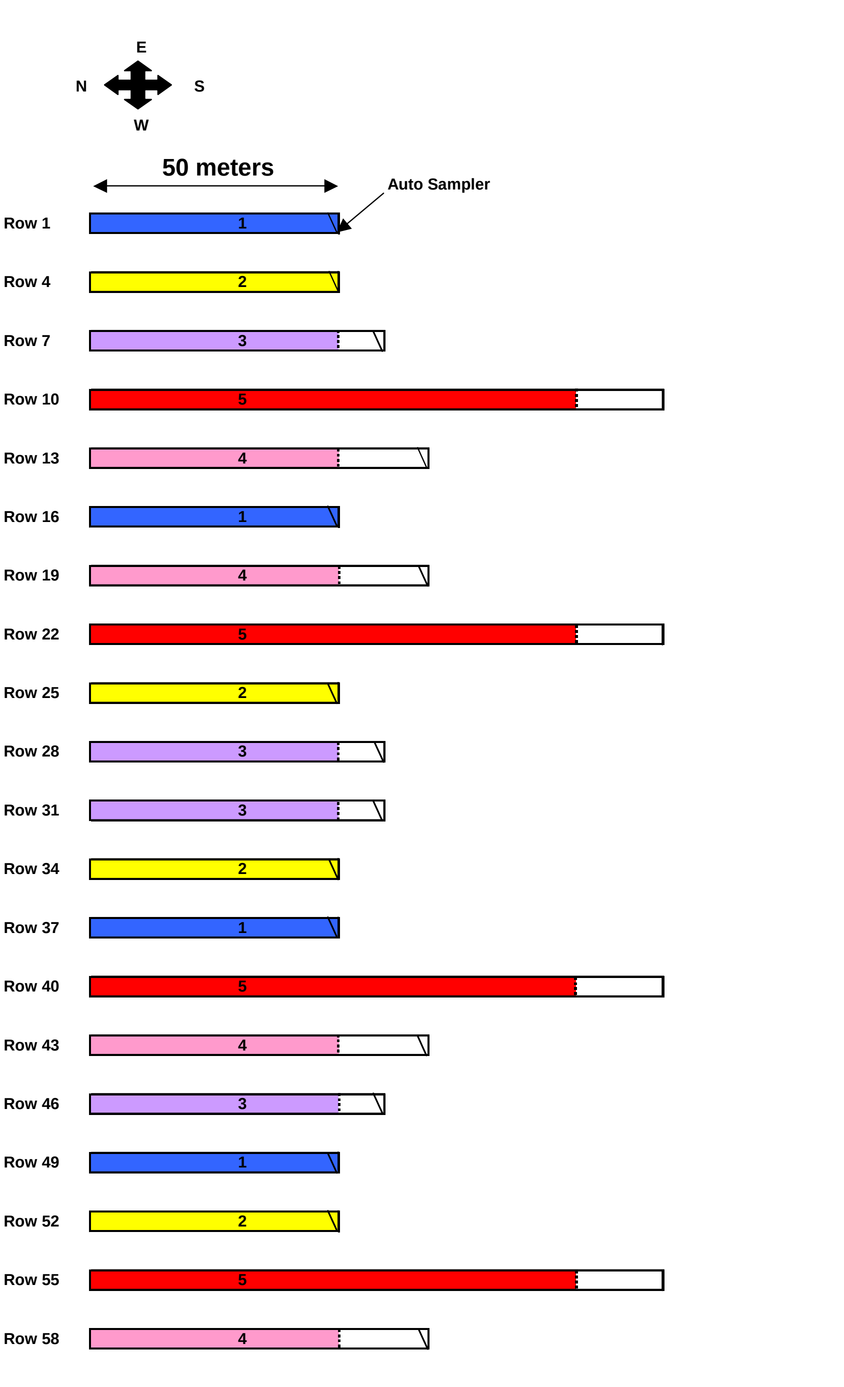
[2] Source = Aquatic Tox Lab, UC Davis

* Alternative site management practices

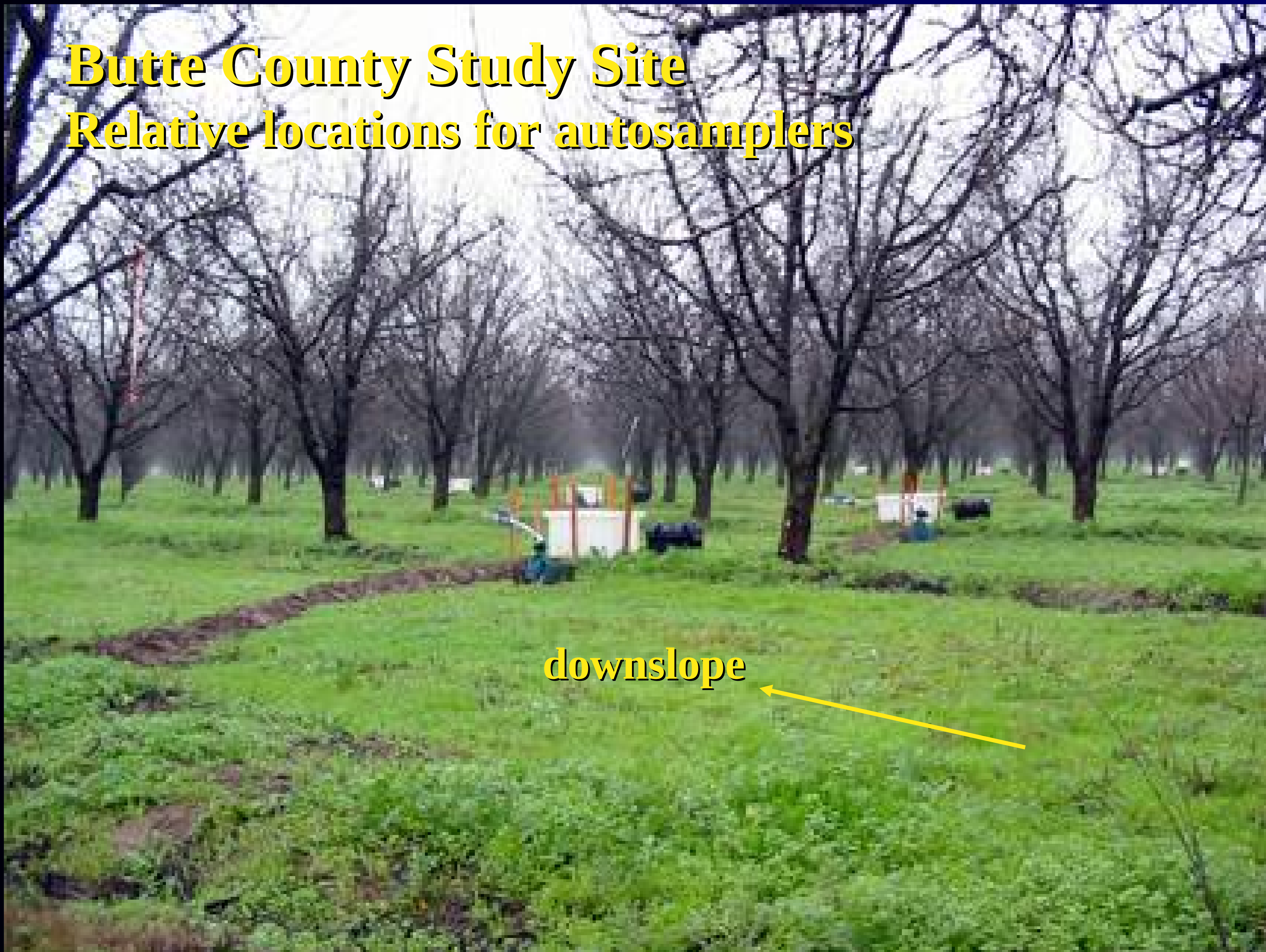
- Earlier treatment timing
- Orchard floor management
- Buffer strips ★
- Post treatment sprinkling★
- Berms/ catch basins

Buffer Strip Width and Post-application sprinkling, Plot Design

#	Treatments
1	50m treated/ no buffer
2	50m treated/ no buffer Post application sprinkling
3	50m treated/ 10m buffer
4	50m treated/ 20m buffer
5	50m treated/ 30m buffer
6	100m treated/ 20m buffer



Butte County Study Site
Relative locations for autosamplers



Artificial rainfall following application

Buffer Strip Width

Mean concentration (ppb) of diazinon in first 400 gal. of runoff and mean diazinon concentration of runoff from each treatment as a proportion of the no buffer control.

Treatment	Mean ± SE ppb [1]	Mean ± SE proportion [2]
No buffer	332.100 ± 99.641	1.000 ± 0.000
50 m + 10 m buffer	178.133 ± 101.309	0.470 ± 0.136 **
50 m + 20 m buffer	229.500 ± 129.907	0.500 ± 0.261 **
50 m + 30 m buffer	67.933 ± 13.763	0.273 ± 0.119 **
100 m + 20 m buffer	143.633 ± 99.151	0.373 ± 0.171 **

[1]ANOV results; $F=1.034$; $df=4,10$; $p=0.4364$

[2]ANOV results following arcsine transformation; $F=4.819$; $df=4,10$; $p=0.0200$;

** mean is significantly different from no buffer control at $p<0.05$ by pairwise t-test.

Post-application sprinkling

Mean concentration (ppb) of diazinon in first 400 gal. of runoff and mean diazinon concentration of runoff from each treatment as a proportion of the not sprinkled control.

Treatment	Mean $\pm$ SE ppb [1]	Mean $\pm$ SE proportion [2]
Not sprinkled	332.100 $\pm$ 99.641	1.000 $\pm$ 0.000
Sprinkled	250.500 $\pm$ 171.225	0.550 $\pm$ 0.226

[1]ANOV results; $F=0.170$; $df=1,4$; $p=0.7015$

[2]ANOV results following arcsin transformation; $F=3.982$; $df=1,4$; $p=0.1167$

Conclusion -

Implementation of integrated pest management practices together with alternative site management practices can significantly reduce the load of target pesticides leaving agricultural (and urban) areas.

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