Mitigation strategies for reducing aquatic toxicity from organophosphate pesticides in cole crops

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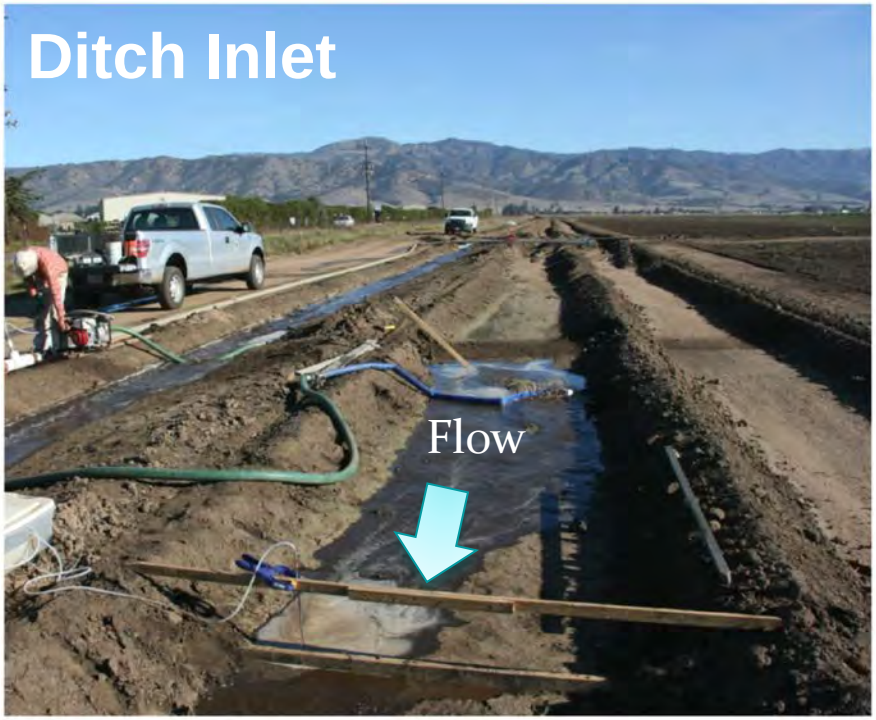
Background

- High pesticide loads in row crop runoff lead to 303(d) listings and TMDLs in central coast watersheds
- Chlorpyrifos targeted by Central Coast Regional Water Quality Control Board (listings are due to OPs and Pyrethroids)
- DPR, the Monterey County Agriculture Commissioner and other stakeholders are investigating different approaches to reduce chlorpyrifos in run-off (emphasis on broccoli)
- Current project funded by DPR to assess on-farm practices to treat runoff
- Regional Board toxicity target is <25 ng/L (~ ½ LC50 for *C. dubia*)

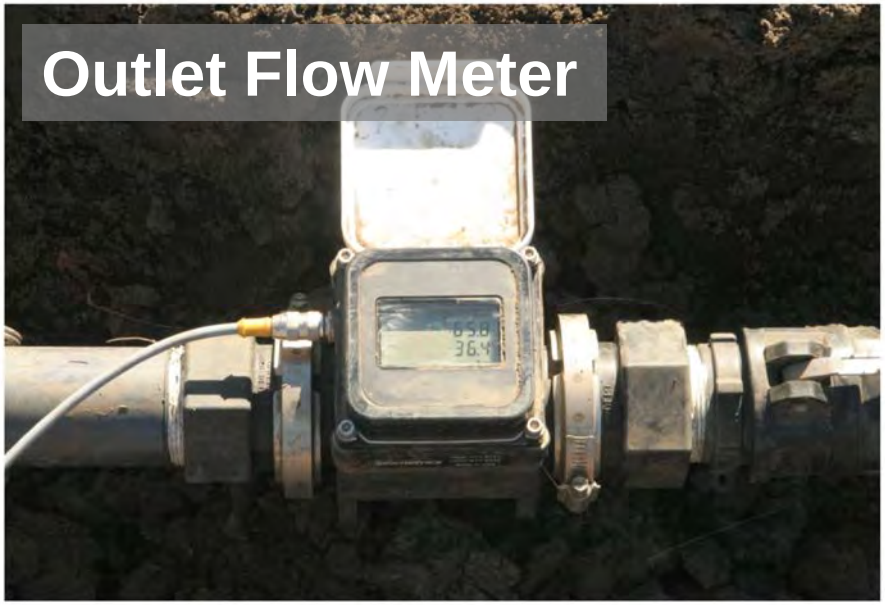
Approach

- Two Year study to assess the effectiveness of 3 treatments compared to a bare ditch: activated carbon, compost, and vegetation to reduce chlorpyrifos in simulated run-off.
- **Year 1 trials (2013)** designed to evaluate each treatment individually
  - 3 replications of bare ditch and each treatments in 300 foot ditches using simulated run-off with chlorpyrifos (~ 3 ppb chlorpyrifos at 30 gal/min)
- **Year 2 trials (2014)** designed to evaluate a combination of treatments in an integrated system
  - 3 replicates in 600 foot ditches at 2 flow rates: 50 gal/min & 100 gal/min

Run-Off Simulation


Ditch Inlet
Flow

Ditch Outlet


Outlet Flow Meter

Bare Ditch

Bare + Compost

Vegetated

Bare + Carbon

Results: Year 1

Bare Ditch	Carbon	Compost	Vegetation
Average Percent Chlorpyrifos Reduction			
19	96	25	82
Average Percent Infiltration			
31	73	67	48
Average Percent Load Reduction			
46	97	77	86
Average Percent TSS Reduction			
39	20	37	75
Toxicity Reduction?			
No	1 of 3	No	No

Integrated System: Carbon and Compost In a Vegetated Ditch

Results: Year 2

50 gal/min	100 gal/min
Average Percent Chlorpyrifos Reduction	
97	89
Average Percent Infiltration	
52	43
Average Percent Load Reduction	
98	94
Average Percent TSS Reduction	
80	82
Toxicity Reduction?	
2 of 3	1 of 3

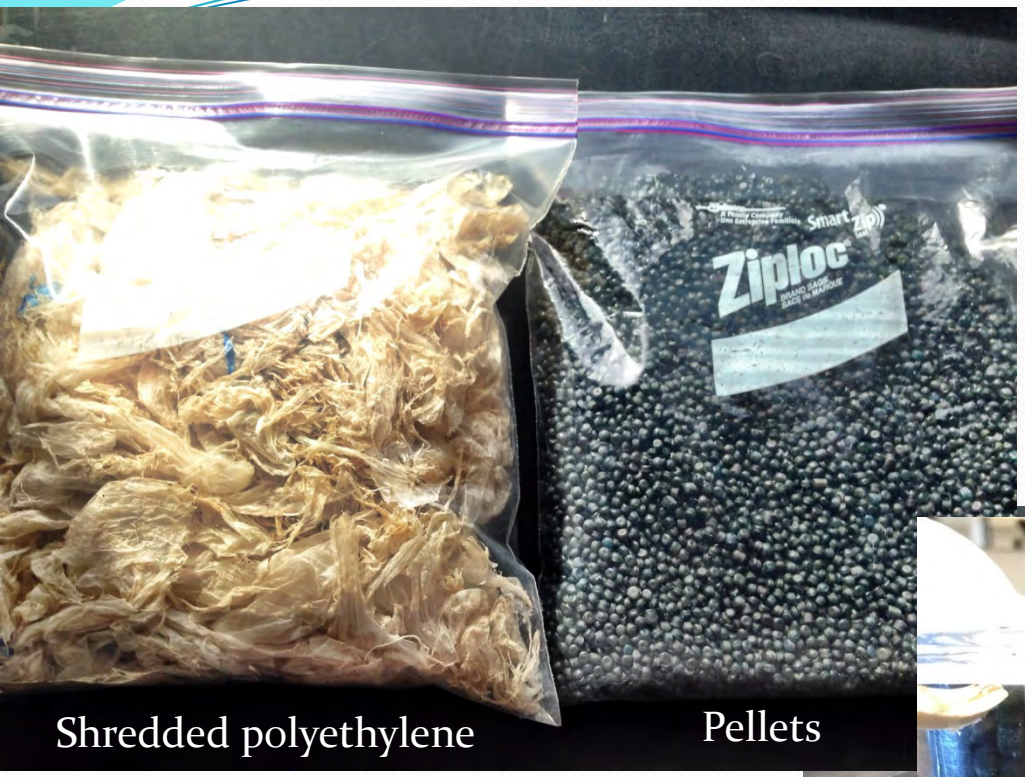
Summary

- Year 1
  - Carbon most effective at reducing chlorpyrifos concentration and load. Vegetation came in second place.
  - Carbon also eliminated toxicity in one of three samples.
  - Final chlorpyrifos concentrations after carbon treatment ranged from 59-92 ng/L (Regional Board target is <25 ng/L).
- Year 2
  - Input doses were generally lower
  - Integrated ditch performed better at lower flow rate
  - Eliminated toxicity in two of three samples at 50 gal/min
  - Final chlorpyrifos concentrations ranged from ND (<50 ng/L) to 82 ng/L

Recycled Plastic Trials –DPR

- Plastic sorbs organic chemicals (e.g., SPMDs; microplastics pollution)
- Recycled low density polyethylene from agriculture (thousands of tons per year in California)
- Alternative to vegetation to avoid food safety conflict
- Collaboration with Encore Plastics Salinas (Aviv Halimi)
- Laboratory bench scale trials confirm proof of concept
- 3 field trials in Fall 2014 - chlorpyrifos

Plastic: Lab Trials



- Shredded low density polyethylene from berry hoop houses (unfinished plastic = $0.10/lb)
- Pellets are finished product for resale ($0.40/lb)

- Bench top trials with chlorpyrifos and bifenthrin
- Pump rate equivalent to field scale flow of 30 gal/min
- 180 minute trials

Lab Results: It works!

	Percent Reduction	
Treatment	Chlorpyrifos	Bifenthrin
Pellets	77%	55%
Shredded	75%	64%

Field Trial #3

- 18 Filtrexx Socks filled with plastic pellets
- Approximate plastic cost $70

Field Results

Trial 1	Trail 2	Trial 3
Average Percent Chlorpyrifos Reduction		
42	25	60
Average Percent Infiltration		
62	29	9
Average Percent Load Reduction		
78	47	64
Toxicity Reduction?		
No	No	No

Future Work

- Evaluate the efficacy of an integrated vegetated ditch system for treating irrigation run-off on a real-world conventional farm.
- Evaluate the treatment effectiveness of biochar to remove pesticides from runoff.
- Evaluate performance of the integrated ditch system to treat an additional current-use pesticide.
- Conduct field trials to evaluate additional recycled plastic materials and optimize plastic deployment design.