CA Department of Pesticide Regulation
Environmental Monitoring Branch
Surface Water Protection Program
1001 I Street, Sacramento, CA 95814

Imidacloprid Detections in Agricultural and Urban Run-off in California

E. Kanawi, R. Budd, M. Ensminger, K. Starner, S. Gill and K. Goh

Introduction

Imidacloprid is a systemic neonicotinoid insecticide that is applied to crops and seeds, structures and landscapes, and on domestic pets to control a variety of insects. Imidacloprid mode of action is through the disruption of nicotinic acetylcholine receptors in the central nervous system of insects. Imidacloprid rapidly translocates in plant tissue and can be found in detectable concentrations in leaves, roots, pollen and nectar. Imidacloprid is toxic to invertebrates through contact or ingestion. During 2010, 188 imidacloprid products were registered for use in California; more than 90,000 kg of imidacloprid was applied to agricultural crops and over 50,000 kg was used for structural pest control and landscape maintenance (CDPR, 2011). Imidacloprid has a high water solubility (514ppm) and a moderate soil adsorption coefficient (K_{OC}=132-310). In addition, imidacloprid is moderately stable in water, with half lives via hydrolysis ranging between 33-44 days (pH 7, 25ºC), and aqueous photolysis less than 1 hour (pH 7, 24ºC). Imidacloprid has the potential to contaminate waterways in California because of its use, solubility in water and persistence in the environment. The US EPA has classified imidacloprid as highly toxic to aquatic invertebrate communities, raising concerns about the effects of imidacloprid in run-off from agricultural and urban sources. In 2010, the California Department of Pesticide Regulation Environmental Monitoring branch began the first state-wide monitoring program to evaluate the presence and concentrations of imidacloprid in California surface waters.

Objectives

1) Determine the frequency of detections of imidacloprid in agricultural and urban run-off from six regions in California (Table 1).
2) Compare the concentrations of imidacloprid in urban and agricultural runoff (Fig. 6).
3) Compare the frequency of detections and concentrations of imidacloprid in urban runoff during storm and non-storm events (Fig. 7).
4) Compare concentrations of imidacloprid detections with the US EPA aquatic invertebrate chronic toxicity benchmark (Fig. 3).

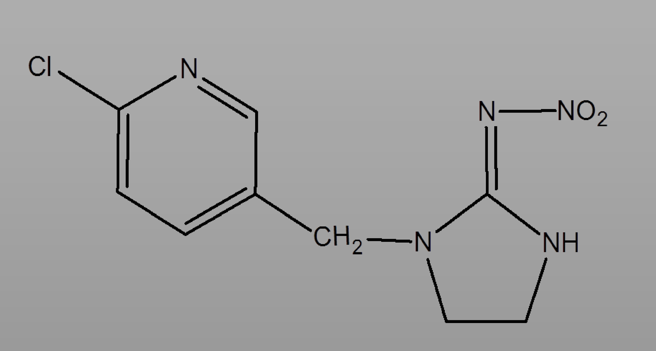

Figure 1: Chemical structure of imidacloprid

Figure 2: Kilograms of Imidacloprid AI used from 2000-2010 in California

Materials & Methods

- •75 samples were taken from three agricultural regions during high use periods (Table 1); Imperial Valley (IMP), Salinas Valley (SAL) and Santa Maria Valley (SM) (Fig. 8).
- •53 dry season and 47 storm event samples were collected in urban waterways (Table 1) in Sacramento County (SAC), Placer County (PLC) and Orange County (OC) (Fig. 8).
- •Samples were collected into1-L amber glass bottles. Bottles were sealed with Teflon-lined lids, transported on wet ice and stored at 4˚C until chemical analysis (CDPR 2011b).
- •Chemical analyses were performed by the California Department of Food and Agriculture's Center for Analytical Chemistry.
- •Statistical analysis was conducted using MiniTab®.

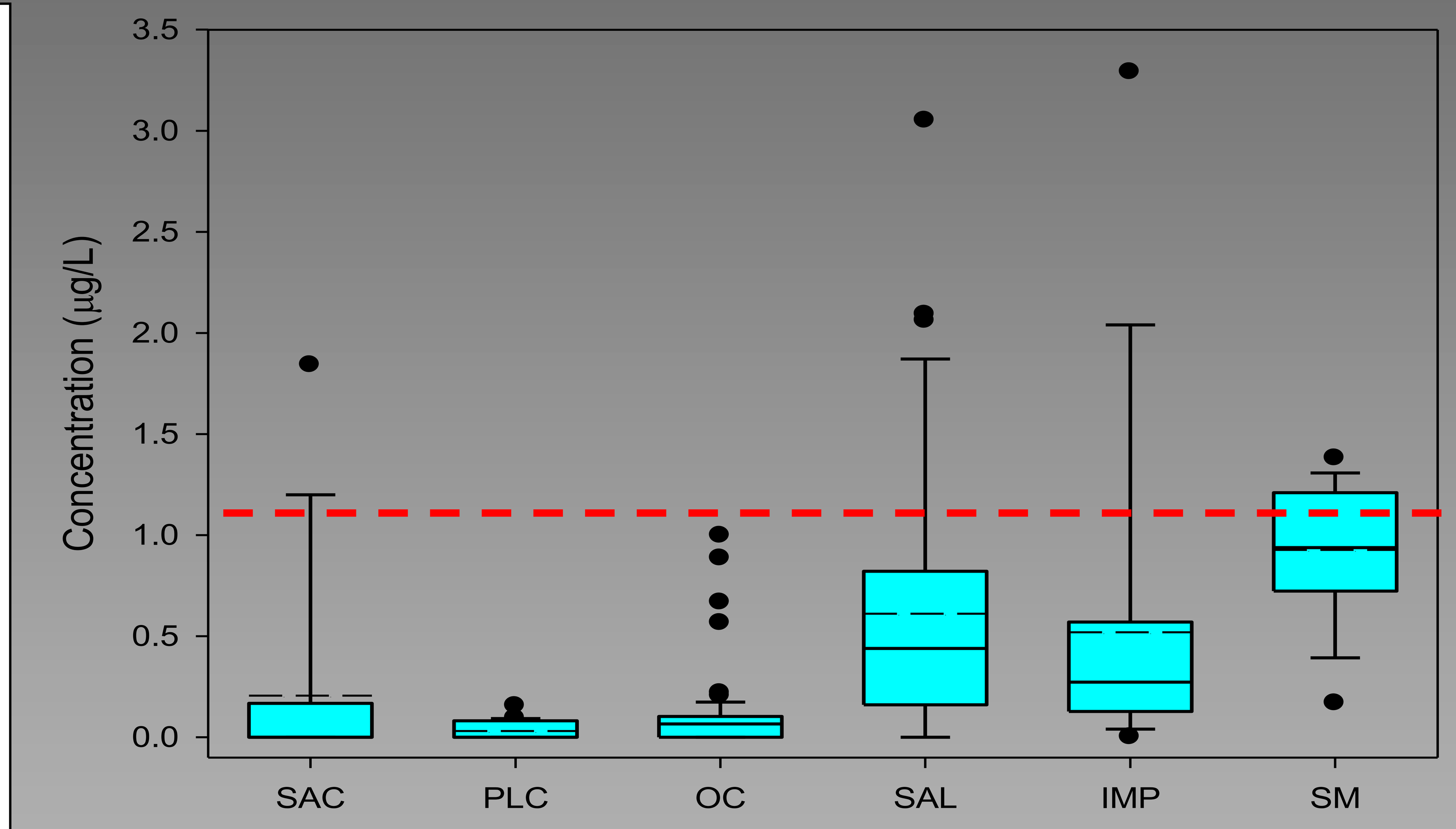

Figure 3: Measured Imidacloprid concentrations. Red dotted line indicates the US EPA's invertebrate chronic toxicity aquatic life benchmark of 1.05 ug/L

Results

Within agricultural regions imidacloprid was detected in 67 of 75 samples (89%, Table 1); the frequency of detection was highest in the Santa Maria Valley with detections found in all 15 samples (100%, Table 1). Imperial Valley and Salinas Valley had 93% and 85% detection frequencies, respectively (Table 1) . Mean concentrations in agricultural regions ranged from 0.52-0.93 µg/L (Table 1). Concentrations exceeded the US EPA's invertebrate chronic toxicity aquatic life benchmark of 1.05 µg/L in 14 samples (19%, Fig. 3). Within urban regions imidacloprid was detected in 55 of 100 samples (55%, Table 1), with only a single sample exceeding the aquatic life benchmark (Fig. 3). Orange County had the highest frequency of detections of urban samples with 26 of 37 samples (67%, Table 1) concentrations of imidacloprid. Placer County and Sacramento County had 35% and 29% (Table 1) frequency of detections, respectively. Mean concentrations in urban regions ranged from 0.03-0.20 µg/L (Table 1). Concentrations of imidacloprid were significantly higher (p<0.001, Fig. 6) in agricultural areas than urban watersheds. However, no significant difference was found between storm and non-storm events within urban samples (Fig. 7).

Table 1: Frequency of detection and concentrations of imidacloprid.

Region	Land Use	Sample Sites	N	Detection Frequency	Max Conc.	Mean	Median
State	-	48	175	70%	3.29	0.34	0.10
Orange	Urban	9	66	67%	1.00	0.10	0.07
Placer	Urban	11	20	35%	0.16	0.03	N.D.
Sacramento	Urban	5	14	29%	1.84	0.21	N.D.
Imperial	Ag	9	14	93%	3.29	0.52	0.27
Salinas	Ag	10	46	85%	3.05	0.61	0.44
Santa Maria	Ag	4	15	100%	1.38	0.93	0.94

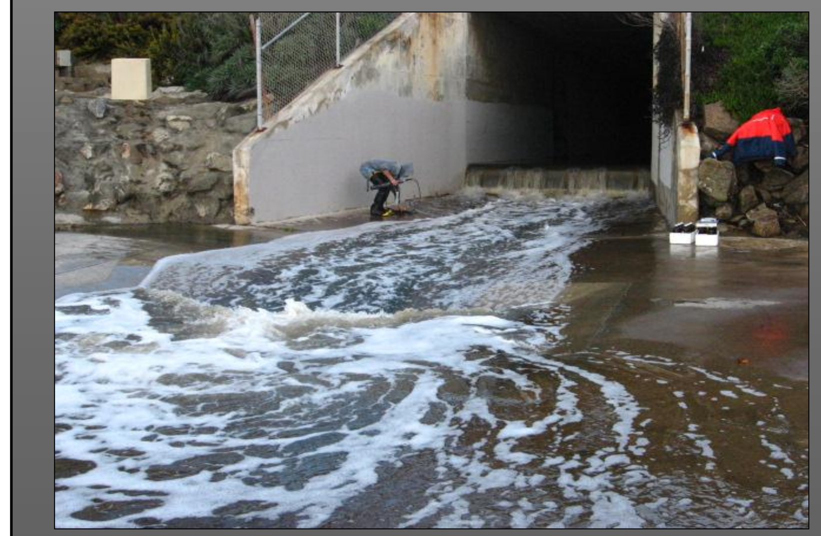

Figure 4: Urban run-off sampling site Salt Creek Watershed, Orange

Figure 5: Agricultural run-off sampling site: Orcutt, Santa Maria

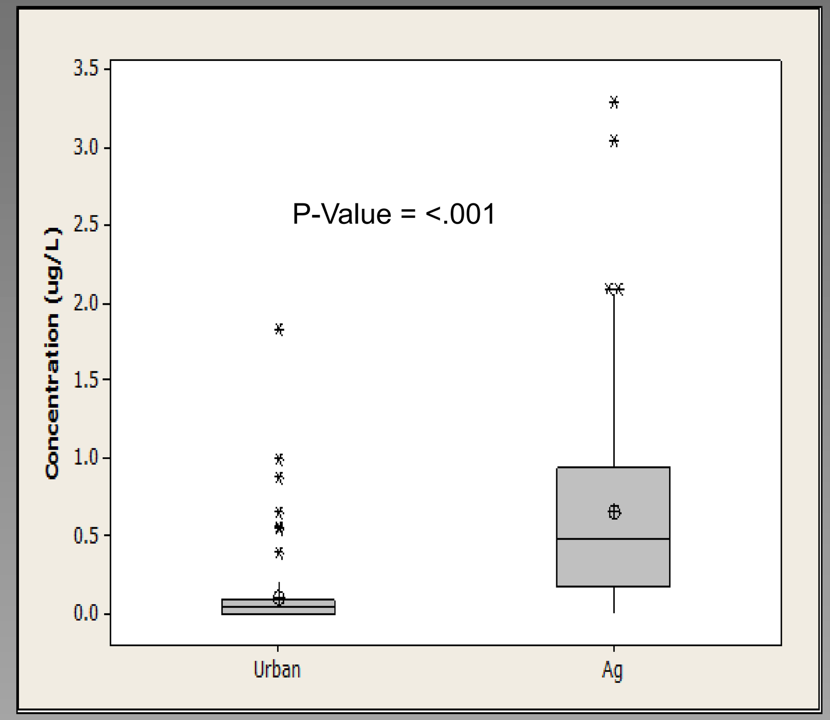

Figure 6: Box plots of imidacloprid concentrations in Urban vs. Ag setting.

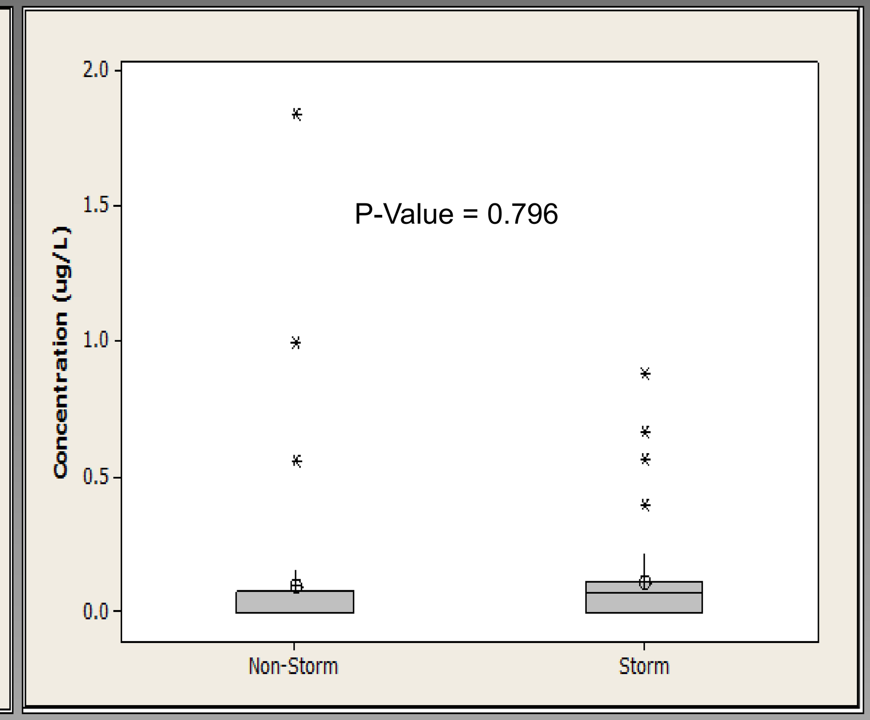

Figure 7: Box plot comparing imidacloprid detections in urban areas during storm and non-storm events.

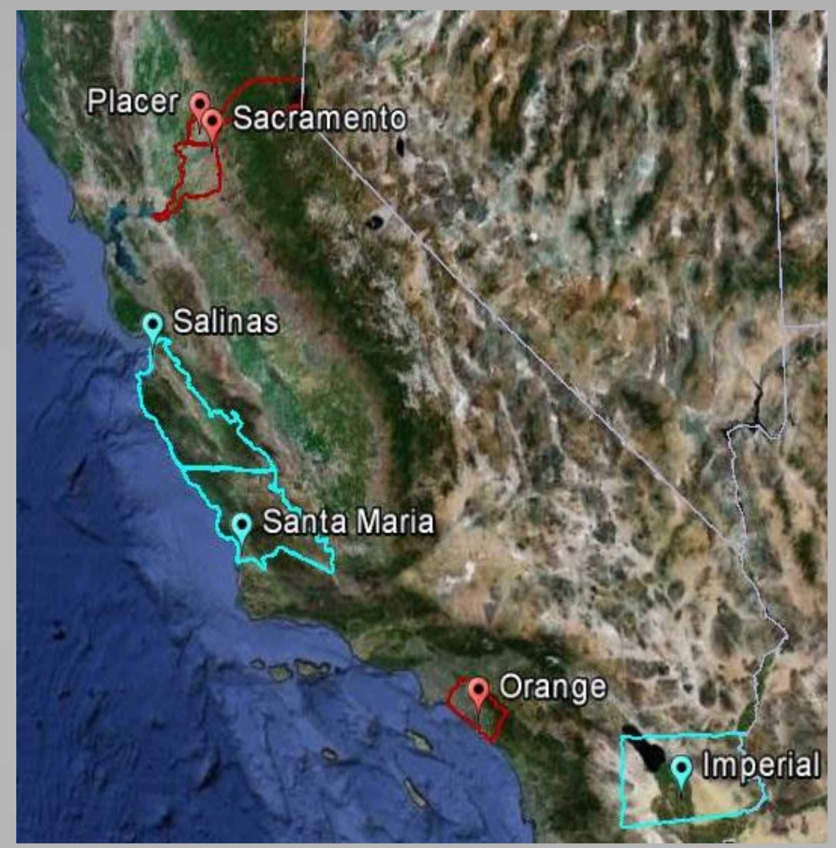

Figure 8: Google Earth map of California with sampling sites

Urban Regions

Agricultural Regions

Conclusions

- •Imidacloprid was found in detectable concentrations in all regions sampled. The frequency of detection was higher in agricultural regions (89%) than in urban regions (55%).
- •Concentrations of imidacloprid found in agricultural runoff were significantly higher than concentrations found in urban runoff (p<.001, Fig. 6).
- •Concentrations of imidacloprid were not significantly different in urban runoff collected during storm events compared to dry season samples (Fig. 7).
- • 14 of 75 agricultural samples (19%) and 1 of 100 urban samples (1%) exceeded the US EPA invertebrate chronic toxicity aquatic life benchmark of 1.05 µg/L (Fig. 3).

References

•CDPR. 2011. California Department of Regulation. California Pesticide Information Portal (CalPIP), Pesticide Use Report (PUR) Data Available at http://calpip.cdpr.ca.gov/cfdocs/calpip/prod/main.cfm (accessed on 25 January 2012.

•CDPR. 2011b. Surface water protocols: Study 269, 270, and 271. Accessed at http://www.cdpr.ca.gov/docs/emon/surfwtr/protocol.htm April 1, 2012.

Acknowledgements:

The authors would like to thank Kevin Kelly, Darren Haver, and the Surface Water Monitoring team for assistance in sample collection. Jesse Ybarra for his support in logistics, and Sue Peoples for her lab coordination.

Poster by Emerson Kanawi Ekanawi@cdpr.ca.gov 916-324-4136