



Better ways to monitor pesticides in drainage systems

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in a rice hull

- Monitoring drainage systems for pesticide contamination is required for irrigation companies to comply with their drainage licences
- Results of this monitoring will affect the future availability of pesticides to farmers
- Alternatives to chemical analysis for the initial screening of samples may reduce the costs of monitoring, and also help determine whether current environmental guidelines accurately reflect the biological impact of particular pesticides

Responsible use of agrochemicals in rice production involves protecting the environment by following guidelines to prevent the release of pesticides into drainage systems. Retaining treated water on farm, either in fields or recirculation dams, helps minimise the non-target effects of pesticides.

Monitoring of drainage systems is required to determine the effectiveness of current pesticide use guidelines, and it is also a condition of the drainage licences held by irrigation companies. Current pesticide monitoring programs are based on chemical analysis of water samples using laboratory instruments. Whilst effective, these techniques have limitations for routine analysis. Chemical analysis is expensive, and the pesticides that can be detected are dictated by the analysis systems being used – the more comprehensive the analysis, the more additional techniques that need to be used, and the greater the cost. In addition, chemical analysis cannot quantify the significance of synergism, where two or more pesticides that would be relatively benign individually combine to produce a significant effect on aquatic life.

This project looks at different methods for assessing contamination of drainage systems that could be used to screen samples before going to the next step of chemical analysis. These approaches test the effects of samples on living organisms and include bioassays of potentially contaminated sediments using midge larvae, the use of ELISA tests for detecting chemicals in water, and the use of enzyme suppression in midge larvae as an indicator of chemical contamination. Results from these techniques will be correlated back to chemical analysis data to determine what approaches may be the most meaningful and cost-effective for regulatory agencies.

Midge bioassays

Working with sediments, rather than water samples, offers several advantages in environmental assessment. Pesticides

with low solubility often bond strongly to sediments and persist longer than they do in the overlying water. Sediments can therefore reflect contamination history over a longer time frame than water samples, which are more of a 'snapshot' of current conditions. Midge larvae are often very susceptible to pesticides, and bioassays with midge larvae are used in many countries to assess sediment health. The procedure involves collecting sediment samples from the field using a soil corer (Figure 1), and then rearing midges from eggs through to adulthood in the laboratory, using the sediment as a substrate (Figure 2).



Figure 1: PVC soil corer used for collecting sediment samples. Holes on the side let excess water drain away, whilst the green plastic disc ensures samples are taken to a uniform depth.



Midge survival and development time are used to determine whether there is any evidence of pesticide contamination. Midge bioassays capture any synergistic interactions between pesticides, but there are some drawbacks – highly soluble pesticides do not bond as readily to sediments, and the midges may not respond to very low concentrations of some pesticides, even when the concentrations are well above current environmental protection limits. Initial work in this project has focussed on refining aspects of the bioassay protocol, such as optimising feeding rates.

ELISA testing

ELISA (enzyme-linked immunosorbent assay) is a kit-based testing method that measures the concentration of chemicals using an antibody reaction. Higher pesticide concentrations result in lower light absorbance by the treated sample.

ELISA is currently being used to measure molinate concentrations in drainage water, but the kit being used is specific for this herbicide only. In some situations false positives and false negatives have been known to occur, caused by variation in the pH or other chemical properties of field water samples.


ELISA validation in spiked water samples has been conducted using the molinate kits, with a view to conducting further investigations with kits specific to other pesticides that may have more widespread use in the future. Irrigation company monitoring using ELISA kits has often led to a slight overestimation of molinate concentrations when compared with laboratory confirmation testing, and this could have

implications when responding to regulatory action levels. This overestimation also occurred when we analysed field-collected water samples spiked with Ordram® – spiked sample calibrations fell below the ELISA kit standard solution calibration line (Figure 3). Water samples with higher levels of salinity and turbidity (sites 204, 208 and CODA) deviated furthest from the standard calibration.

Enzyme inhibition

Acetylcholinesterase (AChE) is an enzyme that is important for nerve signal transmission in invertebrates, and pesticides such as chlorpyrifos and thiobencarb are toxic to invertebrates because they irreversibly inhibit AChE.

By measuring AChE in invertebrates exposed to pesticides, and comparing levels to those in unexposed individuals, it is possible to detect very low levels of pesticide contamination. Chlorpyrifos is a particularly potent AChE inhibitor, and studies with the freshwater shrimp *Paratya australiensis* have shown that chlorpyrifos levels as low as 0.01 µg per litre can be detected – that's just 0.00000001 grams per litre.

Midge larvae are more suitable for the large-scale application of AChE testing, and baseline data for *Chironomus tepperi* is currently being gathered. 

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Figure 2: Replicated midge bioassays take place under controlled conditions using field-collected sediment samples.

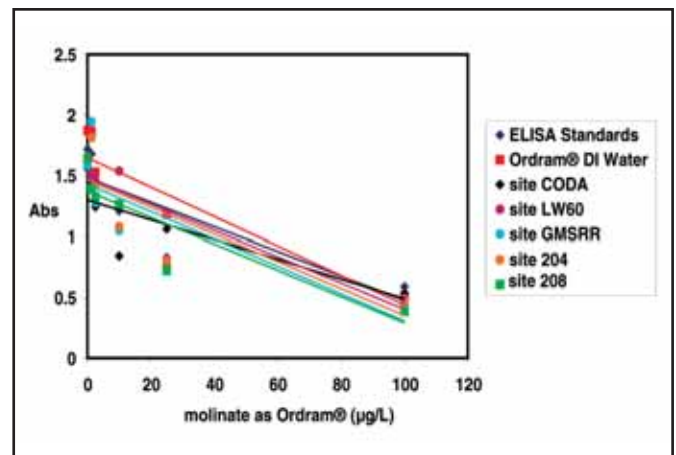


Figure 3: Calibration curves for ELISA standard solutions and spiked field samples collected from across the CIA and MIA.