The chronic effects of pesticides and their persistence in tropical waters

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RELEVANCE OF WORK

Risk = f: \[ \text{Exposure (concentration ; duration)} \] ; \[ \text{Toxicity (to relevant species)} \]

- Concentration in river mouths
- Dilution and dispersal
- Persistence
- Proportion bound to sediments

Foundation species
- Seagrass
- Corals
- Mangroves
- Algae

Contribute to:
- cumulative risk models
- pollution targets
- policy development to protect the GBR from the effects of pollution and climate change
RESULTS: PERSISTENCE

Up to 8 herbicides tested in 12 month experiments

Experiment 1:  *Standard flask*
Filtered water
Dark

Experiment 2:  *Standard flask*
Unfiltered water
2 temperatures
Light and dark

Experiment 3:  *Outdoor pond*
Unfiltered water
± Sediments
Light and dark
RESULTS: PERSISTENCE

Estimated half life = 315 days

- Processing continues
- The majority of herbicides detected in the GBR have very long half lives of 120+ days in tropical seawater.

Example results

Preliminary half-lives for common herbicides in pond experiments

**NOTE:** These data are taken from only two time points and may change significantly once all the data has been analysed.

<table>
<thead>
<tr>
<th></th>
<th>Diuron</th>
<th>Atrazine</th>
<th>Hexazinone</th>
<th>Tebuthiuron</th>
<th>2,4-D</th>
<th>Metolachlor</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Sediment</td>
<td>300</td>
<td>270</td>
<td>690</td>
<td>1160</td>
<td>690</td>
<td>70</td>
</tr>
<tr>
<td>Sediment</td>
<td>120</td>
<td>120</td>
<td>260</td>
<td>530</td>
<td>190</td>
<td>20</td>
</tr>
</tbody>
</table>
RESULTS: SEAGRASS

- How rapidly PSII herbicides affect seagrass (**complete**)
- Effects of herbicides on seagrass (72 h) – Diuron, Atrazine, Hexazinone, Tebuthiuron (**complete**)
- Chronic effects of herbicides on seagrass (**underway**)
72 h exposure laboratory experiments

- Two seagrass species were shown to be as sensitive as corals and algae to four priority herbicides found in the GBR.
- Diuron affects photosynthesis at flood plume concentrations

<table>
<thead>
<tr>
<th>Species</th>
<th>IC$_{50}$ (µg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green algae</td>
<td>2.1</td>
</tr>
<tr>
<td>Halodule</td>
<td>2.4</td>
</tr>
<tr>
<td>Zostera</td>
<td>2.5</td>
</tr>
<tr>
<td>Diatom</td>
<td>2.6</td>
</tr>
<tr>
<td>Coral (zooxanthellae)</td>
<td>2.9</td>
</tr>
<tr>
<td>Foraminifera</td>
<td>2.9 - 20</td>
</tr>
<tr>
<td>Crustose algae</td>
<td>8.5</td>
</tr>
</tbody>
</table>
APPLICATION OF WORK

Direct communication with Key Stakeholders (IG and direct)

- DSEWPaC: Chem. Assessment Section
- APVMA: Reviews + Adverse Experience Reporting
- GBRMPA: WQ guidelines, cumulative impacts, exposure maps
- Canefarmers and WWF

Pesticides working group formed (Meetings: Sep 2012, April 2013)

Fostering communication between researchers, regulators, managers, industry and NGOs. (AIMS, JCU, UQ, UTS, CSIRO, DERM, GBRMPA, SEWPaC, APVMA, Terrain, SRDC, WWF, Davco Farming, BSES, DAFF, Farmacist, NQ Dry Tropics and more..)

- Science updates
- Presentations by SEWPaC, APVMA and more
- Communication and extension
- Emerging issues & chemicals
- Minutes are available – email Michelle Devlin or myself

Incorporation of results into Risk Assessment process for the Reef Plan Scientific Consensus Statement
FUTURE DIRECTIONS

- Long-term effects of herbicides on seagrass growth
  - Test combined effects of herbicides with low light or high temperatures
- Analyse all persistence samples
  - Commence tests on toxicity of herbicide breakdown products
- Continue to integrate the current data into risk assessments
- Work with SEWPaC towards standard toxicity tests relevant to the GBR
THANK YOU

Team: Phil Mercurio (UQ-AIMS)
      Florita Flores (AIMS)
      Catherine Collier (JCU)
      Jochen Mueller (UQ)

RRRC: esp. Michelle Devlin

JCU Partners: Jon Brodie
              Steve Lewis

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