Developing a DGT Methodology to Assess Bioavailability of Soil Herbicide Residues

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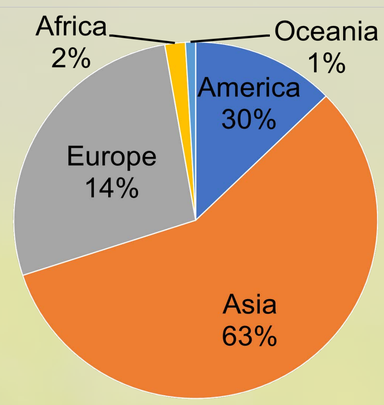
Background

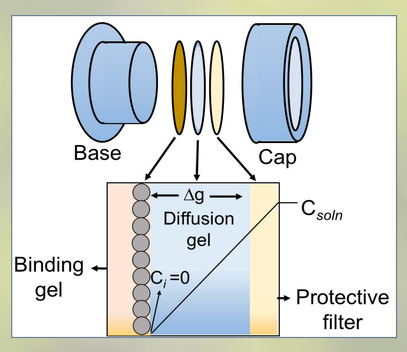
- Global pesticide use in agriculture is 2.7 million tons (41-52% herbicides) with a per capita consumption of 0.37 kg per person per year.
- In 2020, Australia used 63,416 tons of pesticides (of which 44,000 tons were herbicides).
- Repeated and off-label use of herbicides could cause pesticide-induced crop injury and yield loss.
- Analysis methods based on water or exhaustive solvent extraction do not mimic plant available soil herbicide concentrations.
- A method to assess bioavailable soil herbicide concentration is needed to establish an accurate dose-phytotoxicity relationship.



Global pesticide use

Diffusive Gradients in Thin Films (DGT) Methodology

- DGT is an in situ passive sampling technique.
- DGT predicts the bioavailability of solutes by concentrating them into a binding matrix through diffusion (mimicking biological uptake).



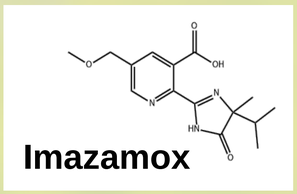
Components of DGT

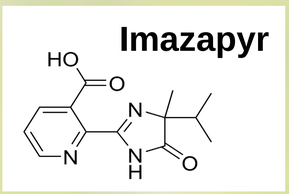
The concentration measured by DGT:

$$C_{DGT} = \frac{M \times \Delta g}{D \times A \times T}$$

M – Mass of herbicide in binding gel
Δg– Diffusion + protection layer thickness
D – Diffusion coefficient
A – Exposed area
T – Deployment period

Target Herbicides

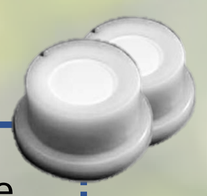




Properties of target herbicides

	M.W. (g/mol)	pKa	Water solubility (g/L)	Soil half-life (days)
Imazamox	305.34	2.3	626	>120
Imazapyr	261.28	1.9	11.27	30-210

Project Plan



1. DGT preparation

a) Selection of binding phase
b) Preparation of binding and diffusion gels
c) Kinetics of herbicide binding to the binding gel discs
d) Elution conditions and elution efficiency
e) Boundary conditions and competition effects

2. Soil incubation experiments

DGT + Soils + herbicides

DGT efficiency in different soils

3. Plant phytotoxicity bioassay

DGT + Soils + herbicides + Crop

Dose-response analysis

4. In-field validation of DGT

Project Progress

- A review of relevant literature has been completed and the PhD candidature has been confirmed.
- A triple quadrupole mass spectrometer coupled with a high-performance liquid chromatography method has been developed for quantifying the target herbicides with a detection limit of 0.1 µg/L.
- Two promising binding agents have been identified based on their high adsorption affinities for both the target herbicides.
- Binding gel preparation using the selected binding agents is being optimised.
- Efficiency of binding gels for herbicide adsorption and elution is being investigated.

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