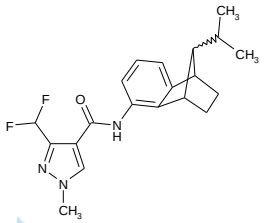
The Behaviour of Isopyrazam in Aquatic Ecosystems - Implementation of a Tiered Investigation

Laurence H Hand and Robin G Oliver, Product Metabolism, Syngenta, Jealott's Hill International Research Centre, Bracknell, Berkshire, RG42 6EY, UK

Introduction

A tiered approach to investigation of the behaviour of Crop Protection Products (CPPs) in aquatic ecosystems was proposed at the 10th AGRO conference in 2008[1]. This approach encompassed studies which followed regulatory guidelines (e.g. OECD) to investigate the role of different basic degradative processes in isolation in the first tier. This was followed by more complex laboratory studies to investigate the role of additional degradative processes, which are not routinely included in regulatory submissions and, finally, with the conduct of a semi-field study designed to investigate the role of each of these processes in a more realistic integrated system under natural environmental conditions. Data has been generated, in each of these tiers, for the new Syngenta fungicide, Isopyrazam. These data serve as an exemplar of how such a tiered approach may be implemented to understand the fate of a CPP in aquatic ecosystems.



The Tiered Approach

Tier 1
Basic Processes
- Hydrolysis
- Direct Photolysis
- Water/Sediment (Dark)

Tier 2
Integrated laboratory studies
- Water/Sediment under UV Light
- Indirect Photolysis

Tier 3
Contribution of Biota
- Degradation by Algae and Macrophytes

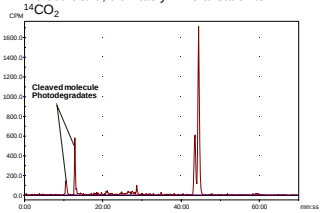
Tier 4
Integrated System
- e.g. Outdoor Water/Sediment

Hydrolysis

- Incubated for 5 days at pH 4, 7 and 9 and 50°C
- No significant degradation observed at any pH at this elevated temperature

Direct Photolysis

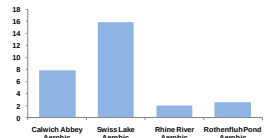
- Some degradation was observed
- DT_{50} for degradation was relatively slow (ca. 60 days natural summer sunlight at 30-50°N).
- Degradation resulted in cleavage of the molecule and, ultimately mineralisation to $^{14}CO_2$



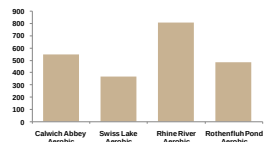
Radiochromatogram following 29 days continuous irradiation

Aerobic/Anaerobic Aquatic Metabolism

- Data generated for 4 water-sediment systems
- Rapid dissipation from the water column to the sediment
- No significant degradation in the sediment thereafter



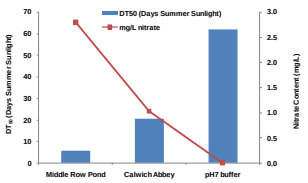
Water Column Dissipation Rates (DT_{50} in days)



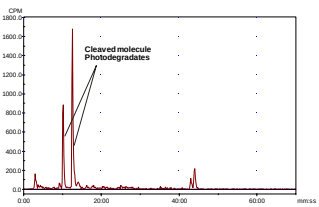
Total System Degradation Rates (DT_{50} in days)

Indirect Photolysis

- Significantly faster degradation in natural water
- DT_{50} for degradation up to one order of magnitude faster than direct photolysis
- Degradation rate proportional to nitrate concentration



- Route of degradation identical to that of direct photolysis



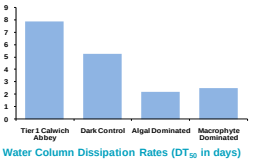
Radiochromatogram following 25 days continuous irradiation

Degradation by Algae and Macrophytes

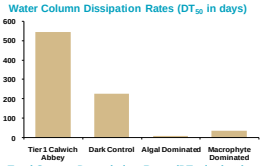
- Based on Tier 1 Aquatic Metabolism Study
- Conducted in Calwich Abbey sediment and water
- Incubated in light/dark cycle
- Visible light only to exclude photolysis
- Systems also incubated in dark as control

Control Test System | Algal Test System | Macrophyte Test System

- Degradation significantly faster in systems containing algae and macrophytes

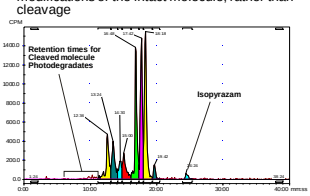


Water Column Dissipation Rates (DT_{50} in days)

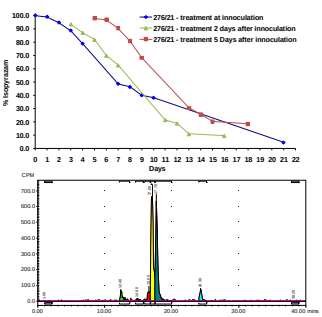


Total System Degradation Rates (DT_{50} in days)

- Route of degradation was primarily through minor modifications of the intact molecule, rather than cleavage



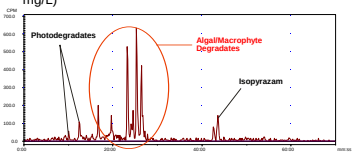
- Similar degradation observed in axenic cultures of *Scenedesmus quadricauda*



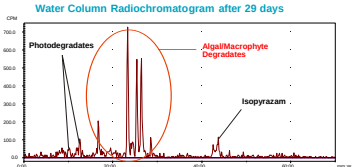
Degradation in an Aquatic Microcosm

- Integrated outdoor study to investigate contributions of microbial, photolytic and algal/macrophyte degradation under more realistic conditions
- Conducted in Calwich Abbey sediment and water

- Samples of water, sediment and macrophytes analysed for parent and metabolites
- Metabolite profile in water and sediment extracts suggests that degradation is primarily mediated by presence of macrophytes and algae and that photolysis is limited.
- Nitrate level in microcosm extremely low (< 0.1 mg/L)

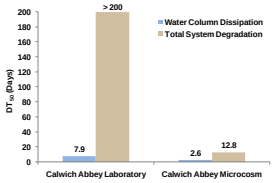


Water Column Radiochromatogram after 29 days

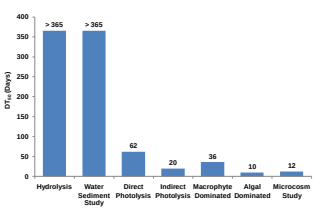


Sediment Extract Radiochromatogram after 29 days

- The dissipation/degradation kinetics observed in the microcosm study are summarised below.



- The degradation rates from all tiers, using data from Calwich Abbey for continuity (where applicable) are summarised below.



Conclusions

On the basis of standard Tier 1 testing, Isopyrazam does not appear to be susceptible to significant environmental degradation. However, by increasing the complexity and realism of the study design it is clear that this initial assessment does not adequately reflect the true behaviour of the compound in aquatic environments. Isopyrazam is, in fact, highly susceptible to both indirect photolysis (dependent on the photosensitizer concentration in the water) and metabolism by algae and aquatic macrophytes. In an integrated system, this metabolism was shown to be the dominant process, with indirect photolysis playing only a minor role. Employing this tiered approach to testing has significantly increased the understanding of the fate of Isopyrazam in aquatic ecosystems

References

[1]Oliver RG, Hand L and Wallace D (2008). From the lab to the field - a tiered approach to refine surface water and sediment persistence and exposure estimates. Platform presentation, 10th International Fresenius AGRO Conference, Mainz, Germany.

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