DEGRADATION OF THE INSECTICIDES PIRIMICARB® AND IMIDACLOPRID® IN INDOOR AND OUTDOOR STREAM MESOCOSMS UNDER DIFFERENT LIGHT CONDITIONS

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Introduction

Pirimicarb and imidacloprid (Figure 2) are insecticides applied in crop protection against aphids and other sucking or biting insects [1][2]. These compounds may pass into water bodies by spray drift or by run-off after application. Pirimicarb and imidacloprid are described as being readily degradable in natural water bodies by solar irradiation and microbial activity [3][4]. A stream mesocosm study was conducted in order to investigate the influence of solar radiation and microbial activity on the degradation process under natural-like conditions. Two scenarios were run: First scenario: Indoor stream mesocosms with established biological activity over a 3 year period under artificial light conditions simulated the solar light spectrum in the visible range, but the ultraviolet components UV A + B were very weak. Therefore, any disapproving of both insecticides in the indoor systems should result from microbial degradation only. Second scenario: Water of the indoor streams was pumped to outdoor streams which were exposed to full sun light but an almost undeveloped biocoenosis. Thus, photodegradation of the two compounds should play a more important role besides biological degradation. The concentrations of pirimicarb and imidacloprid in the water columns were monitored both in indoor and outdoor mesocosms (Figure 1).

Figure 1: Indoor stream mesocosm system 10 m length, 1 m width, run in circular mode [5]

Materials and Methods

Outdoor stream mesocosms:
Flow velocity: 0.15 m/s
Mean light intensity at the water surface: 29 W/m²
Mean water temperature: 20°C
Biological establishment: sand, natural sediment, macrophytes, macroinvertebrates (3 years of development)
Nutrient status: mesotrophic

Experimental Design:
Scenario 1: Influence of microbial degradation
Stream systems were spiked separately with 1 µg/L pirimicarb (indoor 1), 10 µg/L pirimicarb (indoor 2), 10 µg/L imidacloprid (indoor 1), 10 µg/L imidacloprid pulse exposure of 3 h (indoor 2, data not shown)

Scenario 2: Influence of radiation
After a residence time between 8 and 12 weeks, the free water of the contaminated indoor mesocosms was released to outdoor mesocosms where it was exposed to solar radiation and the prevailing meteorological conditions (imidacloprid outdoor 1 and pirimicarb outdoor 2).

Chemical and statistical analysis:
• The method of the derivatisation of imidacloprid for the detection by gas chromatography/mass spectrometry (GC-MS) [6] was modified.
• Pirimicarb and imidacloprid in water samples were analysed as shown in Figure 3.
• Concentrations measured in the water samples were corrected to the volume at the start of each experiment.
• The dissipation of both insecticides in the water column was fitted to a first order degradation curve (Table 1) following the equation: C(t) = C0 x exp(-k x t)

Results and Discussion

The indoor DT50 for pirimicarb were in the same range as described from a water-sediment study performed in the dark [3]. The DT50 in the indoor systems were about 2 to 3.4 times higher than in the outdoor systems despite considerable biological activity and higher water temperatures (Figure 5). The DT50 of imidacloprid in the indoor systems exceeded the indoor residence time (Figure 6, 7). Although the streams were fully exposed to sunlight, and there was no turbidity, an DT50 < 1 d could be observed has to be checked in the future.

Table 1: Parameters of the first order degradation curve fittings

<table>
<thead>
<tr>
<th>Experiment</th>
<th>C0 [µg/L]</th>
<th>k [1/day]</th>
<th>DT50 [days]</th>
<th>C90 %</th>
<th>D90 %</th>
<th>R²</th>
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<tbody>
<tr>
<td>Pirimicarb indoor 1</td>
<td>0.9619</td>
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Conclusion

• Microbial degradation is low for both substances as compared to photodegradation
• Photodegradation was lower than expected from laboratory studies [3][4] although the streams were fully exposed to sunlight, and there was no turbidity.
• If 10°C > t > 0°C, it could be observed has to be checked in the future.
• In the field, biogenous and genotypic turbidity, the occurrence of yellow substances and shading by canopy are common phenomena which have to be considered strong factors in further reducing photodegradation of substances.

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References

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