The Effect of (non-UV) Light on the Biodegradation of Pesticides

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Introduction

Before becoming commercially available, pesticides must undergo rigorous testing and comply with numerous regulatory guidelines. OECD-regulatory guideline 307 dictates that laboratory based soil degradation experiments, used to assess degradation rates of pesticides, are carried out on sieved soil in the dark. These experimental parameters are very different to field conditions, and any impact that the phototrophic communities present in surface soil could have on degradation rates, cannot be evaluated.

Previous collaborative work between Syngenta and Warwick has demonstrated that some pesticides show altered degradation rates when soil samples were exposed to fluorescent non-UV (400-700nm) light:dark cycles, and autotrophic soil surface communities were allowed to develop. Fluorescent non-UV light was used to mimic the photosynthetically active radiation of natural sunlight and prevent photolytic reactions which may occur at wavelengths of <400nm. To date, this effect has been seen in a single silt-loam soil type (pH 6.9, %OM 4.1, Cation Exchange Capacity (CEC) 10.1 meq/100g). The aim of this work was to determine whether these differences in degradation rates are replicable in a different soil type, clay loam (pH 7, %OM 4.2, Cation Exchange Capacity (CEC) 24.3 meq/100g).

Material and Methods

A clay loam soil was collected from a glasshouse site at Jealott’s Hill. The soil was processed through a 2mm sieve and wetted up to pf2 moisture content (27.5%). To each incubation vessel, 100g equivalent dry weight of soil was added. The (non-UV) light kept samples were incubated in Sanyo Environment cabinets at 20°C±2°C and exposed to 16:8 hour (non-UV) light:dark cycles. Dark samples were kept in a constant temperature room at 20°C±2°C. Both the light and dark systems were left to equilibrate for a week.

A known amount of radiolabelled compound (Imidacloprid, Fludioxonil and Cinosulfuron) was added to the soil samples and degradation of parent was traced over 6 sampling points (including time 0). When sampled, extractable residues, non-extractable residues and 14CO2 were quantified to give a mass balance. Remaining parent compound in the extractable fraction was then quantified by HPLC and degradation times to 50% of applied (DT50) were calculated.

Results

Results from HPLC analysis were analysed using Computer Aided Kinetic Evaluation (CAKE) software (conforms to FOCUS guidelines) and DT50’s were calculated for all of the compounds.

Fludioxonil degraded faster to DT50 in the light system than the dark system (Table 1), as observed previously in the silt-loam. Cinosulfuron degraded faster to DT50 in the dark system, as observed previously. There was no appreciable difference in degradation rate of Imidacloprid between the light and dark systems in the clay-loam, in contrast to results observed in the silt-loam.
Table 1. Time taken for compounds to reach DT50

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Light DT50 (Days)</th>
<th>Dark DT50 (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imidacloprid</td>
<td>332.4</td>
<td>336.4</td>
</tr>
<tr>
<td>Fludioxonil</td>
<td>72.54</td>
<td>133.1</td>
</tr>
<tr>
<td>Cinosulfuron</td>
<td>63.95</td>
<td>44.27</td>
</tr>
</tbody>
</table>

Conclusions

Non-UV light had a marked impact on the degradation rate to DT50 of 2 of the 3 compounds. For these 2 compounds the nature of the effect was the same as previously observed in a silt-loam soil.

The results suggest that non-UV light could be an important factor determining altered pesticide degradation rates. However, there may be soil-to-soil differences in the magnitude and direction of these effects. There is a need to understand the mechanisms responsible for the effect of non-UV light on degradation rates.

Future work will look to bridge the gap between lab-based systems and the field.

References