MOBILITY OF TWO WINTER WHEAT HERBICIDES, CHLOROTOLURON AND FLUFENACET, IN UNAMENDED AND AMENDED SOIL AT FIELD SCALE

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INTRODUCTION

The application to soil of organic residues rich in nutrients and organic matter (OM) is a conservative agricultural practice often used to improve the soil fertility as well as to preserve the soil from degradation. Numerous organic residues from agricultural and industrial activities can potentially be used as amendments, such as composted spent mushroom substrate (SMS) and green compost (GC). However, despite these residues can modify the dynamic and environmental fate of herbicides applied to the amended soils, only scarce field studies have been done to assess the effect of organic amendments on pesticides fate [1].

OBJECTIVE

The aim of this work was to assess the effect of the addition of two different organic amendments, SMS and GC, on the mobility of two winter wheat herbicides, flufenacet and chlorotoluron, in an agricultural soil under field conditions.

MATERIALS AND METHODS

FIELD EXPERIMENT

3 treatments by quadruplicate
12 experimental plots (9×9 m²) grown with winter wheat
3 control plots (without herbicide)
9 plots treated with herbicide

CHARACTERISTICS OF UNAMENDED AND SMS- AND GC-AMENDED SOILS (0-30 cm) AT TIME 0 DAY

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Depth (cm)</th>
<th>Bulk density (g cm⁻³)</th>
<th>pH</th>
<th>OC (%)</th>
<th>N (%)</th>
<th>C/N</th>
<th>Eν⁺ (cm² cm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>0-10</td>
<td>1.37</td>
<td>6.44</td>
<td>0.77</td>
<td>0.03</td>
<td>14.4</td>
<td>0.003</td>
</tr>
<tr>
<td>S+SMS</td>
<td>10-30</td>
<td>1.40</td>
<td>6.82</td>
<td>0.91</td>
<td>0.07</td>
<td>12.5</td>
<td>0.195</td>
</tr>
<tr>
<td>S+GC</td>
<td>30-40</td>
<td>1.21</td>
<td>7.15</td>
<td>1.45</td>
<td>0.07</td>
<td>20.7</td>
<td>0.231</td>
</tr>
<tr>
<td>3D</td>
<td>60-80</td>
<td>1.10</td>
<td>6.90</td>
<td>1.83</td>
<td>0.13</td>
<td>12.0</td>
<td>0.249</td>
</tr>
<tr>
<td>6D</td>
<td>100-120</td>
<td>1.26</td>
<td>6.70</td>
<td>0.96</td>
<td>0.07</td>
<td>11.8</td>
<td>0.202</td>
</tr>
</tbody>
</table>

ORGANIC AMENDMENTS

<table>
<thead>
<tr>
<th>pH</th>
<th>Moisture (%)</th>
<th>EC⁺ (mS/m)</th>
<th>OM (%)</th>
<th>N (%)</th>
<th>C/N</th>
<th>Eν⁺ (cm² cm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>7.2</td>
<td>37.7</td>
<td>7.8</td>
<td>59.4</td>
<td>2.3</td>
<td>15.2</td>
</tr>
<tr>
<td>6D</td>
<td>7.2</td>
<td>48.8</td>
<td>2.2</td>
<td>46.0</td>
<td>1.1</td>
<td>21.8</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

EXTRACTION AND ANALYSIS OF HERBICIDES AND TRACER ION

Sampling soil profiles (3 replicates/plot, 0-100 cm)
Dates: 1, 17, 33, 60 and 80 days after application
Sub-sampling: 10 segments of 10 cm
Sieving (<2 mm)
Determination of soil moisture content
Centrifugation and filtration
Evaporation of 8 mL of herbicide extracts
Re-dissolution of the residue in 0.75 mL of acetonitrile
Quantification
HPLC-DAD-MS
Ion Chromatography

HERBICIDES AND TRACER ION

<table>
<thead>
<tr>
<th>Herbicides</th>
<th>Water solubility (mg L⁻¹)</th>
<th>log Kow</th>
<th>OUS Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorotoluron</td>
<td>74</td>
<td>2.9</td>
<td>3.02</td>
</tr>
<tr>
<td>Flufenacet</td>
<td>56</td>
<td>3.2</td>
<td>2.23</td>
</tr>
</tbody>
</table>

DISTRIBUTION PROFILES OF BROMIDE, CHLOROTOLURON AND FLUFENACET IN UNAMENDED, SMS- AND GC-AMENDED PLOTS

Chlorotoluron, the less hydrophobic herbicide, reached 50-60 cm-depth in S+SMS, and 60-70 cm-depth in S and S+GC (>6% of the applied dose).
Flufenacet was limited to 20-30 cm-depth in all treatments.
The highest amounts of herbicides were found at 0-10 cm-depth and the percentage of herbicides recovered at this depth was higher for amended soils than for unamended soils.
Eighty days after application, the recovered amounts of herbicides in the topsoil were (~% of the applied doses): 52% (S), 45% (S+SMS) and 55% (S+GC) for chlorotoluron; and 42% (S), 53% (S+SMS) and 75% (S+GC) for flufenacet.

CONCLUSION AND PERSPECTIVES

The results obtained show that the application to soil of spent mushroom substrates (SMS) and green compost (GC) organic amendments could help to reduce groundwater contamination by herbicides in winter wheat cropping systems.

Adorsorption, dissipation, and microbial studies are in progress in order to interrelate these processes with the environmental fate of the herbicides.

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REFERENCES: