Dissipation and bioavailability of fungicides in a vineyard soil amended with spent mushroom substrate at different rates

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INTRODUCTION

The dissipation of pesticides in soils can be modified by changes in soil management such as the addition of organic amendments. Cymoxanil and tebuconazole are widely applied in vineyards to control fungal diseases (downy and powdery mildew). The dissipation of these fungicides applied and the formation of possible degradation products in an unamended vineyard soil and this soil amended with spent mushroom substrates (SMS) were studied under laboratory conditions. The distribution of fungicides between mineralized, CaCl₂-extractable, methanol-extractable and non-extractable fractions was also evaluated using ¹⁴C-labelled compounds to know the dissipation mechanisms and bioavailability of fungicides over the incubation period. Soil dehydrogenase activity was also determined as an indicator of the overall soil microbial activity.

MATERIALS AND METHODS

SPENT MUSHROOM SUBSTRATE: The SMS used from Agaricus bisporus production has a pH of 6.97 and an organic carbon (OC) content of 22.8%.

SOIL AND AMENDED SOILS: Soil sample was collected from the surface horizon (0-30cm) of a vineyard in Sajazarra, La Rioja (Spain). Amended soils were prepared with SMS at rates of 5% and 50% (w/w). Soils were incubated outdoors for one month.

MAIN PROPERTIES OF THE UNAMENDED AND AMENDED SOILS STUDIED

<table>
<thead>
<tr>
<th>Soil (%)</th>
<th>pH</th>
<th>OC (%)</th>
<th>N (%)</th>
<th>Sand (%)</th>
<th>Silt (%)</th>
<th>Clay (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>7.52</td>
<td>0.67</td>
<td>0.056</td>
<td>49.4</td>
<td>20.2</td>
<td>30.4</td>
</tr>
<tr>
<td>S+5%SMS</td>
<td>7.26</td>
<td>1.73</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S+50%SMS</td>
<td>7.19</td>
<td>16.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

TEBUCONAZOLE

Log Kow = 3.7
WS = 36 mg L⁻¹

CYMoxanIL

Log Kow = 0.67
WS = 780 mg L⁻¹

DEHYDROGENASE ACTIVITY IN SOIL SAMPLES AT DIFFERENT TIMES AFTER FUNGICIDE APPLICATION

The dissipation pattern of both fungicides fitted first-order kinetics or Gustafson and Holden kinetics.

Half-life (DT₅₀) values were < 1 day for cymoxanil in all soils studied. Dissipation of cymoxanil was mainly due to the high mineralized and non-extractable fractions detected from the beginning of the incubation period.

Dissipation rate of tebuconazole in SMS-amended soils (DT₅₀=168 and 125 days for 5% and 50% SMS-amended soils, respectively) was higher than in unamended soil (DT₅₀=1000 days) due to the formation of a higher fraction of non-extractable residues after 60 days of incubation.

Mineralization of ¹⁴C-tebuconazole and ¹⁴C-cymoxanil was higher in unamended soil relative to SMS-amended soils due to the higher fungicide retention by amended soils. The mineralization of ¹⁴C-cymoxanil reached high values, indicating that most of the bioavailable compound was completely degraded. The low mineralization of ¹⁴C-tebuconazole is consistent with the dissipation rates of fungicide in unamended and amended soils.

DHA mean values were higher in SMS-amended soils than in the unamended one. DHA was also stimulated by the addition of fungicides and decreased with the incubation time for both fungicides studied.

MINERALIZED, CaCl₂-EXTRACTABLE, METHANOL-EXTRACTABLE AND NON-EXTRACTABLE FRACTIONS OF ¹⁴C-TEBUCONAZOLE AND ¹⁴C-CYMOXANIL IN UNAMENDED AND SMS-AMENDED SOILS

CONCLUSION: The results indicated that an addition of SMS at high rates can increase the immobilization of fungicides in a vineyard soil and reduce their bioavailability to soil microorganisms to be degraded and/or mineralized.

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