Persistence of residual herbicides in maize silage fields

Key Points

- Residual herbicides are designed to persist in the soil and kill seedlings between germination and emergence. However, if they persist too long, they can prevent the establishment of subsequent winter crops sown after maize.
- To determine the persistence of the residual herbicides atrazine, acetochlor, mesotrione and nicosulfuron, experiments were conducted in the glasshouse (controlled bioassays using mustard and oats) and the field (Waikato, Taranaki and Canterbury).
- In the controlled bioassays, the greater the herbicide dose, the lower the biomass yield of mustard and oats. The detection limit (the dose rate when yield falls below 85% of the untreated) varied between soil and herbicides.
- In the field trials, there was no atrazine, acetochlor or mesotrione detected at any site at harvest. Nicosulfuron was detected in Taranaki at 10 and 15 weeks after application. This affected subsequent growth of mustard but not oats.
- Rainfall appears to be the main driver of herbicide dissipation in the field. Low rainfall is likely during summer so residual herbicides applied from mid December could result in herbicide residues at harvest.

Introduction

Residual herbicides are a key tool in managing weeds in maize fields. They are designed to persist in the soil, and kill seedlings between germination and emergence. However, if residual herbicides are applied late or last too long in the soil, they can prevent the establishment of subsequent winter crops sown after maize.

This project evaluated the persistence of four common residual herbicides used in maize silage crops (atrazine, acetochlor, mesotrione and nicosulfuron) and their likely impact on the establishment of winter crops.

Approach

Experiments were conducted in Waikato (Horotiu silt loam, 5.5%C), Taranaki (Egmont sandy loam, 8.4%C) and Canterbury (Waimakariri silt loam, 3.7%C) during the 2008-09 season. None of the trial sites had been used for long term maize cropping (all less than 3 years of maize). To determine the persistence of the four residual herbicides, both controlled glasshouse bioassays and field trials were conducted.

Controlled bioassays were conducted to get quantitative estimates of herbicide residues from the field treatments. Bioassays involve using plant growth as a way to determining a treatment response and were run as pot experiments in the glasshouse. Untreated soil from each site was dosed with different rates of each herbicide. Mustard and oats were grown in these soils for four weeks and final biomass measured and compared with an untreated control. The detection limits for bioassay are normally set at 85% dry matter compared to untreated, which is generally referred to as the No Observable Effect Level (NOEL).

Field trials

Five treatments (replicated four times) were established at each site (Table 1). Pre-emergence application dates were 9 to 22 October (just after sowing), and post emergence application dates were 20 November to 12 December (between 34 & 69 days after sowing).

To test for herbicide residues, soil samples (0-10 cm) were collected from each plot around four weeks prior to maize silage harvest, and again at the time of maize silage harvest. These soil samples from the field trials were then used in pot experiments to grow the susceptible bioassay species oats and mustard for four weeks in a glasshouse. The growth (or otherwise) of oats and mustard was used to determine if the residual herbicides were still active in the soil. This method of testing is referred to as a bioassay because it measures the biological toxicity of the chemical in the soil.

Table 1. Residual herbicide treatments applied in the field trials.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Trade name</th>
<th>Applcn rate (prod./ha)</th>
<th>Applcn time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated(1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Atrazine</td>
<td>Gesaprim</td>
<td>3.0 L</td>
<td>Pre-em</td>
</tr>
<tr>
<td>Acetochlor</td>
<td>Roustabout</td>
<td>3.0 L</td>
<td>Pre-em</td>
</tr>
<tr>
<td>Mesotrione</td>
<td>Callisto</td>
<td>200 mL</td>
<td>Post-em</td>
</tr>
<tr>
<td>Nicosulfuron</td>
<td>Latro</td>
<td>80 g</td>
<td>Post-em</td>
</tr>
</tbody>
</table>

1. Untreated control plots sprayed post emergence with the non-residual herbicide Emblem (bromoxynil) at 2.25 kg/ha.

Results

Controlled bioassays

As expected, the greater the herbicide dose rate, the lower the biomass yield of oats and mustard (Figures 1 and 2). The detection limit (the dose rate when yields fall below 85% of untreated) for each of the four residual herbicides are given in Table 2.

The detection limit differed between soil type. For example, atrazine applied to the Canterbury soil...
affected plant growth at a very low dose (0.01 mg ai/kg) but in
the Waikato soil, 50 times that dose (0.5 mg ai/kg soil) was
needed to affect plant growth. The greater damage from
atrazine in the Canterbury soil was because atrazine is highly
sorbed by soil organic carbon and this site had the lowest soil
carbon, hence the lowest sorption and highest activity.

The yield decline of mustard due to the nicosulfuron residues
was compared with the results from the controlled bioassays,
and equated to a residue level of around 0.005 mg ai/kg soil.

The detection limit for nicosulfuron, as determined in
the controlled bioassay, was the same for the Waikato
and Taranaki soils (0.002 mg ai/kg soil, Table 2). Two possible reasons why nicosulfuron
was more persistent in the field trial at Taranaki than
Waikato are
• Taranaki was treated later (26 Nov for Waikato
and 12 Dec for Taranaki).
• Between application and final sampling, the
Taranaki site received 236 mm of rain, much
less than the Waikato site (383 mm).

Conclusions
• Rainfall appeared to be the main driver of
herbicide dissipation in the field trials.
• Low rainfall is likely to be a problem later in
the season, so any post-emergence residual
herbicides applied to maize silage crops from
mid December or later could result in herbicides
residues at harvest.

Field trials
For the pre-emergence herbicides atrazine and acetochlor,
there were no residues present at any site at either the early or
late sampling time. The shortest time between application and
sampling was 10 and 17 weeks respectively. However nicosulfuron residues were detected in the
Taranaki soil at both 10 and 15 weeks after application. These residues affected the growth of
mustard (the most sensitive species), but not the oats (Figure 3).

The yield decline of mustard due to the nicosulfuron residues
was compared with the results from the controlled bioassays, and equated to a residue level of
around 0.005 mg ai/kg soil.

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