A monitoring programme to determine the potential of a herbicide degradate to leach to shallow groundwater in maize growing regions of Europe


Classification: EXTERNAL
BACKGROUND TO STUDY

- Syngenta are undertaking a significant pan-European monitoring project to support the registration of a maize herbicide
  - The regulatory process requires an assessment of potential groundwater exposure using regulatory models resulting in potentially high predicted concentrations of a non-relevant metabolite
  - Monitoring is a higher tier approach to refine conservative model predictions by determining high centile exposure with defined confidence
    - Only include countries which have had a product registration for a minimum of five years
    - Ensure that fields monitored have sufficient historical product use and groundwater concentration will tend to approach steady state
  - To address local MS and EU-wide questions estimates of leaching potential in vulnerable areas study design must be statistically rigorous
    - Syngenta wish to determine 90th centile concentration of polar herbicide metabolite beneath treated maize fields with defined certainty
Conceptual Outline

- Identified monitoring program goals and statistical objective
- Identified spatial scope, historical product sales criteria
- Identify drivers for potential vulnerability for this degrade
tate
- Decide on grid cell scale for pan-European analysis & populate GIS
- Combine drivers to rank grid cells by potential vulnerability
- Identify total population of interest by selecting more vulnerable subset
- Divide vulnerable subset into agro-climatic strata to assure representation
- Use stratified sampling to identify desired number of grid cells (& backups)
- Investigate cells to identify all farmers with fields with long use history
- Select candidate fields for drilling at random
- Drill wells in candidate fields and characterize soils and hydrogeology
- Accept ALL wells that meet pre-defined criteria into program
- Correlate monitoring results with actual field conditions & use history
CONCEPTUAL MODEL FOR POTENTIAL VULNERABILITY METRIC

*Crop Data* | *Sales Data* | *Reg Data*
---|---|---

• Where is corn grown and
• Where do farmers use the product?

Shallow groundwater predictor

• Site searching should focus on areas where there is a high probability of finding shallow groundwater

Potential Vulnerability Layer

• Where do we expect leaching of the degradate to be at its greatest?

Used to identify areas where most likely to find fields having desired characteristics and worst-case
ESTIMATING POTENTIAL VULNERABILITY VIA MASS FLUX

- weather (MARS 50K)
- Substance Properties
- Soil SPADE II OCTOP
- Crop According to FOCUS Zone with Irrigation
- Leaching Concentrations at 1m as indicator of Intrinsic Potential vulnerability

Hoogeweg et al. “Development of EuroPEARL 2012 to Support Large-Scale Exposure Assessments and Monitoring Programs”.

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IDENTIFYING GRID CELLS WHERE GW <10M MAY BE EXPECTED

- Shallow groundwater estimated using a custom GIS algorithm.¹
  - Shallow defined as 10 m or less
- Easily coupled with other factors to identify potential high exposure sites.
- Technology is limited to areas that are “pseudo-alluvial”.
  - i.e. It does not predict all areas of shallow groundwater but does pick out the more vulnerable arable alluvial areas

USE GIS TO IDENTIFY UNIVERSE OF 4600 POTENTIAL HIGH EXPOSURE GRID CELLS

Percent Shallow GW per 10 x 10 km Grid Cell
- 0% - 10%
- 11% - 30%
- 31% - 50%
- 51% - 70%
- 71% - 90%
- 91% - 100%

Maize and Sunflower Density per 10 x 10 km Grid Cell
- 0% - 5%
- 5.01% - 15%
- 15.01% - 30%
- 30.01% - 45%
- 45.01% - 60.85%

Mass Flux Cells Percentile Range

50th centile

50th centile

Upper 60th centile
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SELECTION OF GRID CELLS FOR MORE DETAILED INVESTIGATION TO FIND SUITABLE FIELDS

- Selection of 200 grid cells from the total pool of potential grid cells
- Vulnerable gridcell pool was stratified to create agroclimatic “strata” for which we can provide estimates of concentration centiles
  - Selected to sample the full potential mass flux distribution
  - Number of sites in EU and strata selected to ensure that we can confidently predict the 90th centile with a defined confidence
IDENTIFY POTENTIALLY SUITABLE FARMER’S FIELDS

- In each 10 x 10 km gridcell, all farmers that used the target herbicide were identified using:
  - Syngenta sales information
  - Use of market research firms
- Identified farmers were contacted in random order with goal to identify at least one suitable candidate per gridcell
  - Generated detailed data on EU farmer maize cropping practices and herbicide usage
- To be selected as potential candidates for monitoring well installation fields must meet set criteria:
  - Historical product use of a minimum of 3 in 5 years
  - Depth to water must be less than 10 m
  - No evidence of a confining layer in the unsaturated zone
  - Treated field must reside within the 10 x 10 km grid cell boundary
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WELLS INSTALLATION AND INTEGRITY

- Monitoring wells are being installed to a very high technical specification
  - Installation with Geoprobe System® to prevent contamination of groundwater during installation (dual tube technology)
  - Detailed soil characterisation during well installation including top soil
    - Drilling abandoned and site rejected if confining layer discovered
  - Wells with sealed annulus to prevent contamination
  - Dedicated submersible pumps reduce potential for user contamination
  - 2 m screens were installed at a minimum of 3 m below ground surface to account for fluctuating groundwater elevations
  - Well installation conducted to GLP standards
ENSURING APPROPRIATE MONITORING WELL PLACEMENT

- At each candidate monitoring site an estimation of potential groundwater flow direction was undertaken prior to commencing well installation activities
  - Installation of three piezometers considering site features, regional geology and estimated groundwater direction
  - One well installed at the predicted down-gradient location
  - Post installation, groundwater flow direction confirmed and well location assessed for suitability to intercept groundwater from the treated field
ANALYTICAL DATA SHOWS LOW RESIDUES IN VERY SHALLOW GW AT SITES WITH EXTENSIVE USE HISTORY

<table>
<thead>
<tr>
<th>DTW</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Parent (µg/L)</th>
<th>Met1 (µg/L)</th>
<th>Met2 (µg/L)</th>
<th>Notes</th>
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<tbody>
<tr>
<td>1.06 m</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>&lt;0.01</td>
<td>1.05</td>
<td>0.11</td>
<td>Sandy silt; Sprinkler</td>
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<tr>
<td>1.65 m</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>&lt;0.01</td>
<td>0.85</td>
<td>0.05</td>
<td>Silt and sand; flood; ditch</td>
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<tr>
<td>1.06 m</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>0.03</td>
<td>6.05</td>
<td>2.13</td>
<td>Silt; flood irrigation; ditch</td>
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<tr>
<td>1.67 m</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>&lt;0.01</td>
<td>0.33</td>
<td>0.08</td>
<td>Silt loam</td>
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<tr>
<td>4.90 m</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>&lt;0.01</td>
<td>0.48</td>
<td>0.09</td>
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<tr>
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<td>+</td>
<td>+</td>
<td>-</td>
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<td>1.16</td>
<td>&lt;0.05</td>
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<tr>
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<td>-</td>
<td>+</td>
<td>+</td>
<td>&lt;0.01</td>
<td>3.52</td>
<td>1.98</td>
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<tr>
<td>2.70 m</td>
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<td>+</td>
<td>+</td>
<td>-</td>
<td>&lt;0.01</td>
<td>0.22</td>
<td>&lt;0.05</td>
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<tr>
<td>3.02 m</td>
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<td>+</td>
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<td>+</td>
<td>-</td>
<td>&lt;0.01</td>
<td>0.48</td>
<td>&lt;0.05</td>
<td>Sandy silt; ditch</td>
</tr>
<tr>
<td>0.69 m</td>
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<td>-</td>
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<td>+</td>
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<td>&lt;0.01</td>
<td>3.21</td>
<td>0.39</td>
<td>Clay; ditch (not for irrigation)</td>
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<tr>
<td>9.70 m</td>
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<td>-</td>
<td>+</td>
<td>-</td>
<td>&lt;0.01</td>
<td>0.09</td>
<td>&lt;0.05</td>
<td>Sand; flood irrigation; ditch</td>
</tr>
<tr>
<td>2.93 m</td>
<td>+</td>
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<td>+</td>
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<td>0.21</td>
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<td>0.20</td>
<td>&lt;0.05</td>
<td>Sandy clay, Flood irrigation</td>
</tr>
<tr>
<td>1.93 m</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>&lt;0.01</td>
<td>0.10</td>
<td>&lt;0.05</td>
<td>Sandy silt</td>
</tr>
</tbody>
</table>
WORST CASE STATISTICALLY BASED PAN-EUROPEAN MONITORING PROGRAM UNDER WAY

● Syngenta are currently installing a bespoke shallow monitoring well network to allow for the estimation of the 90th centile metabolite concentration across Europe for maize pesticides

● Wells are being installed adjacent to treated fields identified randomly from within a subset of grid cells selected in a stratified random fashion to sample potentially high exposure areas representing both regional and EU-wide maize agriculture
  - Wells installed at the down gradient edge of fields with extensive herbicide use history and shallow groundwater

Residue data obtained to date from the early phase of the project indicates that leaching of this non-relevant herbicide degradate IS less than predicted from conventional regulatory groundwater models
NEXT STEPS

- Installation of remaining wells
- Continuing sampling across the wells and develop time course data
- Correlation of residue data with actual field, climatic, hydrogeology and use history characteristics
- Statistical evaluation of data to determine statistical design effects and express results in terms meaningful at both EU and regional/member state scales
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