Are detailed sorption characteristics regarding soil domains imperative for estimation of glyphosate leaching through fractured clayey till?

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Observations

Heavy rain

Snowmelt
Questions!

Why is glyphosate detected in high concentrations in groundwater beneath fractured clayey soils after heavy rain or snowmelt events?

- Is this behaviour captured by the regulatory model concept?

- Can the detailed information regarding flow and sorption be incorporated into a numerical model, thereby helping us better understand the leaching pattern through fractured clayey soils?
Regulatory model concept

- Homogeneous layers
- Piston flow
- Sorption values from plough layer in entire model
- DT50 distribution with depth as used in FOCUS

Note:
Fluctuating groundwater table
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- Clayey till soils can contain wormholes and fractures that extend to great depths.
- Glyphosate shows varying sorption characteristics in the different soil domains.
- Sorption varies between domains at the same depths (matrix vs. fractures)
- Sorption data from the plough layer are not representative of the entire soil column.
Choice of modelling software

✓ 3D water and solute transport in variably-saturated zone
  • Water flow: Richard’s equation
  • Glyphosate transport: Dispersion-advection equation

✓ Allowing the incorporation of observed domains with user defined associated process understanding

➔ COMSOL Multiphysics
(www.comsol.com)
Conceptual model setup

- Plough layer (1)
- Oxidised matrix (2) with brown macropores and worm holes (3)
- Reduced matrix (8) with oxidised macropores (7)
- Oxidised matrix (6) with oxidised macropores (7)
- Oxidised matrix (4) with reduced macropores (5)
- Reduced matrix (8)
Boundary conditions

- Precipitation
- Δ Actual harvest (7/8 2009)
- Glyphosate (8/8 2009 - day 69)
- Groundwater table
- O Actual manure application (20/8 2009)
- Possible harvest (18-19/8 2009)
Piston flow/transport
Sorption and degradation – 1 domain

Preferential flow/transport
Sorption and degradation – 8 domains
Preferential flow/transport
Sorption only – 8 domains

Preferential flow/transport
Sorption and degradation – 8 domains
Preferential flow/transport
Sorption - 8 domains

Preferential flow/transport
Double sorption - 8 domains

Preferential flow/transport
Half sorption - 8 domains
Answers

Why is glyphosate detected in high concentrations in groundwater beneath fractured clayey soils after heavy rain or snowmelt events?

- No, this behaviour is not captured by the regulatory model concept!
- Taking preferential transport processes into account is imperative for being able to adequately assess the leaching risk
  - Particularly important for settings constrained by highly dynamic natural upper and lower boundary conditions.
- The sorption in the macropore/fracture domain can have an effect on long-term leaching.
- Degradation seems to play a minor role.
Don’t forget fractures!

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http://pesticidvarsling.dk