Opportunities for variable rate application of soil herbicides in arable crops

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Outline

- Soil herbicides in Dutch agriculture
- Advantages & disadvantages
- Interactions between soil herbicides and soil
- Developing and testing DSR’s
  - Greenhouse, model, field
- From soil map to taskfile
- Issues to tackle
- Outlook
Soil herbicides in Dutch agriculture

- Soil herbicides
  - Applied around crop emergence
  - Kill germinating weeds

<table>
<thead>
<tr>
<th>Crop</th>
<th>Soil herbicides (a.i.)</th>
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<tbody>
<tr>
<td>Wheat, winter</td>
<td>diflufenican/isoproturon, aclonifen, pendimethalin, prosulfocarb</td>
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<td>Sugar beet</td>
<td>clomazone, chloridazone/quinmerac, metamitron *</td>
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<td>Potato</td>
<td>prosulfocarb, metazachlool, aclonifen, clomazone, metribuzin, pendimethalin, linuron *</td>
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<td>Onion</td>
<td>pendimethalin, chloridazon *</td>
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<td>Maize</td>
<td>isoxaflutole, s-metolachlor, dimethenamid-P, terbutylazine *</td>
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<td>* also used in post-emergence herbicide mixtures</td>
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Advantages & disadvantages

- **Environmental and Agronomic**
  - Emission (Persistence, leaching etc), (eco)toxicity, phytotoxicity, carry-over
  - + Early season head start of crop, less post-emergence control, resistance management

- Need for smart usage

Source:
http://www.ag.ndsu.edu/cpr/weeds/what-are-the-advantages-of-using-foundation-soil-applied-herbicides-5-3-12ine-3
Interaction with the soil

- Sorption to soil determined by:
  - Physico-chemical properties of herbicide
  - Weather conditions
  - Soil characteristics: SOM, clay, pH, soil moisture
- If sorbed: not available for killing germinating weeds.
- Within field spatial variation -> DSR -> Variable Rate Application of soil herbicides
Developing & testing DSR’s

- Literature, label
- Greenhouse experiments
- Model
- On farm research to test DSR in practice
Decision Support Rules

- Basic model for soil herbicides

Source: Kempenaar et al., 2013
Greenhouse experiment (Tielen, 2010)

- Isoxaflutole, dimethenamid-P
- Soil of varying OM content
- Weed species: Common Groundsel (*Senecio vulgaris*), Chickweed (*Stellaria media*), Smooth crab grass (*Digitaria ischaemum*)
The ED90 indicates a fresh weight reduction of 90%:

- ED$_{90}$ shows the relation between OM and efficacy.
- Differences between weed species.
Interaction with the soil: PEARL

- PEARL is an acronym of *Pesticide Emission Assessment at Regional and Local Scales*. PEARL comprises two parts: a soil water model SWAP (Soil, Water, Atmosphere and Plant) and PEARL to determine the pesticide fate.

*Figure 1 Overview of processes included in the PEARL model.* (Source: (Tiktak et al., 2002) and http://www.pearl.pesticidemodels.eu/pdf/pearlman.pdf)
Model study PEARL

- **Aim:** Determine bioavailability of Dimethenamid-P and isoxaflutole in relation to SOM content in sandy soil using PEARL
- **Crop:** Maize
- **Run for 20 years of weather data**

Source: Heijting et al., 2012
Isoxaflutole $\rightarrow$ DKN

Fitted general model to DKN concentration at $t=7$ days after application

Dimethenamid-P

Fitted general model to DIMP concentration at $t=7$ days after application
Follow up should focus on

- Optimizing time of application to weather circumstances
- Establishing relation between concentration in soil and efficacy
- Studying behaviour in soils with both OM and clay, also for other active ingredients
From soil map to taskfile

Gamma radiation sensor - texture n (clay)

Stomp (pendimethalin) in onion
Mapping within-field variation:

- Sampling + geostatistical interpolation
- Stratifying fields in zones -> sampling
- Sensing

Sources: Heijting et al., 2007 & 2011
Javelin (diflufenican/isoproturon) in winterwheat

- DSR
- Sprayboom width
- Routing
- Response time
- Spray volume if uniformly applied

Sensor map soil

Spray volume Taskfile
Boxer
(prosulfocarb)
In general reduction depends on:

- Basic DSR and range
- Spatial pattern and variation of soil
- Spray equipment
- Routing (size and shape of field)
- Efficacy

Overall expected reduction 20-30%
Issues to tackle

- Validation of soil scans
- Efficacy testing in practice
- Technical hiccups
- Spatial variation of weed patterns
- Further testing needed
Outlook

- Technically possible to apply VRA
- Expected reduction in use 20-30%
- Less phytotoxicity -> positive effect on yield
- Increasing amount and availability of soil scans
- Advances in DSR development
- Discussion on label prescription
Thank you for your attention

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HEIJTING S, BRUIN SD & BREGT AK (2011) The arable farmer as the assessor of within-field soil variation. Precision Agriculture 12, 488-507.


