On-farm evaluation of integrated weed management tools in maize production: agronomic efficacy, herbicide use reduction and economic sustainability

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The PURE project

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  - Supported by the European Commission (Seventh Framework Programme)
Objectives in maize experiments

- To test/evaluate the efficacy of IWM tools in real field conditions in 2011-2012 against the conventional approach.

- To perform a comparative assessment of their economic sustainability.
Experimental sites and design

The experiments (9) were carried out at:
1. Southern climatic conditions – Italy (5 farms)
2. Central climatic conditions - Germany (2 farms)
3. Eastern climatic conditions – Slovenia (2 farms)

- 2 x 0.5 ha plots (CON, IWM)
- Replications by involving several farms in different countries (minimum of 2 farms per country) for 2 years
- On-farm experiments managed with commercially available equipment for field scale applications
- Same crop management between IWM and CON, differing only in the weed management, respectively
Cost-benefit analysis (CBA)

- **Gross margin**
  - Gross margin: Financial yield – Total variable costs

- **Financial yield**
  - Yield
    - Derived from the experiments
  - Price
    - Average price (Eurostat) or regional prices
    - No extra price for IPM-strategies
Cost-benefit Analysis

Total variable costs

• Inputs
  – Seeds, pesticides, herbicides, biological agents, fertilisers

• Application costs
  – Contract work prices
    • Including cost for labour, machinery and fuel
    • Regional contractor prices
IWM tools tested

The IWM tools identified (based on Meissle et al., 2010; Vasileiadis et al., 2011, 2013 and after discussion with stakeholders) and tested were:

1. early-post emergence herbicide in broadcast application when/if scouting and forecasting model (ALERTINF; Masin et al., 2010) indicates followed by hoeing in IT

2. early-post emergence in band application combined with hoeing followed by another hoeing in DE

3. harrowing at 2-3 maize leaves stage and low dose of post-emergence herbicide in SI
# Weed management in 2011-2012

<table>
<thead>
<tr>
<th>Farm/Country</th>
<th>Year</th>
<th>Pre-emergence herbicide</th>
<th>Post-emergence herbicide</th>
<th>Hoeing</th>
<th>Pre-emergence herbicide</th>
<th>Early post-emergence herbicide or other treatment</th>
<th>Hoeing</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE (2 farms)</td>
<td>2011+2012</td>
<td>NO</td>
<td>x</td>
<td>NO</td>
<td>NO</td>
<td>band spraying combined with hoeing</td>
<td>x</td>
</tr>
<tr>
<td>SI (2 farms)</td>
<td>2011+2012</td>
<td>NO</td>
<td>x</td>
<td>NO</td>
<td>NO</td>
<td>Harrowing + reduced doses of herbicides</td>
<td>NO</td>
</tr>
<tr>
<td>Caorle, IT</td>
<td>2011</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NO</td>
<td>Scouting &amp; model indicated no application</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NO</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Mogliano, IT</td>
<td>2011</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NO</td>
<td>Scouting &amp; model indicated no application</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>x</td>
<td>NO</td>
<td>x</td>
<td>NO</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Ceregno, IT</td>
<td>2011</td>
<td>x</td>
<td>NO</td>
<td>x</td>
<td>NO</td>
<td>Scouting &amp; model indicated no application</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>x</td>
<td>NO</td>
<td>x</td>
<td>NO</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Berra, IT</td>
<td>2011</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NO</td>
<td>Scouting &amp; model indicated no application</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>x</td>
<td>NO</td>
<td>x</td>
<td>NO</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Ravenna, IT</td>
<td>2011</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NO</td>
<td>Scouting &amp; model indicated no application</td>
<td>x</td>
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<tr>
<td></td>
<td>2012</td>
<td>x</td>
<td>NO</td>
<td>x</td>
<td>NO</td>
<td>Scouting &amp; model indicated no application</td>
<td>x</td>
</tr>
</tbody>
</table>
Efficacy: IWM vs. CON

- IWM in IT had similar efficacy as the CON in both years.
- In DE 2011, some *C. album* and *C. polyspermum* escapes happened between maize rows in IWM due to late entry for second hoeing (i.e. 100mm precipitation in June).
- In SI 2012, final weed density was significantly higher in IWM as tine harrowing promoted new weed emergence.
Yield: IWM vs. CON

- In both years, no significant differences in grain yield among CON and IWM tools in all countries
- 2012 had very dry summer affecting yields in IT and SI
Herbicide reduction: IWM vs. CON

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>Mean TFI</th>
<th>IWM tool tested</th>
<th>Mean TFI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CON</td>
<td>CON</td>
<td>IWM</td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td>Post-emergence herbicide in broadcast</td>
<td>2</td>
<td>band application plus hoeing</td>
<td>0.6</td>
</tr>
<tr>
<td>IT</td>
<td>Pre- and post emergence herbicide plus hoeing</td>
<td>2.2</td>
<td>scouting/predictive model for spray decisions plus hoeing</td>
<td>0.8</td>
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<tr>
<td>SI</td>
<td>Post-emergence herbicide in broadcast</td>
<td>1.4</td>
<td>Tine-harrowing and reduced herbicide doses</td>
<td>0.9</td>
</tr>
</tbody>
</table>

b Treatment frequency index, number of full rate treatment: $TFI = 1 / n \sum_{t=1}^{T} D_t / DAp_t$ with $n$: number of years in the crop sequence, $T$: total number of pesticide treatments, $D$: applied rate in commercial product, DAp: approved/registered rate for the commercial product.
Gross margin: IWM vs. CON

- Costs were not significantly different in all countries and years.

- In IT, scouting and models indicated no herbicides in 5/5 farms in 2011 and in 1/5 in 2012 reducing costs.

- Gross margin was not significantly different in all countries and years.

- In 2012 IT, gross margin affected by decreased yields both in CON and IWM.
Conclusions on IWM vs. CON

Overall, IWM tools tested in the 3 countries:

• (1) provided sufficient weed control without any significant differences in yields,

• (2) greatly reduced maize reliance on herbicides and

• (3) IWM implementation was economically sustainable as no significant differences in gross margin were observed in any country compared to CON

• (4) Capacity building and willingness of farmers and/or contractors important to use tools in the proper way and have sustainable results
THANK YOU FOR LISTENING!

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