Lolium spp., resistance to herbicides in Europe: a challenge

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Agenda

INTRODUCTION
RESISTANCE OF *LOLIUM* SPP. TO HERBICIDES
STATUS IN EUROPE
EUROPE CROPPING SYSTEMS
DISTRIBUTION AND FUTURES PERSPECTIVES
ACKNOWLEDGMENTS
**Introduction**

Main problematic species in Europe. In central northern EU: ALOMY

*Lolium rigidum, Lolium multiflorum and Lolium perenne = Lolium spp.*

*Figure 1.* Unrooted dendrogram constructed using the neighbor-joining method from the RAPD data matrix calculated with the formula given by Nei and Li (1979). The numbers at the tree nodes are bootstrap values reported as percentage.

Where is a problem *Lolium* spp.?

*Lolium* spp. is a problem in:

- France
- Greece
- Portugal
- UK
- Denmark
- Germany
- Italy
- Israel
- Spain
<table>
<thead>
<tr>
<th>Country</th>
<th># Sites of action involved</th>
<th>Sites of action</th>
<th>Biotypes with multiple Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>3</td>
<td>ACCase, ALS, EPSP</td>
<td>NO</td>
</tr>
<tr>
<td>Greece</td>
<td>1</td>
<td>ACCase</td>
<td>NO</td>
</tr>
<tr>
<td>Portugal</td>
<td>1</td>
<td>EPSP</td>
<td>NO</td>
</tr>
<tr>
<td>UK</td>
<td>2</td>
<td>ACCase, PSII</td>
<td>NO</td>
</tr>
<tr>
<td>Country</td>
<td># Sites of action involved</td>
<td>Sites of action</td>
<td>Biotypes with multiple Resistance</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------</td>
<td>-----------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Denmark</td>
<td>2</td>
<td>ACCase, ALS</td>
<td>YES</td>
</tr>
<tr>
<td>Germany</td>
<td>2</td>
<td>ACCase, ALS</td>
<td>YES</td>
</tr>
<tr>
<td>Italy</td>
<td>3</td>
<td>ACCase, ALS, EPSP</td>
<td>YES</td>
</tr>
<tr>
<td>Spain</td>
<td>3</td>
<td>ACCase, PSII, EPSP</td>
<td>YES</td>
</tr>
<tr>
<td>Israel</td>
<td>4</td>
<td>ACCase, ALS, EPSP, PSII</td>
<td>YES</td>
</tr>
</tbody>
</table>
Resistance of *Lolium* spp. by site of action in European affected countries

Data obtained from weedscience.org
Country status ITALY

Wheat (tens of thousands)
Olive grooves (thousands),
Vineyards (hundreds)
Lucerne (hundreds)

ACCase, ALS inhibitors present a low efficacy in wheat. MR to EPSP and ACCase or ALS in Tuscany region.

EPSP inhibiting-herbicides show a low efficacy in perennials.

ACCase inhibitors in lucerne.
Country status ISRAEL

Negev Region (in orange)

Arable crops - irrigated and dry land; orchards, roadsides.

*Lolium* spp. affects to 80,000 of 200,000 ha (cultivated land) which represent 40% of cultivate land.

Low efficacy: in cereals there is ACCase (mostly clodinafop or pinoxaden) and ALS (mostly tribenuron, flometersulam + florasulam, propoxycarbazone + mesosulfuron).
Country status PORTUGAL

10 000 ha aprox. are affected by glyphosate-resistant (FR= 2-9) *L. perenne* in Douro Region (north).

Non estimated area in cereals where pinoxadene present a low efficacy (FR=2) (south).
Glyphosate resistant *L. perenne* in Douro region (North Portugal)
Country status SPAIN

Cereals: North-eastern: ALS-inhibiting herbicide: chlorsulfuron

- Cataluña Region
- Valencia Region
- Andalucía Region
Glyphosate resistant *Lolium* spp. in southern Spain

10 000 ha affected in Jaén Province

Castellón (east of Spain)
Winter cereals: A survey conducted in 2006 / 2007 showed resistance to at least 1 herbicide in 35 out of 50 (70%) farms randomly sampled.

Diclofop-methyl (62%), tralkoxydim (60%), fluazifop-P-butyl (36%) appears to be widespread in England, but resistance to both cycloxydim (20%) and pinoxaden (18%) is much less common.

ACCase biotypes reported.
No updated information obtained from other countries regarding *Lolium* spp. resistant to herbicides.

**Denmark**  
*L. perenne* ssp. *multiflorum* resistant to ACCase and ALS (clodinafop-propargyl, iodosulfuron-methyl-sodium, and pyroxsulam).

**Germany**  
*L. perenne* resistant to ACCase and ALS (idosulfuron-methyl-sodium, pinoxaden, and pyroxsulam). Other: *A. myosuroides* and *A. spica-venti*.

**Greece (Athos)**  
*L. rigidum* resistant to ACCase (diclofop methyl).
Resistance evolution in *Lolium* spp. in wheat.
FRANCE: Survey and mapping of herbicide resistance in cereals.

Resistant to ACCase by department.

Resistant to ALS by department.

Résistance installée: deux graminées, une dicot

**Vulpin**
*Alopecurus myosuroides*
*Cultures d’hiver*
*Résistance aux inhibiteurs de l’ACCase et de l’ALS*

**Ivraie (« ray-grass »)**
*Lolium sp.*
*Cultures d’hiver*
*Résistance aux inhibiteurs de l’ACCase et de l’ALS*
*Résistance au glyphosate (en vigne)*

**Coquelicot**
*Papaver rhoeas*
*Cultures d’hiver*
*Résistance aux inhibiteurs de l’ALS*

**ACCase: résistance très fréquemment rencontrée**

**ALS: résistance en expansion**

**Glyphosate: en vigne, résistance assez peu répandue**
Resistance Mechanisms

Target site

ALS
ACCase
EPSP

Glyphosate viability in sustainable cropping productions. INIA, 2013. In Spanish.
Non-target site

ALS-metabolism
EPSP-sequestration
ACCase-metabolism

Glyphosate viability in sustainable cropping productions. INIA, 2013. In Spanish.
## Control Methods

<table>
<thead>
<tr>
<th>Country</th>
<th>Chemical alternatives/herbicide rotation</th>
<th>Other than chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>Yes</td>
<td>Mowing, crop rotations where possible</td>
</tr>
<tr>
<td>Israel</td>
<td>Yes</td>
<td>Crop rotations where possible</td>
</tr>
<tr>
<td>Portugal</td>
<td>Yes</td>
<td>Mowing</td>
</tr>
<tr>
<td>Spain</td>
<td>Yes</td>
<td>Mowing</td>
</tr>
<tr>
<td>UK</td>
<td>Yes</td>
<td>Delayed drilling, ploughing, stale seed beds</td>
</tr>
</tbody>
</table>

Halflife of *Lolium seeds* is short (2-3 years) so a deep plowing once every 4 years would reduce dramatically the resistant *Lolium’s* emergence.
Cover crops in citrus orchards.
- Weed control nearly 100%!!! without herbicides.
- Excellent control of *Sorhum halepense* and *Rottboellia cochinchinensis*.

*Our conditions:*

- Study of Allelopathy?
- Integration in olive and citrus orchards with an adapted species, i.e. *Medicago, Scorpiurus, Vicia, Melilothus*?
Future challenges

i.e. Portugal has 10 000 ha affected of 179 500 planted = nearly 6%!!

STOP

the “pro” of resistant species

Area (ha) of main cereals in affected countries.

Area (ha) of vineyards in affected countries.

Area (ha) olive grooves in affected countries.
Remarks

1- Collaboration between and among European countries/researchers to have real time data.

2- Make consciousness to farmers/technicians/distributors about the herbicide resistance problem.

3- Further collaboration among “crop” companies.

3- A further survey to know the real problem.

4- Avoid the dissemination of resistant biotypes.

5- Have to use alternative/combined control methods.
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