## Global HRAC Member Companies.

### Our Members:

<table>
<thead>
<tr>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arysta LifeScience</td>
</tr>
<tr>
<td>BASF</td>
</tr>
<tr>
<td>Bayer CropScience</td>
</tr>
<tr>
<td>Corteva Agriscience™, Agriculture Division of DowDuPont</td>
</tr>
<tr>
<td>FMC</td>
</tr>
<tr>
<td>Syngenta Crop Protection</td>
</tr>
<tr>
<td>Sumitomo Chemical Company</td>
</tr>
</tbody>
</table>

### Our Staff:

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair</td>
<td>Mark Peterson - Corteva</td>
</tr>
<tr>
<td>Secretary/Treasurer</td>
<td>Roland Beffa – Bayer</td>
</tr>
<tr>
<td>Communications Lead</td>
<td>Julia Fellmann, Syngenta</td>
</tr>
</tbody>
</table>
Working Groups:

<table>
<thead>
<tr>
<th>Auxin</th>
<th>HPPD</th>
<th>Communications</th>
<th>Issues Engagement</th>
<th>MOA Classification</th>
<th>PPO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terry Wright</td>
<td>Roland Beffa</td>
<td>Julia Fellmann</td>
<td>Harry Strek</td>
<td>Rex Liebl</td>
<td>John Pawlack</td>
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</tbody>
</table>

Key objectives for Working Groups:

- Consolidate and communicate information for specific MOAs
- Monitor research
- Support intellectual dialogue
- Customize BMPs for a given MOA
- Address specific resistance topics (e.g. Monitoring)
Global HRAC
Initiatives and Activities

• Disseminate information on resistant weeds:
  – The International Survey of Herbicide Resistant Weeds
  – HRAC Website
  – Seminars and Symposia

• Build recommendations:
  – Working groups
  – Testing protocols

• Mode of Action Classification:
  – Poster
  – Online tool
  – Coordination with other entities
Regional/Country HRAC Objectives and Actions

- Education materials, seminars, symposia
- Research collaborations
- Collection of information on resistant weeds
- Development of Best Management Practices
## New Resistance cases in Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Weed species</th>
<th>First Year</th>
<th>Active ingredient</th>
<th>Site of Action</th>
<th>Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td><em>Bromus sterilis</em></td>
<td>2017</td>
<td>propoxycarbazone</td>
<td>ALS (B/2)</td>
<td>wheat</td>
</tr>
<tr>
<td>Greece</td>
<td><em>Lolium rigidum</em></td>
<td>2017</td>
<td>glufosinate</td>
<td>Glutamine synthase inhibitor (H/10)</td>
<td>grapes, olives, orchard</td>
</tr>
<tr>
<td>Hungary</td>
<td><em>Sorghum halepense</em></td>
<td>2017</td>
<td>Foramsulfuron / nicosulfuron</td>
<td>ALS (B/2)</td>
<td>Corn</td>
</tr>
<tr>
<td>Serbia</td>
<td><em>Sorghum halepense</em></td>
<td>2017</td>
<td>Fenoxaprop, fluazifop, haloxyfop,…</td>
<td>ACCase (A/1)</td>
<td>Soybean</td>
</tr>
<tr>
<td>Ukraine</td>
<td><em>Echinochloa cruss-galli</em></td>
<td>2017</td>
<td>Imazamox, penoxulam</td>
<td>ALS (B/2)</td>
<td>Rice</td>
</tr>
</tbody>
</table>
2018 Activities and Accomplishments

• Continued engagement with local/regional HRACs
• MOA Classification Working Group completes updates and revisions
• Herbicide MOA app
• PPO Working Group initiated
• Auxin Working Group sponsored review paper
• Review of resistance testing methods in progress
• Survey of HRAC stakeholders completed
Industry Perspective of How to Meet the Herbicide Resistance Challenge

Mark A. Peterson, Global HRAC Chair
Herbicide Resistant Weeds Globally

Number of herbicide-resistant species by country
Challenges of Herbicide Resistance

Undermines sustainability
Hurts our customers
Limits return on investment

Challenges to Resistance Management

Technical
Economic
Societal
How Does Industry Meet These Challenges?

Technical

• Develop new technologies (small and large companies)
• Evaluate integrated programs
• Study resistant weeds to understand mechanisms

Economic and Societal

• Education
• Stewardship programs
• Incentives
Biotechnology

- Gene insertion (adding new DNA)
- Gene editing (manipulating existing DNA)
- Manipulation of transcription (e.g. RNAi)

These technologies offer significant promise
Societal and political acceptance issues are limiting the potential
Uncertainty of market access can cause companies to reconsider investments
Robotic weeding

- Possibly starting to come of age
- John Deere recently acquired Blue River Technology
- Most devices are currently focused on plant-selective spraying (www.seeandspray.com)
- Could non-chemical means be incorporated in the future?

Precision Weed Management

- UAV-mounted sensor technology
- Faster detection of resistant weeds
- Potential to incorporate spot-control devices

Huang, et al. Weed Tech. 2017
Other Alternative Management Tools

- How can technology change crop competitiveness?
- Which companies can bring these technologies forward?

Selective fertilization with phosphite allows unhindered growth of cotton plants expressing the ptxD gene while suppressing weeds

Devendra Pandeyab,1, Damar L. Lópezarredondo b,1, Madhusudhana R. Janga, LeAnne M. Campbella, Priscila Estrella-Hernándezb, Muthukumar V. Bagavathiannac, Luis Herrera-Estrellad,d, and Keerti S. Rathoreran,a,2

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Summary

• Weeds are evolving
• Our thinking must evolve as well
• The Industry needs to work cooperatively and inclusively in some areas
• Public and Private weed scientists as well as farmers need to be open to new ideas and new methods of weed control
Thank You!

Contact us at hracglobal.com