How can **Science** help to Fight Weed Resistance?

The Weed Resistance Competence Centers (WRCC): Weed Resistance Research

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Agenda

- Weed Resistance is a global challenge
- The Weed Resistance Competence Center
- Partnerships
- Bayer’s commitment to Integrated Weed Management
- Summary
Where is it?

The challenge of feeding a growing global population is being made more difficult by the spread of herbicide resistant weeds. Farmers need a varied toolbox of available products and practices to combat the build-up of resistance.

2016: 250 different resistant species in 86 crops and 66 countries – and the trend is continuing upwards!

The most problematic Weeds worldwide

in Corn Farming
- Palmer amaranth (Amaranthus palmeri)
- Waterhemp (Amaranthus tuberculatus)
- Kochia (Kochia scoparia)
- Marestail (Coryza canadensis)
- Ryegrass (Lolium spp.)
- Wild oat (Avena fatua)
- Johnson grass (Sorghum halepense)
- Giant ragweed (Ambrosia trifida)
- Panicum species

in Cereal Farming
- Black grass (Alopecurus myosuroides)
- Wild oat (Avena spp.)
- Loose silky-bent grass (Apera spica venti)
- Ryegrass (Lolium spp.)
- Brome grass (Bromus spp.)

in Soybean Farming
- Digitaria insularis
- Eleusine indica
- Lolium spp.
- Chloris spp.
- Sorghum halepense
- Conyza spp.
- Euphorbia heterophylla
- Bidens spp.
- Amaranthus spp.

in Rice Farming
- Echinochloa spp.
- Leptochloa spp.
- Cyperus spp.
Global herbicide market by MoA

Only 6 MoA classes represent ¾ of the market

2014

2009

Total Value 18 bn €

Total Value 13 bn €

Lack of herbicide diversity = strong resistance selection pressure

R: denotes serious resistance issues
Mission and Objectives of the Weed Resistance Competence Center

As a scientific foundation, the Weed Resistance Competence Center acts as Bayer’s global reference center for weed resistance management.

The Weed Resistance Competence Center has three objectives:

1. It strives to be the leader in weed resistance competence, understanding resistance to herbicides – how resistance mechanisms work, how resistance evolves, and how it can be managed in each field.

2. It wants to take this knowledge and use it to develop and offer the best strategies and specific solutions for resistance management, aiming to tailor them to individual fields for each farmer.

3. It wants to effectively communicate its knowledge and solutions.
Weed Resistance Management: Weed Resistance needs a Holistic Approach

Scouting
- Global oversight & local know-how
- In-field investigation & detection
- Extensive expertise & knowledge base

Diagnostics
- Greenhouse bioassays
- Molecular diagnostics
- Analytical diagnostics

Outreach & Education
- IWM, Mode of action rotation, residuals & mixtures
- Crop rotation, row spacing, seeding rate
- Tillage, selective cultivation, cover crops

Research & Development
- New modes of action
- Breeding & trait development
- Resistance management
“Herbicide resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type.” Darwin evolution law.


**Types of Resistance:**

**Target Site Resistance**
- Site of action specific
- => Change MoA

**Enhanced Metabolic Resistance**
- Site of action unspecific
- => Change to other chemical structure (can be in same MoA group) favoured by low dose applications

Others: Differential uptake, Differential redistribution, sequestration, increased gene copy number, enzyme overexpression (both also TSR), delayed germination, rapid necrosis / defoliation
Leadership in Resistance Diagnostics & Research

Current Diagnostics Methods

- Greenhouse Bioassays
- Metabolic Resistance Analysis
- Target-site Resistance Analysis

Research

- Identification of genes responsible for metabolic resistance
- Resistance evolution and driving factors
- Resistance test kit prototypes
- New herbicide discovery
- Field studies with current products (platform & resistance evolution)

Understanding resistance better helps us to make the best recommendations
Diagnostic Campaign – From the Field to the Gene

- Detection of target-site and metabolic resistances
- In/next-season recommendation

1. Dig out up to 8 black-grass plants
2. Cut off the roots
3. Place two shoots on each sheet of paper
4. Fold the paper and put it back into the bag
5. Pour in the water, remove air bubbles, and close the bag

- Live plant material (for metabolic resistance)
- Also done for seeds e.g. complaint handling
- In close coordination with Bayer teams in countries
- Need to share resources between countries

Rapid logistics and processing can lead to in-season recommendations

Fill in the form! Put all bags into the envelope provided and send it!
Mutation Diagnostics - Target-Site Resistance

Sampling

DNA-Extraction

PCR

Pyrosequencing

Data Storage (ABase)

Analysis (Spotfire)

Visualisation (ArcGis)

Leaf Material

Seeds

Target-Site Resistance / Pyrosequencing® Technology
Herbicide Metabolism Diagnostic

Sampling → Incubation → Extraction → HPLC → Data Storage (ABase) → Analysis (Spotfire) → Visualisation (ArcGis)

Feuilles ← Graines

14C-Labelled Detection Technology

Resistant

Metabolite

Susceptible

Parent

CPS
External collaborations: examples

- Generate mathematical models improving the prediction of weed resistance evolution
- Discover key factors inducing weed resistance to herbicides
- Unravel key genes involved in the metabolic resistance

Current focus EU, US and AUS
Bayer’s Integrated Weed Management (IWM) program offers farmer customized solutions

The Integrated weed Solutions are implemented according to Best Management Practices:
- IWM Principles
- IWM Guidelines
- Product stewardship

Providing integrated solutions for optimized weed control and protect yield

Solution offer based on …

Science & Partnership
- Scientific competence
- Valuable partnerships

Two main approaches to enhance farmers’ productivity and secure food supplies in the long term:
✓ Offering new solutions to increase productivity
✓ Offering solutions solving an issue (e.g. weed resistance management) by proposing the appropriate solution case by case
Spread of ALS-resistant *Apera spica-venti* in Germany

Weed control is field-by-field and can be achieved with the existing solutions, and the application of good practices and recommendations. Keep the soil seedbank as low as possible.
Summary

- Sustainability of **modern herbicides** is at a crossroads because of **resistance**
- Lack of new **resistance-breaking herbicides** is a serious liability
- We need to **sustain the effectiveness of our current products** by getting farmers to use the products as recommended, and combinations including more non-chemical weed control measures to increase diversity ...and
- We need to find **new, effective herbicides**

**Bayer CropScience is investing heavily in the future of weed control**
Thank you for your attention