European HRAC
Update on regional activities

EPPO Resistance Meeting

September 16, 2021

EHRAC Member Companies

ADAMA	Marine DJEDDAH
BASF We create chemistry	Bernd SIEVERNICH
Bayer Crop Science	Mark BARTLETT, Xavier BELVAUX, Hubert MENNE
Corteva agriscience	Eileen PATERSON, Marisa SALAS
FMC FMC CORPORATION	Gilles BERTIN, David HENNENS
Gowan	Barrie HUNT
Nufarm	Simon MOYAL
syngenta	Matt CORDINGLEY
UPL	Marc BONNET

- 9 companies
- 13 members
- Chair (2021-2022)
  Bernd SIEVERNICH, BASF
- Co-Chair
  Mark BARTLETT (BAYER)
- Coordinator
  Alan PORTER (external)
- ~5 meetings/year
  Feb / Apr / July / Sept / Nov
  preferably one F2F
- 3 Working Groups

WG New MoA-Classification

HRAC	Legacy HRAC	
1	A	Inhibition of ACCase
2	B	Inhibition of ALS
3	K1	Inhibition of microtubule assembly
4	O	Auxin mimics
5	C1,2	Inhibition of photosynthesis PS II – Serine 264
6	C3	Inhibition of photosynthesis PS II – Histidine 215
9	G	Inhibition of EPSP synthase
10	H	Inhibition of glutamine synthetase
12	F1	Inhibition of PDS
13	F4	Inhibition of DOXP synthase
14	E	Inhibition of PPO
15	K3	Inhibition of VLCFAs
18	I	DHP inhibition

HRAC	Legacy HRAC	
19	P	Auxin transport inhibitors
22	D	PS I electron diversion
23	K2	Inhibition of microtubule organization
24	M	Uncouplers
27	F2	Inhibition of HPPD
28	none	Inhibition of dihydroorotate dehydrogenase
29	L	Inhibition of cellulose synthesis
30	Q	Inhibition of fatty acid thioesterase
31	R	Inhibition of serine threonine protein phosphatase
32	S	Inhibition of solanesyl diphosphate synthase
33	T	Inhibition of homogentisate solanesyltransferase
34	F3	Inhibition of lycopene cyclase
Ø	Z	Unknown mode of action

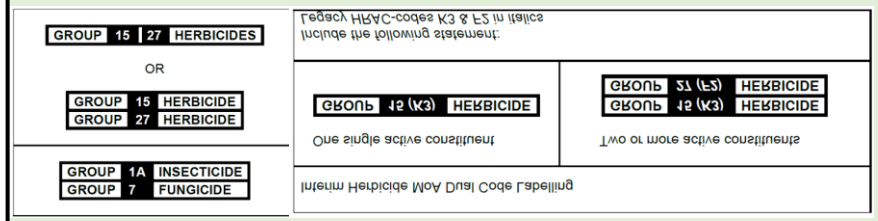
GHRAC

- Published a new MoA-classification in 2020
  - Transition from alphabetical to numerical codes
  - Addition of 5 new or re-classified MoA-groups
  - Rationalization of chemical family names
  - Addition of 15 new active substances

EHRAC activities

Communication on the new HRAC MoA-system (e.g. on national and international conferences) to promote a fast implementation and utilization in practice

Aligned with CLI and GHRAC on a dual MoA labelling recommendation (letter /number) within the CLI MoA Labelling Guidance



Single coding

Dual coding

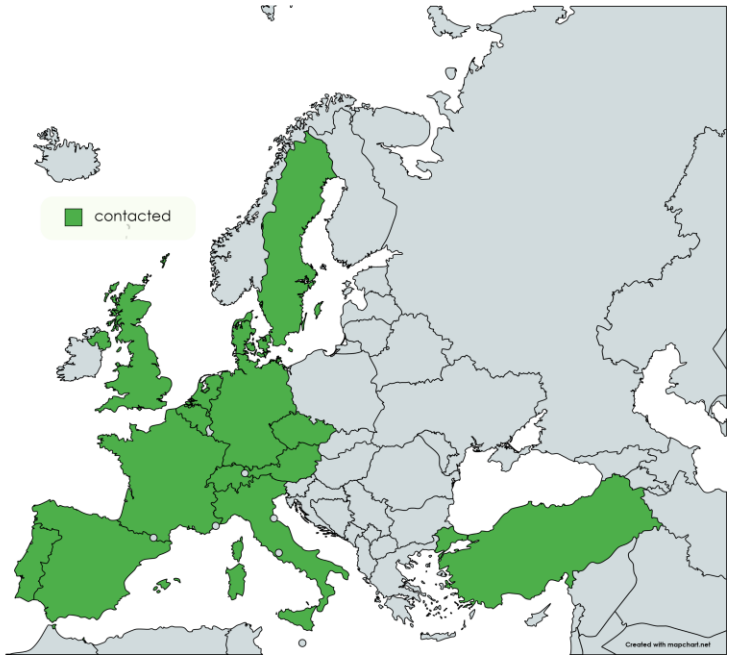
Providing practical advise how to handle integration of former group N into new group 15 (K3)

➔ *Aligned with GHRAC to further support combination or sequence of active substance belonging to former Groups N and K3 (new Group 15)*

WG Herbicide Resistance Country Working Groups

- Connect to national European resistance working groups to promote exchange and collaboration
- EHRAC survey sent out summer 2020 to known Country Working Groups
    1. to introduce EHRAC and provide information on current activities.
    2. to learn about the structure and actions of the ongoing national working groups and
    3. to determine how communication between the organizations could be improved and
       develop effective long-term collaboration
- Key expectations of EHRAC:
    - Help connecting with the working groups in other countries
    - Help setting up national working groups in the countries where there is none
    - Facilitate a smooth transition to the new HRAC MoA classification by providing information
      to regulatory and advisory bodies
    - Data dissemination, knowledge sharing and collaborative actions
    - Be an active group (not only an online page), sharing ideas/actions/research with the
      national country groups
- **Virtual meeting scheduled for November 09, 2021**

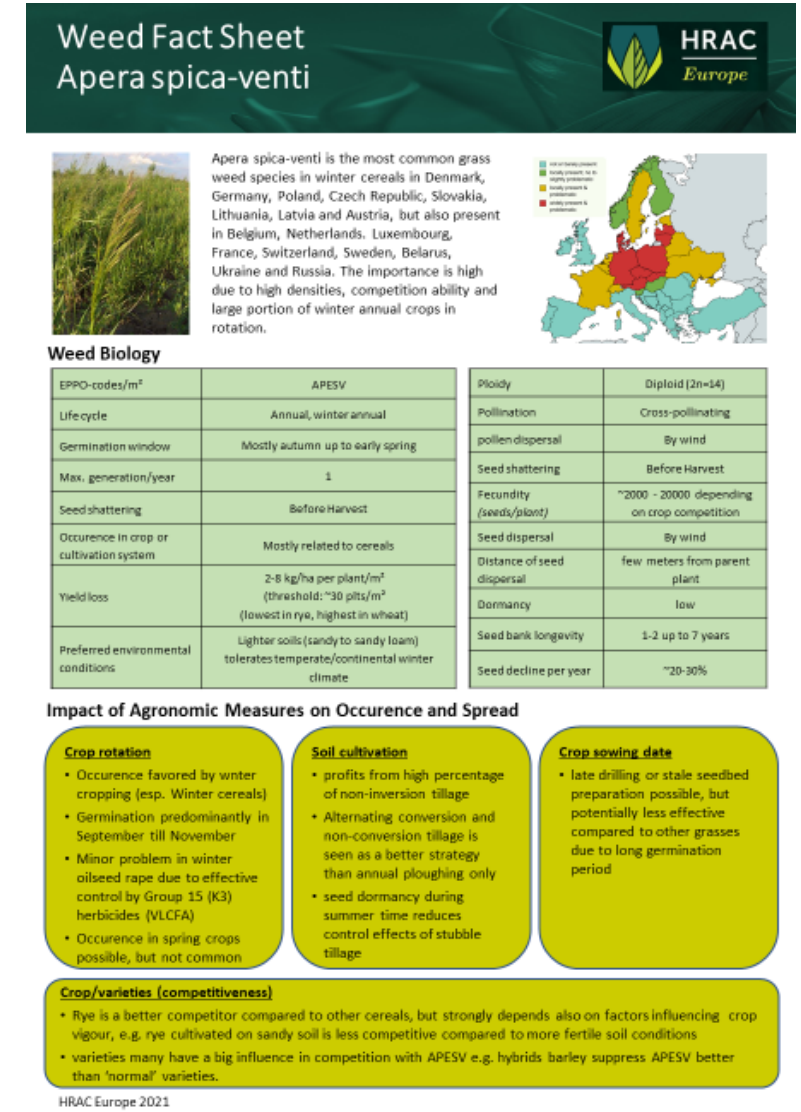
Contacted Countries



WG Weed Fact Sheets

- Provide information related to the
  - Biology,
  - Resistance status and
  - Best Management Practise

  of important European weeds prone to develop resistance
- Shall provide a quick overview on information related to the importance and problem severity
- Does not list individual cases of resistance
- Support given by well acknowledged scientist and institutes
- First round started with:
  - *Apera spica-venti*
  - *Bromus sterilis*
  - *Echinochloa crus-galli*
  - *Lolium* spp



Weed Fact Sheet
Apera spica-venti

HRAC Europe

Apera spica-venti is the most common grass weed species in winter cereals in Denmark, Germany, Poland, Czech Republic, Slovakia, Lithuania, Latvia and Austria, but also present in Belgium, Netherlands. Luxembourg, France, Switzerland, Sweden, Belarus, Ukraine and Russia. The importance is high due to high densities, competition ability and large portion of winter annual crops in rotation.

Weed Biology

EPPO-codes/m²	APESV
Life cycle	Annual, winter annual
Germination window	Mostly autumn up to early spring
Max. generation/year	1
Seed shattering	Before Harvest
Occurence in crop or cultivation system	Mostly related to cereals
Yield loss	2-8 kg/ha per plant/m² (threshold: ~30 plts/m² (lowest in rye, highest in wheat)
Preferred environmental conditions	Lighter soils (sandy to sandy loam) tolerates temperate/continental winter climate

Ploidy	Diploid (2n=14)
Pollination	Cross-pollinating
pollen dispersal	By wind
Seed shattering	Before Harvest
Fecundity (seeds/plant)	~2000 - 20000 depending on crop competition
Seed dispersal	By wind
Distance of seed dispersal	few meters from parent plant
Dormancy	low
Seed bank longevity	1-2 up to 7 years
Seed decline per year	~20-30%

Impact of Agronomic Measures on Occurence and Spread

Crop rotation
- Occurence favored by wnter cropping (esp. Winter cereals)
- Germination predominantly in September till November
- Minor problem in winter oilseed rape due to effective control by Group 15 (K3) herbicides (VLCFA)
- Occurence in spring crops possible, but not common

Soil cultivation
- profits from high percentage of non-inversion tillage
- Alternating conversion and non-conversion tillage is seen as a better strategy than annual ploughing only
- seed dormancy during summer time reduces control effects of stubble tillage

Crop sowing date
- late drilling or stale seedbed preparation possible, but potentially less effective compared to other grasses due to long germination period

Crop/varieties (competitiveness)
- Rye is a better competitor compared to other cereals, but strongly depends also on factors influencing crop vigour, e.g. rye cultivated on sandy soil is less competitive compared to more fertile soil conditions
- varieties many have a big influence in competition with APESV e.g. hybrids barley suppress APESV better than 'normal' varieties.

HRAC Europe 2021

Recent resistance cases :www.weedscience.org

Date last updated	Species	Country	First Year	Crop	Site of action
August 30, 2021	*Amaranthus retroflexus*	Ukraine	2020	Corn (maize), and Sunflower	Inhibition of Acetolactate Synthase HRAC group 2/B
August 11 2021	*Alopecurus myosuroides*	Switzerland	2019	Wheat, and Winter barley	**Multiple resistance: 2 sites** Inhibition of the Acetyl CoA Carboxylasa HRAC group 1/A Inhibition of Acetolactate Synthase HRAC group 2/B
August 11 2021	*Lolium perenne* spp. multiflorum	Switzerland	2018	Sugar beets, and Triticale	**Multiple resistance: 2 sites** Inhibition of the Acetyl CoA Carboxylasa HRAC group 1/A Inhibition of Acetolactate Synthase HRAC group 2/B
August 11 2021	Lolium *perenne spp. multiflorum*	Switzerland	2018	Peas	**Multiple resistance: 2 sites** Inhibition of Acetolactate Synthase HRAC group 2/B Inhibition to PSII – Ser264 binder HRAC group 5/ C1, C2
August 11 2021	*Sorghum halepense*	Serbia	2018	Soybean	**Multiple resistance: 2 sites** Inhibition of the Acetyl CoA Carboxylasa HRAC group 1/A Inhibition of Acetolactate Synthase HRAC group 2/B
March 9, 2021	*Oryza sativa* var. sylvatica	Turkey	2020	Rice	Inhibition of Acetolactate Synthase HRAC group 2/B
August 19, 2019	*Conyza sumatrensis*	Turkey	2019	Peaches	Inhibition of Enolpyruvyl Shikimate Phosphate Synthase HRAC Group 9/G
December 16, 2020	*Bromus rubens*	Spain	2018	Almonds, Olive, and Orchards	Inhibition to Enolpyruvyl shikimate phosphate synthase HRAC group 9/G
November 26, 2020	*Bromus madritensis*	Spain	2018	Grapes, and Olive	Inhibition to Enolpyruvyl shikimate phosphate synthase HRAC group 9/G
June 22, 2020	*Hordeum murinum* ssp. leporinum	Spain	2018	Olive, and Orchards	Inhibition of Enolpyruvyl Shikimate Phosphate Synthase HRAC Group 9 (Legacy G)
September 2, 2019	*Rapistrum rugosum*	Spain	2018	Winter barley, and Winter wheat	Inhibition of Acetolactate Synthase HRAC Group 2 (Legacy B)
November 13, 2020	*Elusine indica*	Italy	2019	Nurseries	Inhibition to Enolpyruvyl shikimate phosphate synthase HRAC group 9/G
October 20, 2020	*Amaranthus tubeculatus* (=A. radis)	Israel	2019	Corn (maize), Cotton, and Sunflower	Inhibition of Acetolactate Synthase HRAC group 2/B
October 1, 2020	*Apera spica venti*	Belgium	2019	Wheat	Inhibition of Acetolactate Synthase HRAC group 2/B

Recent resistance cases

Date last updated	Species	Country	First Year	Crop	Site of action
October 24, 2019	*Capsella bursa-pastoris*	Norway	2019	Wheat	Inhibition of Acetolactate Synthase HRAC Group 2 (Legacy B)
July 3, 2020	*Conyza canadiensis*	France	2019	Grapes	Inhibition to Enolpyruvyl shikimate phosphate synthase HRAC group 9/G
May 13, 2019	*Galinsonga parviflora*	France	2018	Endive	Inhibition of Acetolactate Synthase HRAC Group 2/B
December 15, 2018	*Lolium perenne* spp. multiflorum	France	2018	Wheat	Very Long-Chain Fatty Acid Synthesis inhibitors HRAC Group 15/K3,N
September 10, 2020	*Avena fatua*	Ireland	2019	Spring Barley, and Winter barley	Inhibition of the Acetyl CoA Carboxylasa HRAC group 1/A