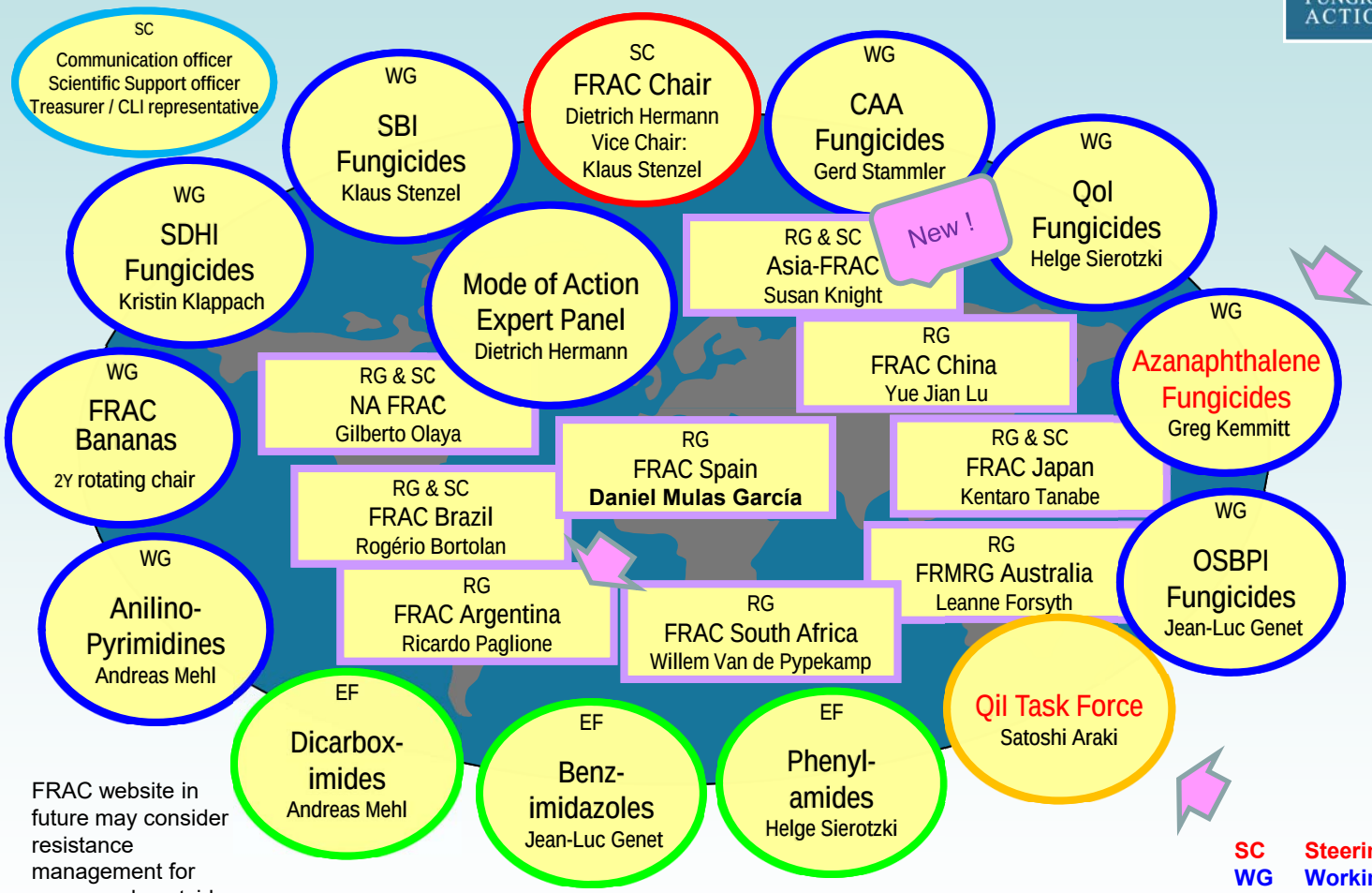
2017 FRAC Update

EPPO Resistance Panel

Paris, 11 September 2018

Organization of FRAC – What's New?



FRAC website in future may consider resistance management for compounds outside WGs/EF

SC Steering Committee
WG Working Group
EF Expert Forum
RG Regional FRAC Group

Organization of FRAC – What's New?

- FRAC Argentina: Very active
- Asia FRAC
  - Asian countries now realize the importance of resistance management
  - Clear interest in improving awareness of modes of action and resistance management strategies
- FRAC Azanaphthalenes
  - Following the merger of Dow and DuPont (Corteva™ Agriculture Division of DowDuPont) this working group will cease to operate
  - Will continue to publish resistance status & recommendations on the FRAC website
- FRAC QiI Task Force
  - Currently for oomycete fungicides (Nissan & ISK)
  - Considering including fenpicoxamid (Corteva™) once cross-resistance is established (a challenge since no known spectrum overlap)

FRAC Steering Committee 2018

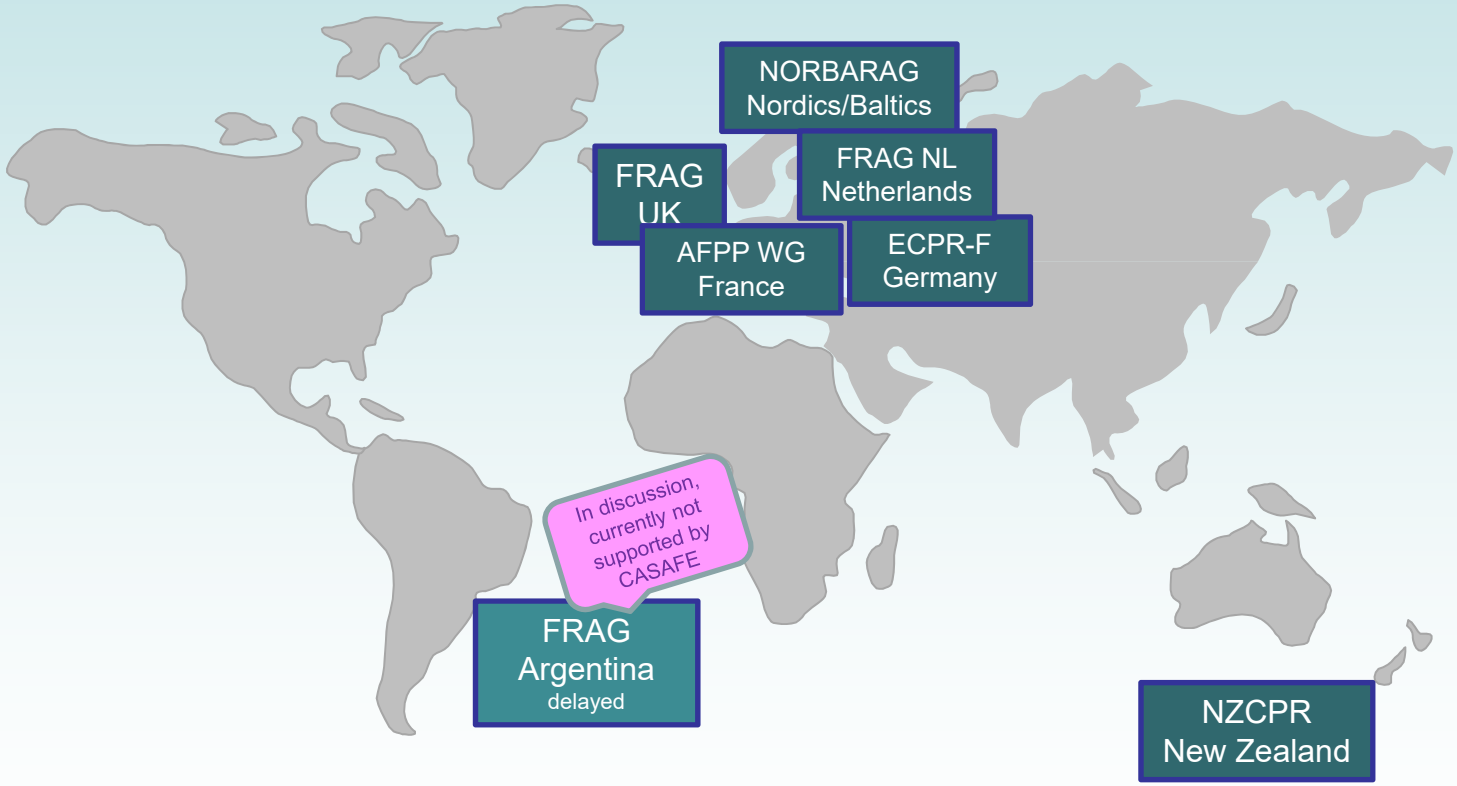
Name	Company	FRAC Role
Dr. D. Hermann	Syngenta	Chairman FRAC, Chairman MoA Expert Panel
Dr. K. Stenzel	Bayer	Vice Chairman FRAC, Chairman SBI Fungicides WG
Mr. D. McKenzie		Scientific Support Officer
Dr Anika Bartholomaeus	Bayer	FRAC Treasurer
Dr. J. Derpmann	Bayer	Communication and Website Officer
Dr. G. Kemmitt	Dow-DuPont	Chairman Azanaphthalene WG; FRAC-MoA Poster
Dr. A. Mehl	Bayer	Chairman Anilinopyrimidines WG & Dicarboximide Expert Forum
Dr. G. Stammler	BASF	Chairman CAA Fungicides WG
Dr. Kristin Klappach	BASF	Chairwoman SDHI Fungicides WG
Dr. H. Sierotzki	Syngenta	Chairman QoI-WG & Phenylamides Expert Forum
Mr. J.-L. Genet	Dow-DuPont	Chairman OSBPI-WG & Benzimidazoles Expert Forum
Dr. K.-H. Lorenz	BASF	Chairman Banana FRAC 2018-20
Dr. K. Tanabe	Nippon Soda JP	Representative Japan FRAC (Chair), QiI Task Force representative
Dr. G. Olaya	Syngenta USA	Representative North America FRAC (Chair)
Mr. R. Bortolan	Bayer Brazil	Representative Brazil FRAC (Chair)
Dr. Susan Knight	Syngenta APAC	Representative Asia FRAC (Chair)
Mr. A Ward	*CLI*	*Stewardship director, CLI representative*

New !

- FMC and Sumitomo invited to send a representative to the FRAC SC
- The FRAC SC meets 2x annually for a 1.5 day meeting
- Ad hoc approvals by E-mail or via teleconferences
- Monthly calls between Chair and Vice Chair

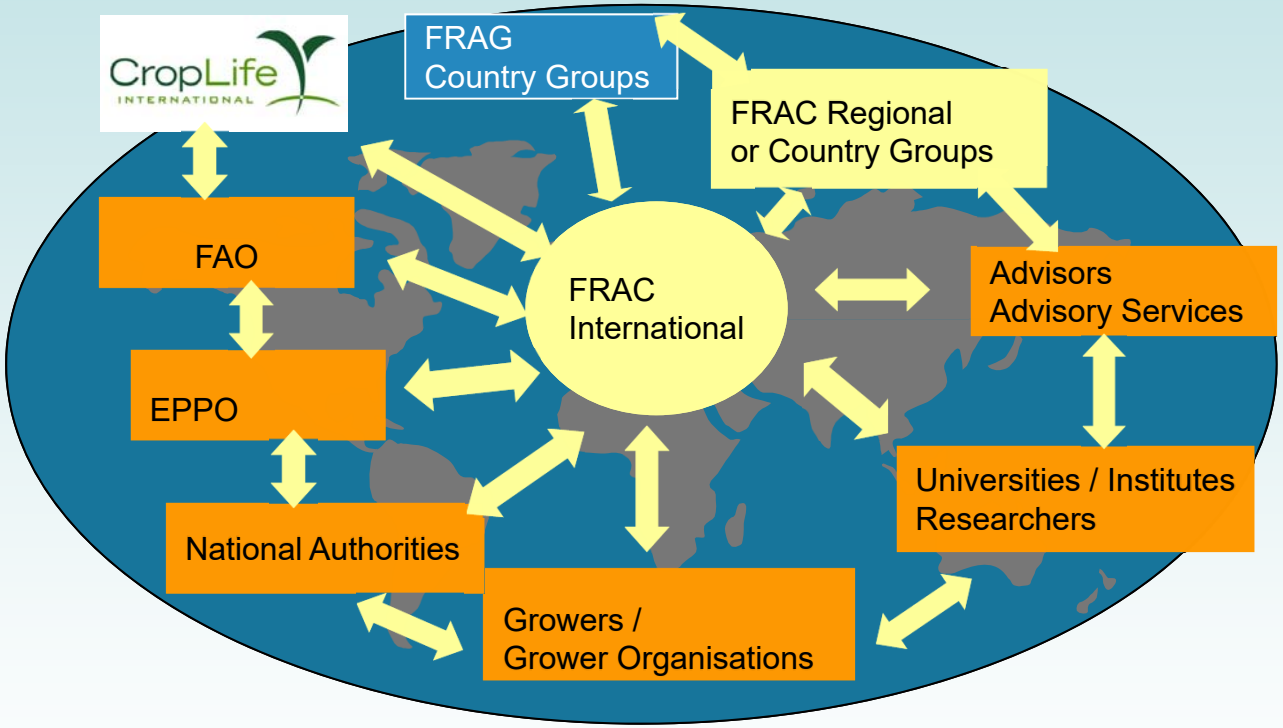
Outreach to other national groups

National fungicide resistance action groups are led by representatives of national institutes and regulatory authorities, with industry representation.



Global FRAC 2018

FRAC - Outreach



Recent FRAC Publication

Importance of multisite fungicides in managing pathogen resistance

The Fungicide Resistance Action Committee (FRAC) is a Specialist Technical Group of CropLife International. The purpose of FRAC is to provide fungicide resistance management guidelines to prolong the effectiveness of "at risk" fungicides and to limit crop losses should resistance occur.

FRAC Guidelines for resistance management are produced by the individual FRAC Working Groups and Expert Fora. These Guidelines provide information on how to use specific areas of fungicide chemistry for control of plant diseases on various crops while maintaining a good anti-resistance strategy.

One of the key recommendations is to make use of multisite fungicides (see FRAC Group M) in spray programs, especially in crops with multiple sprays such as fruits and vegetables, or certain arable crops. Due to their mode of action, multisite fungicides are considered as a low resistance risk group. Therefore, they offer the possibility for use as mixing partners or alternating with single site and other medium to high resistance risk fungicides. Over the past decades, no cases of field resistance against multisites have been reported.

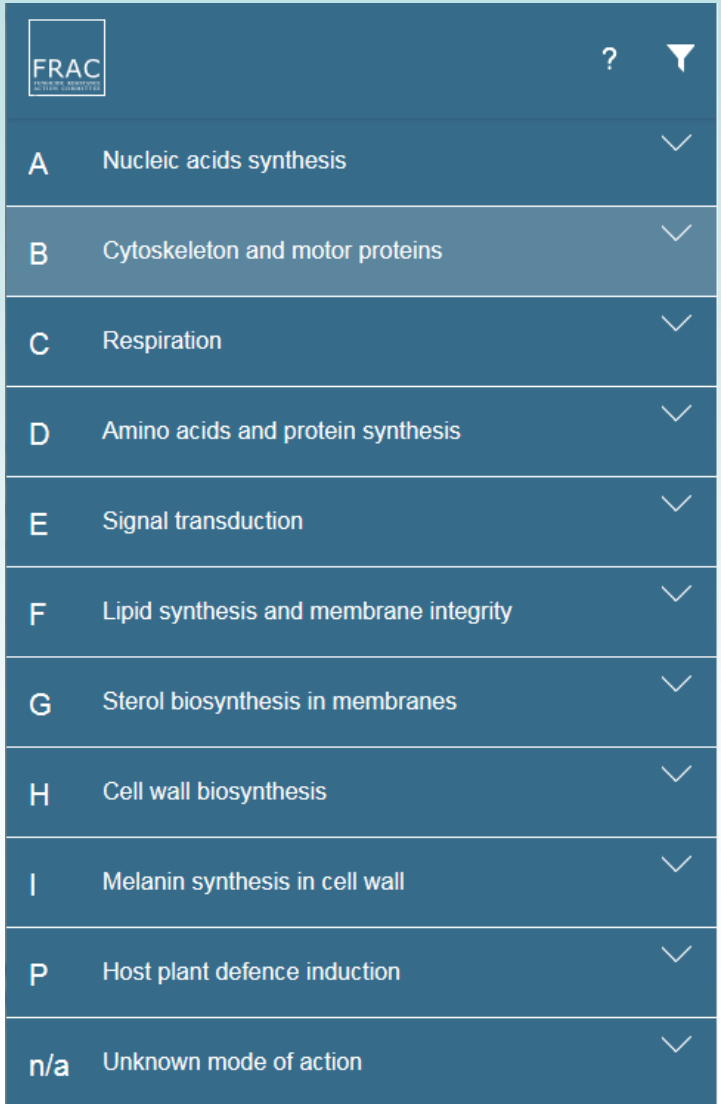
There are clear benefits to recommending multi-site fungicides in spray programs:

- Multisite fungicides display a low risk to develop resistance and are effective mixing/alternating partners for medium to high risk fungicides.
- Beyond protecting and prolonging the lifespan of highly effective medium to high resistance risk fungicides, multisite fungicides provide added levels and spectrum of disease control. With this they can also support the single sites to be even more efficient.
- Multisite fungicides are considered a valuable tool to manage resistance by preventing or delaying its development to many pathogens in many crops.
- In some crops, multisites play an increasing role in spray programs to sustain effective disease control and resistance management, e.g. for *Zymoseptoria tritici* in wheat, *Ramularia collo-cygni* in barley and for *Phakopsora pachyrhizi* in soybeans.

Restricting the use of multisite fungicides from use in important crops could result in faster development of resistance to single site mode of action fungicides. This in turn could lead to epidemic disease development, serious crop losses, and finally the loss of highly effective fungicides for a sustainable disease management.

June 2018

FRAC MoA APP



Get the FRAC Mode of Action App:
https://play.google.com/store/apps/details?id=info.frac.moa
https://itunes.apple.com/de/app/frac-moa/id1225391696?mt=8

AI's not covered by WG or EF

- Active ingredients with unique mode of action or from a single company
- Plan to publish resistance status and company use recommendations
- Volunteer basis
- Draft example for the AZN here

Resistance management recommendations and proposals for Fungicides not includedz in current working groups as requested by manufacturers

Compound	Quinoxyfen , Proquinazid
Chemistry	Azanapthalenes
FRAC MoA Code	13
TAREGT SITE AND CODE	E1 - Signal transduction (mechanism unknown)
Uses	Powdery mildew control in wheat, barley, grapevines, stone fruit, cucurbits, peppers, hops, strawberries
Resistance status	• Resistance known to these molecules in *Erysiphe necator*. • Medium risk. • Resistance management required. • Cross resistance with proquinazid found in *Erysiphe necator* but not in *Blumeria graminis*
Recommendations	**Recommendations for cereals** • Apply Group 13 fungicides preventatively. • Apply a maximum of 2 Group 13 fungicides containing sprays per crop solo or in mixture (co-formulations or tank mixes) with effective mixture partners from different cross-resistance groups. • If a second application is needed, it should be in tank-mix with an effective powdery mildewicide with another mode of action. • Always follow product specific label recommendations for resistance management. **Recommendations for grapes** • Apply Group 13 fungicides preventatively. • Group 13 fungicides must be applied in spray programs with fungicides of a different mode of action. • Apply a maximum of 3 Group 13 fungicide containing sprays per season, solo or in mixture

FRAC
FUNGICIDE RESISTANCE ACTION COMMITTEE

Update from Working Groups 2017

SBI Working Group

- **Wheat Septoria**
  - In 2017 the sensitivity of the populations was overall stable on an European level with regional differences
  - In regions with limited options in fungicides classes and/or use of significantly reduced rates DMIs are at higher risk and performance might be impacted
- **Barley Ramularia**
  - Field performance was regionally significantly affected.
  - Relevant CYP51-mutations have been identified (I325T, I328L, Y403C/Y405H)
  - Very high frequency of high resistant strains in southern Germany
- **Barley Net Blotch** (Pyrenophora teres)
  - In 2017 significant shifts of sensitivity of populations in France.
  - Highest EC50 values were observed in areas of high disease pressure, coupled with the break-down of variety-resistance and sub-optimal use of azoles in programs
- **Other pathogens**
  - The sensitivity level was on the same level as in previous years

QoI Working Group

- **Barley Pyrenophora teres**: increase in resistance frequency
- **Potato Alternaria solani**: low to high frequency of resistance
- **Botrytis of soft fruits**: high frequency of resistance
- **OSR Sclerotinia**: Sensitive. AOX involvement to be elucidated
- **Rice Pyricularia**: High levels detected in Vietnam. No resistance in Europe, China & Indonesia
- First report of QoI resistance in **Pythium spp in corn**
- Twelve regions/countries were added to the database

SDHI Working Group

- The most active Working Group
- Resistance monitoring conducted globally on 15 crops and 27 pathogens
- **Wheat Septoria:** Mutation H152R detected in 2017 again in Ireland and the United Kingdom and for the first time in Germany
- **Barley net blotch**: Mutations C-G79R and C-H134R are the most frequently detected in Europe
- **Barley Ramularia**: Low to high frequency of mutations observed in Germany, France, United Kingdom, Ireland and Netherlands
- **Soybean rust**: No to high frequencies of less sensitive populations were observed in the South of Brazil
- Resistance confirmed at moderate levels in **cucurbit powdery mildew**, **potato Alternaria & Helminthosporium**, higher levels in **strawberry and grape Botrytis**
- **Fully sensitive** situation for wheat powdery mildew, yellow rust & brown rust, barley scald, *M. nivale, Ustilago nuda*, apple scab, apple powdey mildew, potato *Rhizoctonia,* stone fruit *Monilinia*.
- All data now published on the FRAC webpage
- No changes to guidelines
- Sumitomo joined the working group (Inpyrfluxam)

Anilinopyrimidines (AP) Working Group

- **Botrytis** in grapes, vegetables, strawberries: resistance levels unchanged
- **Apple scab** (Venturia inaequalis): situation unchanged
- **Use recommendations** unchanged
- The MoA group name will be changed following a paper on the mode of resistance soon to be published

CAA Working Group

- Resistance of **downy mildew on grapes** is moderate to high and being monitored by region
- ***Phytophthora infestans*** still remains sensitive
- No data for other pathogens
- No changes to the recommendations

Azanaphthalenes (AZN) Working Group

FRAC
FUNGICIDE RESISTANCE ACTION COMMITTEE

- **Wheat powdery mildew** - The situation remains stable
- **Grape powdery mildew** - Some reduced sensitivity reported in a number of regions in Europe but no complaints
- **Use recommendations** remain unchanged

OSBPI Working Group

- Corteva (DowDuPont) and Syngenta
- Resistance monitoring started or planned by both companies in all global regions:
  - European Union
  - Africa: South Africa
  - Asia Pacific: Japan, China, Taiwan, Korea, India, Indonesia, Australia
  - Latin America: Brazil, Argentina, Uruguay, Colombia, Ecuador, Mexico,
  - North America: USA, Canada
- All 2017 samples were fully sensitive

QiI Task Force

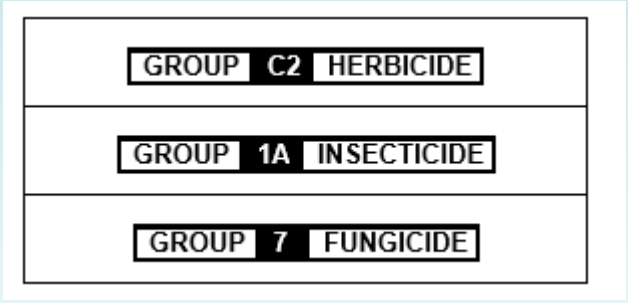
- Currently only oomycete fungicides amisulbrom & cyazofamid
- **Grape downy mildew** *(Plasmopara viticola):* non-specific alternative respiration (AOX) isolates found in France 2016, however specific resistant against QiI Fungicide has been not detected
- **Potato late blight** *(Phytophthora infestans):* No resistant isolate of against QiI fungicides was detected in FR, GB, DE, NL, IT, BE in 2015, 2016.
- Use recommendations for both pathogens unchanged

MoA Code List 2018 (published in March): Agreed and implemented updates

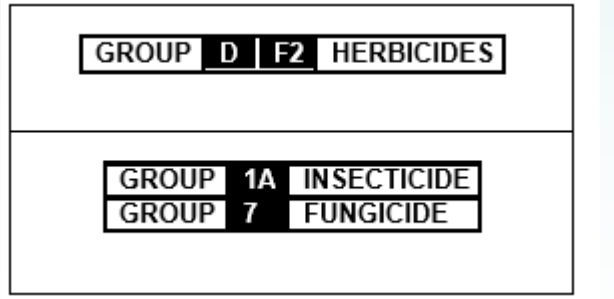
- Fenpicoxamid (QiI), isoflucypram (SDHI), inpyrfluxam (SDHI) and fluindapyr (SDHI) are now on the FRAC code list.
- Mefentrifluconazole (SBI) will be included in 2019.
- Metyltetraprole (QoI): Sumitomo has been asked but have not yet agreed to inclusion.

MoA Labelling

Examples with single ai



Products with 2 or more ais



CropLife INTERNATIONAL

Mode of Action Labelling Guidance

Mode of Action Labelling
The development of resistance is a critical focus for the crop protection industry. The more farmers use a pesticide with the same mode of action (MoA), without another overlapping MoA and/or non-chemical control measures, the more likely it is that pests will develop resistance. Academics and industry experts agree that sequential applications or applying mixtures of products with different effective MoAs are key strategies to delay the onset of pest resistance.

The crop protection industry understands the consequences of the development of resistance and is proactively taking the lead in addressing the problem. CropLife International with the support of the fungicide, herbicide and insecticide resistance Action Committees (RACs), is advancing the understanding and practice of responsible resistance management. All RACs have communication resources which include websites, training modules, brochures and posters to emphasize the need to increase diversity in pest control, in particular by using several efficient MOAs in sequence or in mixtures.

The inclusion of MoA information on product labels, supported by training and other resources, is critical to ensure growers have the information they need to follow resistance management guidelines. MoA labelling is currently only a regulatory requirement in a small number of countries, however there are strong indications that more countries will make it mandatory in the foreseeable future.

Industry Commitment
To support the widespread adoption of responsible resistance management practices, CropLife International members have made a voluntarily commitment to include MoA icons and groups on all product labels by 2023. The inclusion of MoA information on product labels will ensure growers have simple access to critical information to support implementation of resistance management.

CropLife International encourages all pesticide manufacturers to adopt this MoA labelling icon approach, for managing pesticide resistance and the stability of crop production. CropLife International would encourage pesticide regulatory authorities to consider the mandatory use of the icons and the global icon format or at least allowing them to be voluntarily displayed on the label.

MoA Labelling Guidance
The MoA labelling provides a clear and simple method to inform, pesticide retailers and users, the type of pesticide and its mode of action group. The MoA groups can be used to identify products with the same mode of action; these should not be used repetitively. It is recommended that pesticides are used as part of an integrated pest management strategy in order to maximize pest control and sustainably manage pesticide effectiveness.

Labelling Specifics
It is recommended that the MoA icon is displayed in a prominent position on the label. A clearly defined font should be used, e.g. Arial or Calibri for users of Latin script. A black and white colour scheme is recommended.

The icon uses the word GROUP in capital letters in black font on a white background; the mode of action letter or numeral should be in white font on a black background; the word HERBICIDE (or FUNGICIDE or INSECTICIDE) in capital letters in black font on a white background. Both lines, and the whole indicator, are contained within black rectangles. See examples below.

Other FRAC Activities

- Joint review of resistance monitoring data for Soybean in June 2018 for QoI, SDHI, DMI & FRAC Brazil. Not a new Working Group
- Considering a similar approach for barley Ramularia
- FRAC list of Resistant Plant Pathogens updated on FRAC website as of December 2017: http://www.frac.info/docs/default-source/publications/list-of-resistant-plant-pathogens/list-of-resistant-plant-pathogenic-organisms_dec2017.docx?sfvrsn=34014b9a_2
- The FRAC Pathogen Risk List is being updated
- Aspergillus fumigatus – project to be completed in 2018