2015 FRAC Update

EPPO Resistance Panel

Lyon, 14-15 September 2016

Role and Purpose of FRAC

- The main goal of **FRAC** is to provide resistance management advice and guidelines and thereby sustain the effectiveness of “at risk” fungicides
- **FRAC** represents a centre of knowledge and expertise, and seeks via effective networking with independent bodies to actively promote effective resistance management.
- **FRAC** offers a wide range of services (publications, FRAC code lists, methods, training) to assist researchers, advisors and growers.
- Key route for communication is the FRAC website: www.frac.info

FRAC works proactively

- Seeking scientific knowledge
- Carrying out science in resistance, in the member companies, with universities, extension scientists, governments, EPPO, etc etc.
- Constantly monitoring populations, sharing knowledge
- Working with other experts to give best advice on disease management and fungicide resistance management strategies

List of FRAC International member companies

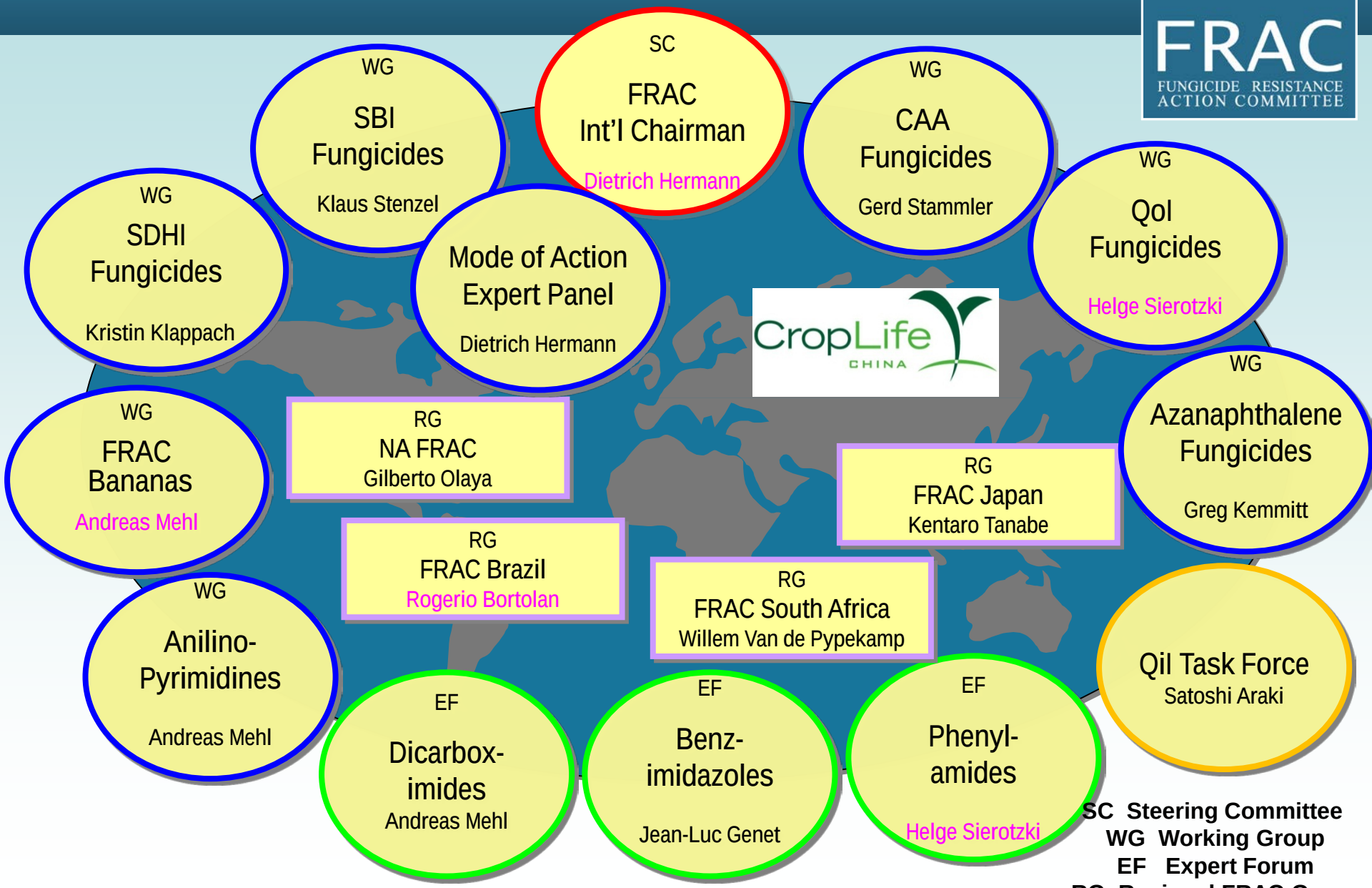
- ADAMA Agricultural Solutions
- BASF
- Bayer Crop Science
- Dow
- DuPont
- FMC
- Isagro
- KI Chemical
- Sumitomo
- Syngenta

Note: Several other companies are represented in regional groups and on working groups

FRAC Organisation Changes

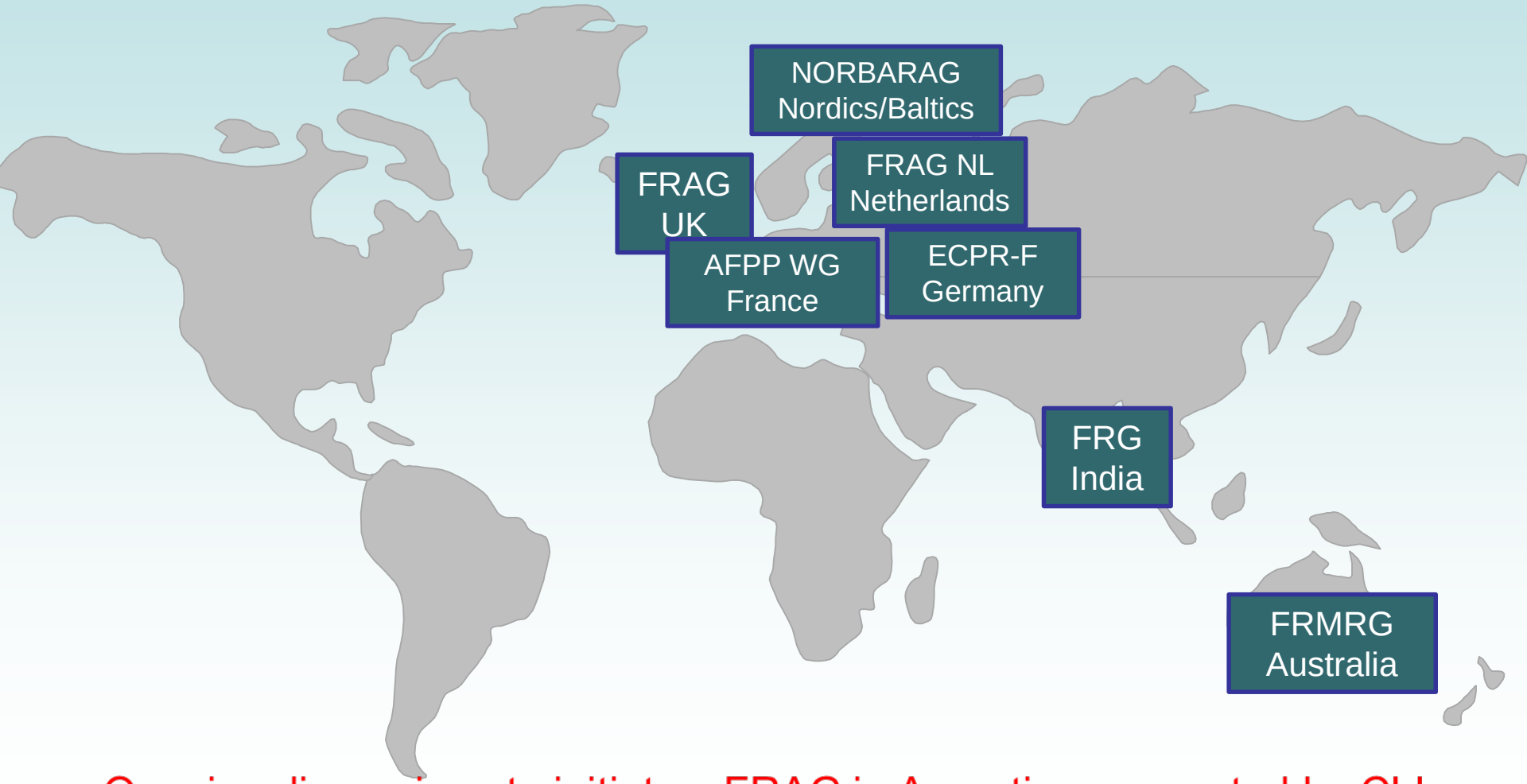
- **Dietrich Hermann** (Syngenta) elected as Chairman of the FRAC steering committee. **Klaus Stenzel** (BCS) confirmed as vice-chair.
- **Helge Sierotzki** (Syngenta) now chairman of the FRAC QoI WG and FRAC PA expert forum.
- **Andreas Mehl** (BCS) now chairman of the FRAC Banana WG.
- **Craig Austin** (DuPont) elected as FRAC Communication Officer.
- **Rogerio Bortolan** (BCS) elected as chairman of FRAC Brazil.
- ISK considering to join NAFRAC SDHI group (isofetamid).
- DuPont and Syngenta have proposed to form a formal working group for oxathiapiprolin (OSBPI) to be formally validated in December 2016.
- Formation of new Arylphenyl-ketones WG (Metrafenone, Pyriofenone) pending.

Organisation of FRAC



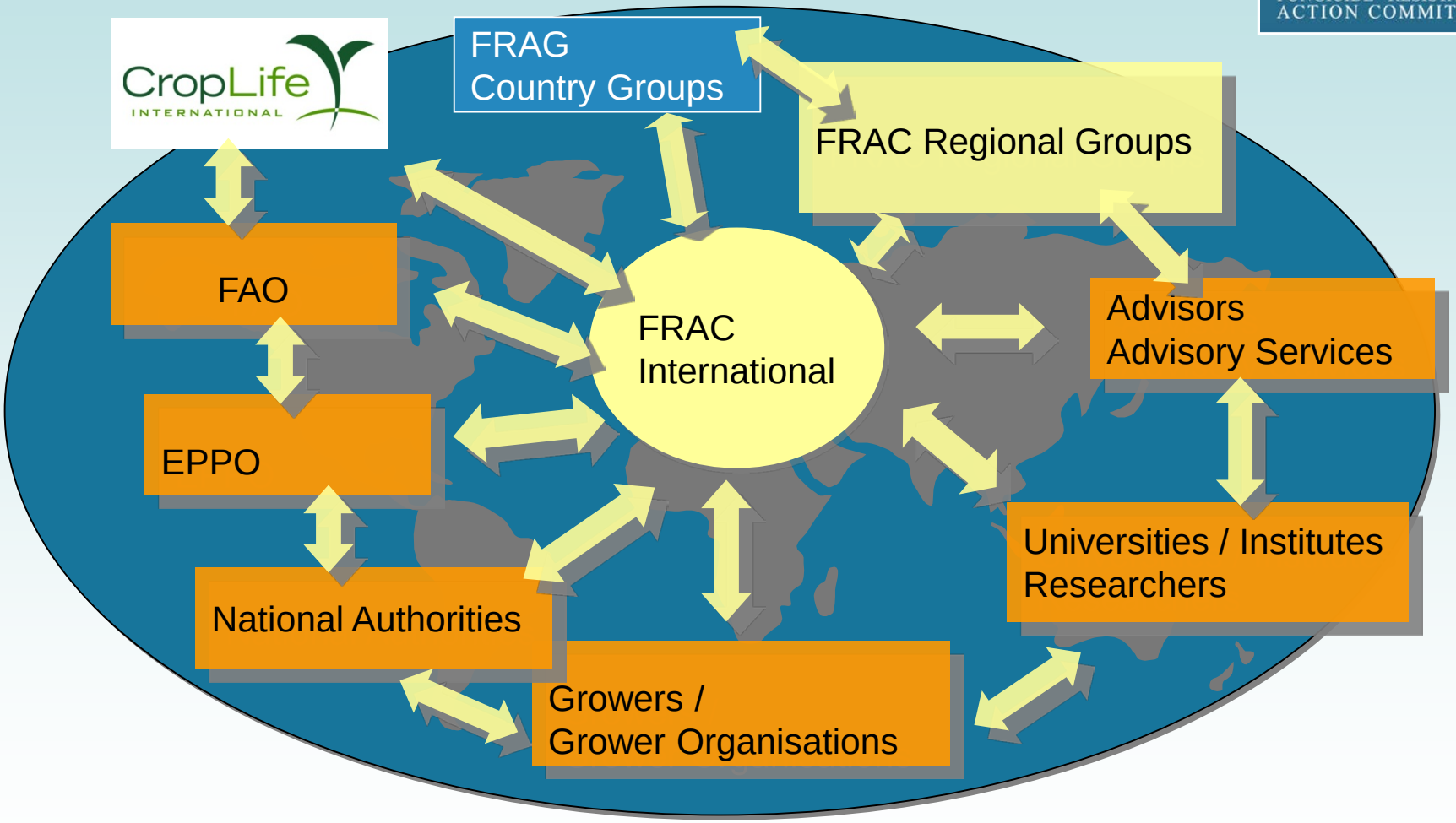
SC Steering Committee
WG Working Group
EF Expert Forum
RG Regional FRAC Group

Outreach to other national groups



- Ongoing discussions to initiate a FRAG in Argentina, supported by CLI

FRAC – Outreach, Influence and Politics



Resistance Management Strategies

FRAC
FUNGICIDE RESISTANCE ACTION COMMITTEE

- **Use of good plant protection practice**
  - **resistant crop cultivars, non-chemical control, husbandry systems, crop rotations, tillage systems, efficient application**
- **Application of Plant Protection Products**
  - **limit the number of applications of a chemical class (mode of action = MOA) to reduce selection pressure***
  - **restrict application timing to the optimum for pest control**
  - **respect the recommended use rate**
- **Use of Mixtures and Alternations**
  - *** limiting number of application is most effective when used in combination with mixtures / alternations of different MOAs**
  - **mixture / alternation partners must be a different MOA and effective**
  - **mixtures / alternations reduce the selection pressure and provide more robust disease control**
  - **resistance risk declines as number / area of applications with the product declines**
  - **relies upon a diversity of modes of action being available for a target disease**

FRAC Leaflet

Working Together Globally To Manage Fungicide Resistance

FRAC
FUNGICIDE RESISTANCE ACTION COMMITTEE

Fungicide resistance affects all those concerned with crop health; farmers and growers, as well as the advisors and industry who provides advice and products to ensure healthy productive crops.

Sound resistance management is key to ensure optimum crop yields and quality. It helps maintain the effectiveness and number of modern fungicides that are available to farmers and growers. Resistance and poor disease control in the field could quickly lead to overuse of some fungicides as users strive to control their disease problems, leading in turn to increased and undesirable loading on the environment.

FRAC, the Fungicide Action Committee, was formed in 1982. It operates as an expert group within CropLife International and has the following objectives: (1) providing advice to producers, suppliers and users of crop protection products on how best to use fungicides in order to avoid, delay and manage fungicide resistance in crops worldwide and (2) providing educational material to train people in the science of fungicide resistance and its management. FRAC members are frequent contributors to scientific publications, conferences and symposia.

FRAC is a specialist technical group of:
CropLife INTERNATIONAL

FRAC Leaflet

FRAC
FUNGICIDE RESISTANCE ACTION COMMITTEE

Update from Working Groups

2015

SBI Working Group

- In general stable situation.
- **Septoria** - Slight increase in frequency of resistance reported for some locations, notably DE and UK. Thought to be brought on by high pressure and less azole use. Recommendations were amended to emphasize the need to follow use recommendations strictly.
- **Soybean rust** - Slight shifts in sensitivity to DMIs were reported but there were few samples.
- **Botrytis** - High resistance frequencies for KRIs against *Botrytis* on grapes and strawberries reported and recommendations were amended to use only in strict alternation, no block application

QoI Working Group

- Monitoring results show little changes regarding the sensitivity situation. In general stable situation.
- No changes were made to the general recommendations.
- Soybean rust:
  - In 2015, the mutation F129L has been found in the majority of the samples throughout Brazil and Paraguay, which can lead to reduced sensitivity.
  - In regions where target site mutations in key target soybean pathogens are present mixtures are mandatory.
  - Discussions on the robustness of the mixture partners e.g. multi-sites.
- Corn Grey Leaf Spot (*Cercospora zeae-maydis*):
  - Initial analysis confirmed the presence of the intron, preventing the G143A mutation. All studied strains from US showed cyt b wild-type sequence.
- Some changes are being considered for the use of QoIs on rice.

CAA working Group

- The situation was generally stable and there were no changes to the recommendations
- Data on pathogens of lower importance were often requested but are difficult to generate.

Anilinopyrimidines (AP) Working Group

- Overall, the situation was stable.
- The frequency of *Venturia* resistance was reported to be lower than in 2014.
- Some discussion concerning MDR and a publication by Syngenta is expected in the near future.
- No change in use recommendations.

SDHI Working Group

- **Septoria** – first isolates with high resistance factors in IRE
- **Barley net blotch** – stable situation compared to 2014
- **Ramularia barley** –first time occurrence of strains with strongly decreased dose-response in bioassays, carrying the mutation sdhC-H142R or sdhC-H149R.
- **Grape powdery mildew** – **single isolates carrying mutations** in sdh were identified, field performance not affected
- **Apple scab** - cases of resistance detected e.g. ES
- **White mold, OSR** – So far full sensitivity. Discrepancies between FRAC and French findings centered on methodology, geographic distribution and recommendations
- **Phoma, OSR** (*L.biglobosa*) – full sensitivity
- **Grey mold** – further cases detected but no sign. increase was reported
- **Alternaria** – single resistant mutations reported from different vegetable crops, no sign. increase
- **Soybeans** – rust monitoring data showed full sensitivity
- ***Helminthosporium solani*** and ***Rhizoctonia solani*** were monitored for the first time – full sensitivity
- No changes to recommendations

SDHI Working Group

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Crop	Common name	Pathogen	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Asparagus		STEMBO												no monitoring		no monitoring	no monitoring	
Carrots	Carrot leaf spot	ALTEDA											no monitoring			no monitoring	no monitoring	
Cereals, wheat	Eye spot	eye spot														no monitoring	no monitoring	
Cereals, barley	Powdery mildew	PUCCHD										no monitoring		no monitoring			no monitoring	
Cereals, wheat	Brown rust	PUCCRT																
Cereals, barley	Net blotch	PYRNTE																
Cereals, barley	Ramularia	RAMUCC																
Cereals, barley	Scald	RHYNSE																
Cereals, wheat	Septoria	SEPTTR																
Cereals, wheat	Powdery mildew	ERYSGT																
Cereals, wheat	Snow mold	MONGNI																ongoing
Cucurbits	Corynespora leaf blotch	CORYCA									no monitoring	no monitoring	no monitoring	no monitoring		no monitoring	no monitoring	
Cucurbits	Gummy stem blight	DIDYBR									non-FRAC	no monitoring	no monitoring	no monitoring	no monitoring	no monitoring	no monitoring	
Cucurbits	Powdery mildew	P.xanthii, SPHRFU									US case not confirmed							
Grapes	Grey mold	BOTRCI																
Grapes	Powdery mildew	UNCINE													no monitoring			
OSR	Phoma	LEPTBI (B-type, more aggressive)										no monitoring						
OSR	Phoma	LEPTMA (A-type)										no monitoring						
OSR	White mold	SCLESC																
Ornamentals	Grey mold	BOTREL									no monitoring	no monitoring	no monitoring	no monitoring	no monitoring	no monitoring	no monitoring	
Pomefruit	Powdery mildew	PODOLE															no monitoring	
Stonefruit	Brown rot	MONISP															no monitoring	
Pomefruit	Scab	VENTIN																
Potato	Early blight	ALTESP														no monitoring	no monitoring	
Potato		HELMSO																
		RHIZSO																
Potato, tomato	Brown leaf spot	ALTEAL										no monitoring						
Potato, tomato	Early blight	ALTESO																
Strawberry	Grey mold	BOTRCI																
Vegetables	Grey mold	BOTRCI																
Soybean		CORYCA																
Soybean	Soybean rust	PHAKPA																

AZN Working Group

- Wheat powdery mildew
  - No major change in sensitivity recorded.
  - Field performance remains good
  - No changes to current resistance risk management recommendations

- Grape powdery mildew
  - No significant change of overall EU wide sensitivity of *E. necator* populations. Resistant isolates continue to be reported in several countries.
  - Performance remains good when used in rotational spray programs
  - No changes to current resistance risk management recommendations

- Cucurbit powdery mildew
  - No monitoring was conducted in 2015.
  - Field performance remains as expected when the product is used according to label recommendations

QiI Draft Recommendations (unchanged)

FRAC
FUNGICIDE RESISTANCE ACTION COMMITTEE

Plasmopara viticola – Grape downy mildew

- Apply QiI fungicides preferably in a preventive manner
- Apply a maximum of 50 % of the total number of intended applications for disease control not exceeding a total of 4 QiI fungicides sprays during one crop cycle
- Apply QiI fungicide based products according to manufacturers' instructions

Phytophthora infestans – Late blight of potatoes

- Apply QiI fungicides preferably in a preventive manner
- Apply a maximum of 50 % of the total number of intended applications for late blight control
- Alternation with fungicides having other modes of action is recommended in spray programs
- Apply QiI fungicide based products according to manufacturers' instructions

OSBPI Use Recommendations (1)

- The number of foliar applications of OSBPI products within a total disease management program must be limited as follows:
  - Grapes: Make no more than two (2) applications per season.
  - All other crops:
    - Make no more than four (4) applications or 33% of the total period of protection needed per crop, whichever is more restrictive.
    - Where the total number of fungicide applications targeting oomycetes is less than three (3), apply no more than one (1) application of an OSBPI product
    - There should be no more than two (2) foliar applications of any OSBPI product for the control of soil-borne pathogens
- Applications of OSBPI products are to be made no more than three (3) times in sequence before applying a fungicide with a different mode of action
- Applications of OSBPI products can be made in alternation with a fungicide with a different mode of action

OSBPI Use Recommendations (2)

- **Seed/soil treatments**:
  - No foliar fungicide application of an OSBPI fungicide should be made following a seed/soil treatment* with OSBPI fungicides targeting the same pathogen.
- **Multiple crops**:
  - On multiple crops, do not make more than six (6) foliar applications of OSBPI product per year on the same acreage, targeting the same pathogen.
  - Do not make more than one seed/soil treatment application of OSBPI per year on the same acreage, targeting the same pathogen.
- **Nursery crops**:
  - OSBPI products must not be used in nursery production of transplanted agricultural crops.

* Directed stem sprays are interpreted as a foliar not a soil application

FRAC Code List

FRAC Code List ©*2016: Fungicides sorted by mode of action (including FRAC Code numbering)

MOA	TARGET SITE AND CODE	GROUP NAME	CHEMICAL GROUP	COMMON NAME	COMMENTS	FRAC CODE
A: nucleic acids synthesis	A1: RNA polymerase I	PA – fungicides (PhenylAmides)	acylalanines	benalaxyl benalaxyl-M (=kiralaxyl) furalaxyl metalaxyl metalaxyl-M (=mefenoxam)	Resistance and cross resistance well known in various Oomycetes but mechanism unknown. **High risk. See FRAC Phenylamide Guidelines for resistance management**	4
			oxazolidinones	oxadixyl		
			butyrolactones	ofurace		
	A2: adenosin-deaminase	hydroxy-(2-amino-) pyrimidines	hydroxy-(2-amino-) pyrimidines	bupirimate dimethirimol ethirimol	Medium risk Resistance and cross resistance known in powdery mildews. Resistance management required.	8
	A3: DNA/RNA synthesis (proposed)	heteroaromatics	isoxazoles	hymexazole	Resistance not known.	32
			isothiazolones	octhilinone		
	A4: DNA topoisomerase type II (gyrase)	carboxylic acids	carboxylic acids	oxolinic acid	Bactericide. Resistance known. Risk in fungi unknown. Resistance management required.	31

Fungicides in the same group are cross-resistant

Fungicides in different groups are NOT cross-resistant

FRAC Mode of Action Classification

- FRAC does not make product recommendations or endorsements
- Inclusion of a fungicide / natural product / biological in the list is purely a technical classification according to mode of action based upon scientific data
- It is not an "Approval" by FRAC
- It is not an endorsement by FRAC that any products based upon the active ingredient are "valuable for resistance management"
- Inclusion in the FRAC list should not be used in promotional / advertising material by companies

FRAC Code List Updates

- Inclusion of Phenamacril to B6, code 47
- Inclusion of Pydiflumetofen to C2, code 7
- Picarbutrazox, group name changed to tetrazolyloxime
- Guanidines – Dodine: Distinction into Guanidines (U12) and bis-guanidines (M7) agreed. Need clarity on X-resistance between guanidines and bis-guanidines
- BLAD polypeptide included as M12 (Multitarget MoA).
- Zinc-Thiazole –multisite compound (M3)
- Validamycin - formerly H3 - classify as U18
- Compounds on radar for future inclusion:
  - Pyraziflumid (NF0721),
  - Dipymetitrone (BCS), IR9792 SDHI (FMC/Isagro - fluindapyr not approved)
  - Ipfentrifluconazole, mefentrifluconazole (BASF),
  - Quinofumelin (Mitsui),
  - Dichlobentiazox (Kumiai),
  - Plant oils – Eugenol, Geraniol, Thymol (FRAC code F7) :

FRAC Methods

In a joint effort to create standardized methods, members of different FRAC Working Groups have reviewed and collected detailed, ready-to-use bioassay techniques to monitor fungal pathogens of economic importance.

The following requirements were considered while establishing these techniques:

- The method must be robust, reliable and repeatable
- It must be as simple as possible to operate in terms of technology and user skills
- It should be as cheap to operate as possible and capable of a high throughput in a short time
- The data obtained must be able to be related to sensitivity responses in the field