

SDHI
Working Group

FRAC
FUNGICIDE RESISTANCE
ACTION COMMITTEE

Succinate Dehydrogenase Inhibitor (SDHI) Working Group

4th Meeting on December 1, 2010

Protocol of the discussions and use recommendations of the SDHI Working Group of the Fungicide Resistance Action Committee (FRAC)

Participants

BASF	Kristin Klappach (Chairwoman) Randall Gold Gerd Stammler Martin Semar
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Bayer CropScience	Helene Lachaise (via telecon) Andreas Mehl Dominique Steiger
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Du Pont	Robert Bird (excused) Jean-Luc Genet
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LKC (repres. Mitsui)	Matthew Kane
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Syngenta	Tyler Harp Andy Leadbeater Helge Sierotzki Steve Dale
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Venue:

Lindner Hotel & Conference Centre, Frankfurt/ Main, Germany

1. Monitoring Results 2010 (FRAC members)

1.1 Cereal diseases

Wheat – Septoria leaf blotch (*Mycosphaerella graminicola*)
(Bayer CropScience, Syngenta, BASF, DuPont)

Extensive monitoring programmes were carried out since 2003. All isolates tested were sensitive, within the baseline.

Wheat – brown rust (*Puccinia recondita*)
(Bayer CropScience, Syngenta)

Extensive monitoring programmes were carried out since 2005. All isolates tested were sensitive, within the baseline.

Wheat – eye spot (*Oculimacula yallundae*, *O. acuformis*)
(Bayer CropScience)

Extensive monitoring programmes were carried out since 2003. All isolates tested in 2009 were sensitive, within the baseline.

Barley – rust (*Puccinia hordei*)
(Bayer CropScience)

Extensive monitoring programmes were carried out since 2005. All isolates tested were sensitive, within the baseline.

Barley – net blotch (*Pyrenophora teres*)
(Bayer CropScience, Syngenta, Du Pont , BASF)

Extensive monitoring programmes were carried out since 2003. All isolates tested were sensitive, within the baseline.

Barley – scald (*Rhynchosporium secalis*)
(Bayer CropScience , Syngenta, BASF, DuPont)

Extensive monitoring programmes were carried out since 2003. All isolates tested were sensitive, within the baseline.

Ramularia leaf spot (*Ramularia collo-cygni*)
(Bayer CropScience, Syngenta, BASF)

Preliminary baseline results show full sensitivity (Germany, Switzerland).

1.2. Grape diseases

Grape grey mould (*Botrytis cinerea*)
(Bayer CropScience, BASF)

Extensive monitoring programmes were carried out since 2003.
In 2010, resistance was confirmed at several locations in Germany and detected by FRAC for the first time in France, Hungary and Austria. No resistance was detected in Spain, Portugal and Italy.

When used according to manufacturers' recommendations, field performance of SDHI containing products is good.

Grape powdery mildew (*Erysiphe necator*)
(Bayer CropScience, BASF)

Extensive monitoring programmes were carried out since 2003. All isolates tested were sensitive, within the baseline (Spain, Portugal, France, Italy, Germany).

1.3 Pomefruit diseases

Apple scab (*Venturia inaequalis*)
(Bayer CropScience, Syngenta, BASF)

Extensive monitoring programmes were carried out since 2005.

All isolates tested were sensitive, within the baseline.

All populations tested during the 2010 monitoring program were sensitive, within the baseline (Portugal, Spain, France, Belgium, Netherlands, Italy, Austria, Germany, Lithuania, Poland, Denmark).

Apple powdery mildew (*Podosphaera leucotricha*)
(BASF, Syngenta)

All isolates tested were sensitive, within the baseline (UK, Belgium, Netherlands, Germany, France, Spain, Lithuania, Portugal, Austria, Switzerland, Poland).

1.4. Cucurbit diseases

Cucurbit powdery mildew (*Sphaerotheca fuliginea*, syn. *Podosphaera xanthii* *Erysiphe cichoracearum*)
(BAYER CROPSCIENCE, BASF)

Extensive monitoring programmes were carried out since 2005.

A few resistant isolates were detected in 2010 in France.

No resistance was detected in monitoring studies in 2010 in Italy and Spain,.

1.5 Other crops

Strawberries – grey mould (*Botrytis cinerea*)
(Bayer CropScience, BASF, DuPont)

Extensive monitoring programmes were carried out since 2003. In 2010, resistance was detected in Germany, Spain, Belgium, Poland, France and in the UK.

When used according to manufacturers recommendations, field performance of SDHI containing products is good.

Oilseed rape – Sclerotinia (*Sclerotinia sclerotiorum*)
(BASF)

Extensive monitoring programmes were carried out since 2006.

All sites tested in 2008 were sensitive, within the baseline with one exception: few isolates were found at one site (France) with sensitivity outside of the baseline. In 2009, no resistant isolates were detected (France, Germany, UK).

A few suspicious isolates were identified in FR in a routine monitoring programme in 2010 and are under further investigations. Field performance was not affected.

Oilseed rape (*Leptosphaeria maculans*, *L.biglobosa*)
(BASF)

All isolates tested were sensitive, within the baseline (UK, Austria, Poland, Germany).

Potato (*Alternaria solani*, *A.alternata*)
(BASF)

Monitoring studies in 2009 and 2010 show full sensitivity (F, NL, UK)

Carrot (*Alternaria dauci*)
(BASF)

Monitoring studies in 2009 and 2010 show full sensitivity (GR, UK, F, NL, D)

2. Detection of Resistance (other monitoring data sources, non-FRAC)

A complete overview on resistant plant pathogenic organisms, including published cases of SDHI resistance, can be viewed in the publications area of the FRAC website. See the [List of Resistant Plant Pathogens](#).

3. Use Recommendations

3.1 General SDHI Guidelines (all crops)

- Strategies and General Guidelines for the 2011 season
 - Strategies for the management of SDHI fungicide resistance, in all crops, are based on the statements listed below. These statements serve as a fundamental guide for the development of local resistance management programs.
 - Resistance management strategies have been designed in order to be proactive and to prevent or delay the development of resistance to SDHI fungicides.
 - A fundamental principle that must be adhered to when applying resistance management strategies for SDHI fungicides is that:

The SDHI fungicides (benodanil, bixafen, boscalid, carboxin, fenfuram, fluopyram, flutolanil, fluxapyroxad, furametpyr, isopyrazam, mepronil, oxycarboxin, penflufen, penthiopyrad, sedaxane, thifluzamide) are in the same cross-resistance group.

- Fungicide programs must deliver effective disease management. Apply SDHI fungicide based products at effective rates and intervals according to manufacturers' recommendations.
 - Effective disease management is a critical component to delay the build-up of resistant pathogen populations.
 - The number of applications of SDHI fungicide based products within a total disease management program must be limited.
 - When mixtures are used for SDHI fungicide resistance management, applied as tank mix or as a co-formulated mixture, the mixture partner:
 - should provide satisfactory disease control when used alone on the target disease
 - must have a different mode of action
 - SDHI fungicides should be used preventively or at the early stages of disease development.
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3.2 SDHI Guidelines – Grapes

- Apply SDHI fungicides according to manufacturers' recommendations.
- When mixtures are used for SDHI fungicide resistance management, applied as tank mix or as a co-formulated mixture, the mixture partner:
 - should provide satisfactory disease control when used alone on the target disease
 - must have a different mode of action
- Apply a max. of 3 SDHI-containing fungicides per year over all diseases, solo or in mixture with effective mixture partners from different cross-resistance groups.
- A maximum of 4 SDHI fungicide applications may be used where 12 or more fungicide applications are made per crop.
- If used solo, apply SDHI fungicides in strict alternation with fungicides from a different cross-resistance group.
- If used in mixture, apply SDHI fungicides in a maximum of 2 consecutive applications.
- Apply SDHI fungicides preventively.
- For SDHI fungicide applications specifically targeted against grey mould, *Botrytis cinerea*, refer to the table below.

Grey mould (*Botrytis cinerea*) spray table:

Total number of <i>Botrytis cinerea</i> spray applications per crop	1	2	3	4	5	6	>6
Maximum recommended Solo SDHI fungicide sprays (apply in strict alternation)	1	1	1	2	2	2	3
Max. recommended SDHI fungicide sprays in mixture (apply a max. of 2 consecutive applications)	1	1	2	2	2	3	3

3.3 SDHI Guidelines – Pomefruit

- Apply SDHI fungicides according to manufacturers' recommendations.
- When mixtures are used for SDHI fungicide resistance management, applied as tank mix or as a co-formulated mixture, the mixture partner:
 - should provide satisfactory disease control when used alone on the target disease
 - must have a different mode of action
- Apply SDHI fungicides using not more than 2 consecutive applications.
- Apply SDHI fungicides preventively.

The following spray table shall be used as a guideline irrespective of the targeted disease in pomefruits.

Total number of spray applications per crop	1	2	3	4	5	6	7	8	9	10	11	12	>12
Maximum recommended Solo SDHI fungicide sprays	1	1	1	1	2	2	2	3	3	3	3	4	4
Max. recommended SDHI fungicide sprays in mixture	1	1	2	2	2	3	3	3	3	3	3	4	4

3.4 SDHI Guidelines – Stonefruits

- Apply SDHI fungicides according to manufacturers' recommendations.
- When mixtures are used for SDHI fungicide resistance management, applied as tank mix or as a co-formulated mixture, the mixture partner:
 - should provide satisfactory disease control when used alone on the target disease
 - must have a different mode of action
- Apply a max. of 3 SDHI-containing fungicides per year over all diseases, solo or in mixture with effective mixture partners.

- If used solo, apply SDHI fungicides in strict alternation with fungicides from a different cross-resistance group.
- If used in mixture, apply SDHI fungicides in a maximum of 2 consecutive applications.
- Apply SDHI fungicides preventively.

3.5 SDHI Guidelines – Other multi-spray crops (e.g. vegetables, including small berries and strawberries)

- When mixtures are used for SDHI fungicide resistance management, applied as tank mix or as a co-formulated mixture, the mixture partner:
 - should provide satisfactory disease control when used alone on the target disease
 - must have a different mode of action

The following spray table shall be used as a guideline irrespective of the targeted disease in the crops specified above.

Total number of spray applications per crop	1	2	3	4	5	6	7	8	9	10	11	12	>12
Maximum recommended Solo SDHI fungicide sprays (apply in strict alternation)	1	1	1	1	2	2	2	3	3	3	3	4	*
Max. recommended SDHI fungicide sprays in mixture (apply a max. of 2 consecutive applications)	1	1	1	2	2	3	3	3	3	3	4	4	*

* When more than 12 fungicide applications are made, observe the following guidelines:

- When using a SDHI fungicide as a solo product, the number of applications should be no more than 1/3 (33%) of the total number of fungicide applications per season.
- For programs in which tank mixes or pre-mixes of SDHI are utilized, the number of SDHI containing applications should be no more than 1/2 (50%) of the total number of fungicide application per season.
- In programs where SDHIs are made with both solo products and mixtures, the number of SDHI containing applications should be no more than 1/2 (50%) of the total no. of fungicide applied per season.

3.6 SDHI Guidelines - Banana

Guidelines for the use of SDHI fungicides in banana are published by the Banana FRAC working group (next meeting scheduled for 2012).

3.7 SDHI Guidelines – Cereals 2010

- Apply SDHI fungicides always in mixtures
 - The mixture partner:
 - should provide satisfactory disease control when used alone on the target disease
 - must have a different mode of action
 - Apply a maximum of 2 SDHI fungicide containing sprays per cereal crop.
 - Apply the SDHI fungicide preventively or as early as possible in the disease cycle. Do not rely only on the curative potential of SDHI fungicides.
 - Strongly reduced rate programs including multiple applications must not be used. Refer to manufacturers' recommendations for rates.
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3.8 All other crops

- Refer to the general guideline for the use of SDHI fungicides.
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3.9 Seed treatment

SDHIs are and will be used in seed treatment products.

It is FRAC's target to protect this fungicide group and integrate all uses in technical recommendations.

Therefore FRAC is working on a proposal to judge if and how seed treatments should be considered within resistance management strategies.