Succinate Dehydrogenase Inhibitor (SDHI) Working Group

2nd Meeting on February 6, 2009, 10:15 am – 4:00 pm
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
Bayer CropScience	Helene Lachaise Andreas Mehl Dominique Steiger
Du Pont	Jean-Luc Genet
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Participants, excused

Du Pont	Robert Bird
Syngenta	Paul Varney

Venue:

Sheraton Hotel and Towers, Frankfurt Airport, Germany

Source: www.frac.info
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1. Monitoring Results 2008 (FRAC members)

1.1 Cereal diseases

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

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

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

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

Wheat – eye spot (*Oculimacula herpotrichoides*)
(Bayer CropScience , BASF)

Extensive monitoring programmes were carried out since 2003. All isolates tested 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)

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

1.2. Grape diseases

Grape grey mold (*Botrytis cinerea*)
(Bayer CropScience, Du Pont, BASF)

Extensive monitoring programmes were carried out since 2003.
In 2006, isolates with SDHI resistance were detected at two sites in Germany.
In 2007, resistance was confirmed at a few locations in Germany and one location in Spain. No resistant isolates were detected in France, Italy, Portugal, Greece.

In 2008, resistance was confirmed in few locations in Germany. No resistance was detected in France, Portugal, Spain, Austria, Switzerland 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.

1.3 Pomefruit diseases

Apple scab (*Venturia inaequalis*)
(Du Pont, Bayer CropScience, Syngenta)

Extensive monitoring programmes were carried out since 2005.
All isolates tested were sensitive, within the baseline.
2008 monitoring is still in progress with no reported resistance cases recorded so far.

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

All isolates tested were sensitive, within the baseline (Belgium, Germany).

1.4. Cucurbit diseases

Cucurbit powdery mildew (*Sphaerotheca fuliginea, Erysiphe cichoracearum)*
(Bayer CropScience, BASF)

Extensive monitoring programmes were carried out since 2005.
A few resistant isolates were detected in 2007 in the Netherlands.
No resistance was detected in monitoring studies in 2008.

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

Leaf spot on cucurbits (*Corynespora cassiicola*)
(Mitsui)

Monitoring was carried out since 2005. In 2005, the first resistant isolate in *Corynespora cassiicola* has been detected in Japan.
Where resistance has been detected, field performance of SDHI containing products may be affected.

1.5 Other crops

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

Extensive monitoring programmes were carried out since 2003.
In 2007, isolates with SDHI resistance were detected at a few locations in Germany. No resistance was detected in Belgium, Italy, UK and Austria.
In 2008, resistance was detected at a few locations in Germany, Spain and in the UK. No resistance was detected in Belgium.

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 isolates tested were sensitive, within the baseline.

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

List of confirmed cases of resistance to SDHI.

Crop	Disease	Geography	Source, reference
Pistachio	*Alternaria alternata*	US, California	Avenot HF, Michailides TJ (2007). Resistance to boscalid in *Alternaria alternata* isolates from pistachio in California. *Plant disease* **91** (10), 1345-1350
Cucurbits	*Corynespora cassiicola*	Japan, Ibaraki	Miyamoto T, Ishii H, Seko T, Tomita Y, Kobori S & Ogawara T (2007). Occurrence of boscalid-resistant isolates of cucumber Corynespora leaf spot fungus (*C. cassiicola*). Japanese Journal of Phytopathology **74**: in press. (Japanese abstr.)
Cucurbits	*Podosphaera xanthii*	US, NY and GA	M.T. McGrath (2008). Fungicide sensitivity in *Podosphaera xanthii* and efficacy for cucurbit powdery mildew in NY, USA, in 2003-2006. Journal of Plant Pathology **90** (2, Supplement), S 2.90 M. Miazzi and M.T. McGrath (2008). Sensitivity of *Podosphaera xanthii* to registered fungicides and experimentals in GA and NY, USA, in 2007. Journal of Plant Pathology (2008), 90 (2, Supplement), S 2.90

A complete overview on resistant plant pathogenic organisms, including published cases of SDHI resistance, can be viewed in the Publications area of the FRAC web site under (List of Resistant Plant Pathogens).

List of resistant plant pathogens

3. Use Recommendations

General SDHI Guidelines (all crops)

- Strategies and General Guidelines for the 2009 season (foliar applications)
    - 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, furametpyr, isopyrazam, mepronil, oxycarboxin, 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.

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 mold, *Botrytis cinerea*, refer to the table below.

Grey mold (*Botrytis cinerea*) spray table:

Total number of *Botrytis cinerea* 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

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

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.

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.

SDHI Guidelines - Banana

Guidelines for the use of SDHI fungicides in banana will be established by the Banana FRAC working group (next meeting scheduled for February 2010).

SDHI Guidelines – Cereals 2009

- 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 always in mixtures
- 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.

All other crops

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