



STEROL BIOSYNTHESIS INHIBITOR (SBI) WORKING GROUP

**Annual Meeting 2015 on December 04, 2015, 08:30-16:10,
and Telephone Conference on March 22, 2016, 11:00-11:45**

**Protocol of the discussions and recommendations of the SBI
working group of the Fungicide Resistance Action Committee
(FRAC)**

**Participants of the SBI WG Meeting on December 04, 2015
TelCo participation on March 22, 2016, indicated by (+TC)**

BASF	Martin Semar (+TC) Gerd Stammler (+TC)
Bayer CropScience	Frank Goehlich Andreas Mehl (+TC) Klaus Stenzel (+TC)
Dow	Greg Kemmitt (+TC)
Du Pont	Jean-Luc Genet
ADAMA	Martin Huttenlocher
Sumitomo	Norio Kimura Yves Senechal
Syngenta	Steve Dale Helge Sierotzki (+TC) Stefano Torriani (+TC)
FRAC Brazil for ASR discussion via Skype	Ronaldo Rodrigues (BASF)

Venue of the meeting: Lindner Congress Hotel, Frankfurt
Hosting organization: FRAC

Anti-Trust Guidelines (from FRAC Constitution) were shown before the Meeting started

1. DMI AND AMINES: CEREAL DISEASES

1.1. WHEAT

1.1.1. Leaf spot (*Mycosphaerella graminicola* / *Zymoseptoria tritici*)

Presentation of monitoring data: BASF, Bayer CropScience, ADAMA, Syngenta

- Disease pressure in 2015 in Europe was moderate.
- DMIs field performance was good when used according to the manufacturers and FRAC recommendations. No general field resistance has been reported.
- Monitoring was carried out in Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Italy, Ireland, Latvia, Lithuania, the Netherlands, Poland, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, and United Kingdom.
- After the slight increase in the frequency of less sensitive isolates from 2002 to 2004, the situation had stabilised between 2005 and 2008. In 2009, a trend to slightly higher EC₅₀ values was observed in important cereal growing areas (France, Germany, Ireland, United Kingdom), this trend has slowed down in 2010 to 2012 and was stable in 2013. 2014 sensitivity was in the same range as 2011.
- In 2015, depending on the individual active ingredient and regions slight shifts of sensitivity of populations have been observed. Highest EC₅₀ values were observed in areas of elevated disease pressure and sub-optimal use of azoles in spray programs (e.g. reduction of rates in comparison to the manufacturer's recommended rate and inappropriate use of effective mix-partners).

1.1.2. Powdery mildew (*Blumeria graminis* f.sp. *tritici* / *Erysiphe graminis* f.sp. *tritici*)

In 2015 the disease pressure was moderate across Europe.

DMIs

Presentation of monitoring data: Bayer CropScience

- DMI field performance was good.
- Monitoring was carried out in Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Poland, Sweden, and United Kingdom.
- Sensitivity data presented confirmed that the situation was overall stable within the range of variability detected during the last 20 years. Differences in the sensitivity can be detected in dependence on the active ingredient and on the region, with esp. higher resistance factors in northern France.

Amines

Presentation of monitoring data: Bayer CropScience

- Field performance of amine based products was good.
- Monitoring was carried out in Belgium, Czech Republic, France, Germany, Hungary, Italy, Poland, and United Kingdom.
- Sensitivity data presented confirmed that the situation was stable remaining in the range of variability seen over more than 25 years.

1.1.3. Wheat brown rust (*Puccinia triticina*)

No monitoring data for 2015 available due to bi-annual monitoring.

Presentation of monitoring data in 2014: Bayer CropScience, BASF

- Brown rust disease pressure was moderate in most of the countries in Europe (2014, 2015).
- Good field performance of DMLs against rust has been maintained (2014, 2015).
- Monitoring in 2014 has been carried out in Belgium, France, Germany, Hungary, Italy, Poland, and United Kingdom.
- Sensitivity data from 2014 for wheat brown rust showed that the sensitivities in 2014 were in the range of those of the last ten years.

1.1.4. Eyespot (*Tapesia* spp, syn. *Oculimacula* spp.)

For 2015, no monitoring data are available yet. Incidence of eye-spot has increased in comparison to previous years. Field performance was good.

Presentation of monitoring data for 2014: Bayer CropScience

- Sensitivity data have been presented for W and R types. Between 2003 and 2012 there was no change in the sensitivity of both types, stable situation had been observed during the last 9 years. In 2013, some sensitivity change has been observed in the United Kingdom, but not in France or Germany. In 2014, further sensitivity decrease has been observed in the United Kingdom, and for the first time also in France and Germany. However, overall, resistance factors still remain low and performance was not affected.

1.1.5. Tan spot (*Pyrenophora tritici-repentis*)

No monitoring was carried out during 2014 and 2015.

1.1.6. Yellow rust (*Puccinia striiformis*)

First sensitivity analysis was carried out in 2014 by BASF.

Isolates from Germany showed a normal distribution of sensitivity, no indication for shifting was detected.

1.2. BARLEY

1.2.1. Powdery Mildew (*Blumeria graminis* f.sp. *hordei* / *Erysiphe graminis* f.sp. *hordei*)

In 2015, disease pressure was moderate in Europe.

Monitoring was carried out in Denmark, France, Germany, Sweden, and United Kingdom.

DMIs

Results from 2015 monitoring were presented by Bayer CropScience:

- DMI products performed well.
- The sensitivity of the populations stayed in the range observed for more than 15 years.

Reduced sensitivity was reported in barley powdery mildew in western and eastern Australia (ACNFP/Curtin University) in 2014.

Amines

Results from 2015 monitoring were presented by Bayer CropScience:

Monitoring was carried out in Austria, Czech Republic, France, Germany, Italy, and United Kingdom.

- Amine products performed well.
- The sensitivity of the populations stayed in the range observed for more than 15 years.

1.2.2. Scald (*Rhynchosporium secalis*)

Presentation of monitoring data: BASF, Bayer CropScience, Syngenta

- Disease pressure was low in Europe in 2015.
- Field performance of DMIs was good.
- Monitoring was carried out in France, Germany, Ireland, Spain, Poland, and United Kingdom. Monitoring ongoing for Finland and Belgium.

- Stable situation. The sensitivity of the populations stayed in the range observed in the previous 10 years.

1.2.3. Net blotch (*Pyrenophora teres* /*Drechslera teres*)

Presentation of monitoring data for 2015: Bayer CropScience, Syngenta

- Disease incidence was moderate in 2015.
- Field disease control was good.
- Monitoring was carried out in Belgium, Croatia, Denmark, France, Germany, Hungary, Italy, Ireland, Latvia, Poland, Slovakia, and United Kingdom.
- The sensitivity of the populations in 2015 stayed in the range observed since more than 10 years.

1.2.4. Ramularia leaf spot (*Ramularia collo-cygni*)

Presentation of monitoring data for 2015: Bayer CropScience

- Disease incidence was moderate.
- Monitoring was carried out exclusively in Germany.
- In 2015, extensive monitoring in Germany showed especially in trial-sites for the first time occurrence of strains with strongly decreased dose-response in lab assays, leading to moderate to high resistance factors. The relevance for the practice and the genetic background of these findings is currently under investigation.

1.3. GENERAL RECOMMENDATIONS FOR CEREALS (DMIs AND AMINES) (changes 2015 in bold)

The recommendations for the use of DMI and amine fungicides in mixture or alternation programmes with different mode of action fungicides remain unchanged. **It needs to be emphasized that it is essential for resistance management purposes to follow strictly the manufacturer's and FRAC recommendations.**

Repeated application of DMI or amine fungicides alone should not be used on the same crop in one season against risky pathogens (e.g. cereal powdery mildews, barley net blotch, scald) in areas of high disease pressure for that particular pathogen.

Reduced rates of DMIs can contribute to accelerate the shift to less sensitive populations. It is critical to use effective rates of DMIs in order to ensure robust disease control **and effective resistance management**. DMIs must provide effective disease control and be used at manufacturers recommended rates.

When used in mixture, recommended effective rates of the SBI must be maintained.

Split and reduced rate programmes, using multiple repeated applications at dose rates below manufacturer's recommendations, provide continuous selection pressure and accelerate the development of resistant populations, and therefore must not be used.

To ensure good performance **and particularly resistance management in situations of even low** disease pressure it is essential to adhere to dosages and spray timings as recommended by manufacturers. **Curative** applications should be avoided. Application timing has to be appropriate to all mix partners' characteristics. Mixing with a non-cross resistant fungicide at effective dose rates **contributes** to a more effective disease control and resistance management.

The amine fungicides are effective non-cross-resistant partner fungicides for DMIs on cereals for the control of pathogens included in the label recommendation of each respective product.

2. DMI: INDUSTRIAL CROPS

2.1. SOYBEAN:

2.1.1. Asian soybean rust (*Phakopsora pachyrhizi*)

Presentation of monitoring data: BASF, Bayer CropScience, FRAC Brazil, Syngenta

- A sensitivity baseline has been established in Brazil based on 2005/6 data.
- Extensive monitoring was carried out since 2007/8 across the country.
- The performance of DMIs used alone was reduced.
- Sensitivity shifts have been observed with a trend to stabilize in season 2010/11. This has to be seen in connection with the recommendation of an azole use in mixtures only and the introduction of a crop-free period. This trend continued in the following seasons until season 2013/14.
- In 2014/2015, slight shifts in sensitivity have been observed compared to 2013/14.
- Despite this situation it is recognized that a variability in performance of DMI mixtures has been observed which likely is related to other factors.

Recommendations for Asian soybean rust:

Refer to the general recommendations for SBI's.

In addition to ensure robust disease control and resistance management it is essential to:

- Apply DMI fungicides always in mixtures with effective non-cross resistant fungicides. Refer to manufacturers recommendations for rates.
- Apply preventively or as early as possible in the disease cycle.

- Apply DMI fungicide containing products always at intervals recommended by the manufacturers and adjusted to the disease epidemics. Avoid extended spray intervals.
- Good agricultural practices must be considered to reduce disease pressure and resistance risk e.g. avoiding multiple cropping.

2.1.2. Target Spot (*Corynespora cassicola*)

First studies were carried out with isolates from season 2013/14 and 2014/15 by BASF. These initial studies showed high sensitivity to DMIs.

2.2. OILSEED RAPE

2.2.1. Phoma leaf spot and stem canker, blackleg (*Leptosphaeria maculans* / *L. biglobosa*)

Presentation of monitoring data for 2014/15 (samples from autumn 2014 to spring 2015): BASF. Monitoring ongoing (Bayer CropScience).

- Monitoring was carried out in France, Germany, Hungary, and Poland.
- Monitoring data from 2006 to 2015 showed a stable sensitivity range as in the last years.
- For recommendations see General Recommendations.

2.2.2. Sclerotinia stem rot, white mould (*Sclerotinia sclerotiorum*)

Presentation of monitoring data for 2014: BASF, for 2015: Bayer CropScience, Syngenta, BASF

- Monitoring was carried out in 2014 in: Belgium, Czech Republic, Denmark, France, Germany, Hungary, Poland, and UK.
- Monitoring was carried out in 2015 in Czech Republic, France, Germany, Hungary, Poland, and Ukraine.
- Monitoring data from 2014 and 2015 showed a stable sensitivity range as in the last years.
- For recommendations see General Recommendations.

2.3. SUGAR BEET

Leaf spot (*Cercospora beticola*)

Presentation of monitoring data for 2015: Syngenta, BASF and Bayer CropScience.

- Preliminary monitoring data available so far for Austria, France, Germany, Italy, the Netherlands, Poland, and Romania. Further monitoring analysis ongoing in Belgium, Czech Republic, and Spain.
- Stable situation in the last three years in the central European countries observed.
- The broad range of sensitivity leads to the assumption that a shift took place before routine monitoring was set up.
- Single isolates with slightly increased ED50 values were detected in Italy and Germany but seem to not increase over time.
- Field performance can be affected when solo DMI's are used.
- For recommendations see General Recommendations.

3. DMI AND AMINES: OTHER CROPS

3.1. GRAPE VINE:

Powdery mildew (*Erysiphe necator*)

Monitoring data for **DMIs** were presented by Bayer CropScience (2015), Dow (2014), DuPont (2014), and Syngenta (2015). Monitoring analysis for 2015 is still ongoing.

- Disease pressure was moderate to high in 2014 and 2015.
- Performance of DMIs and amines was as expected.
- Monitoring was carried out in 2014 in Austria, Germany, France, Switzerland, in 2015 in Austria, Bulgaria, Czech Republic, France, Germany, Italy, Slovakia, Spain, and Switzerland.
- 2014 and 2015: Sensitivity for **DMIs** in Europe was stable and generally in the normal range of fluctuation as observed in the previous years with regional differences.
- Exclusive frequency measurements of single *cyp51* mutations are not sufficient to describe the sensitivity situation in *Erysiphe necator* populations towards **DMIs**.

Monitoring data for **amines** for 2014 were presented by Bayer CropScience:

- Stable situation in the European countries with low resistance factors towards **amines**.

Recommendations:

- DMI's and amines should be used preventative and curative situations should be avoided.
- The existing strategy for effective disease control and resistance management continues to be successful and the use recommendation is a maximum of 4 applications per season. The strategy includes the use of mixtures or alternation with non-cross resistant fungicides.
- To ensure that SBI's can remain the effective basis for control of *Erysiphe necator* in grapevine, their use should adhere to the full recommended rate (either alone or in mixture) at the recommended timing and application volume and an accurate treatment of each row.

3.2. APPLE:

3.2.1. Apple scab (*Venturia inaequalis*)

Presentation of monitoring data for 2015: Syngenta

- Disease pressure in 2015 was moderate across Europe.
- The performance of DMIs was good on this disease in 2015 when compounds were used according to the manufacturers' and FRAC recommendations within spraying programmes.
- Monitoring was carried out in Belgium, France, Germany, Greece, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Serbia, Spain, and Switzerland.
- No sensitivity changes in European populations were observed from 2011 to 2015 within a fluctuation range as in previous years.

Recommendations:

- DMI fungicides are not recommended for season long use and a maximum of 4 DMI sprays either alone or in mixture is recommended.
- DMIs should be used in mixtures or (block) alternations with a non-cross resistant fungicide. Application of recommended label rates is important.
- Preventative applications should always be the first choice with DMIs. Curative applications are only recommended when accurate disease warning systems are available.

3.2.2. Powdery mildew (*Podosphaera leucotricha*)

Presentation of monitoring data for 2015: Syngenta

- Performance of DMI was good.
- Monitoring was carried out in Belgium, France, Hungary, Italy, Latvia, the Netherlands, Poland, Portugal, Spain, and Switzerland.

- Monitoring was started in 2010 across Europe. No change in sensitivity comparing 2015 to 2010 was observed.
- See General Recommendations.

3.3. TOMATO/POTATO - *Alternaria solani* and *Alternaria alternata*

Presentation of monitoring data: Syngenta

- Monitoring was started in 2012 in Europe. Results for 2015 were presented.
- Monitoring was carried out in Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Latvia, the Netherlands, Slovakia, Spain, Switzerland, and United Kingdom.
- Homogenous sensitivity of both pathogens was observed in different countries across Europe and no change occurring in 2015. Stable situations like in previous years.

3.4. CUCURBITS - *Podospaera xanthii*/*Sphaerotheca fuliginea*

Presentation of monitoring data: Syngenta

- Monitoring was carried out in, Belgium, Bulgaria, Czech Republic, France, Italy, the Netherlands, and Spain.
- No change of sensitivity has been observed from 2011 to 2015.
- Monitoring in 2014 was carried out in China. All samples were sensitive with a homogenous distribution of sensitivity.

3.5. BANANA:

Black Sigatoka (*Mycosphaerella fijiensis*)

The conclusions and guidelines of the February 2014 meeting of the FRAC Banana Working Group are available on the FRAC Website (<http://www.frac.info/frac/index.htm>). The next meeting of the group is planned for 2016.

4. SBI-CLASS III (KETO-REDUCTASE-INHIBITORS - KRI)

This group comprises of Fenhexamid and Fenpyrazamine as inhibitors of the Keto-Reductase (KRI). Both are cross-resistant.

4.1. Grey mould (*Botrytis cinerea*) on grape vine

- Presentation of monitoring data: Bayer CropScience, Sumitomo
- Disease pressure was moderate across Europe in 2013 and 2014, low to moderate in 2015.

- Field performance of botryticides is most effective if embedded in sound spray programmes respecting the individual resistance management recommendations.
- In 2014, monitoring was carried out in Austria, France, Germany Italy, Spain, Hungary, and in Chile.
- In 2015, monitoring was carried out in Chile, Germany, and Italy.
- Resistant isolates were detected. High frequencies of resistant isolates were detected in 2014 and 2015 in Chile, moderate frequencies in Germany, low frequencies in France, very low frequencies in Italy in Spain, Hungary, and Austria.

4.2. Grey mould (*Botrytis cinerea*) on strawberries

- Presentation of monitoring data: Bayer CropScience, Sumitomo
- Monitoring was carried out in 2014 in Austria, Denmark, Germany, the Netherlands, France, Italy, and Poland.
- 2015 monitoring was carried out in Denmark, France, Germany, Italy, Poland, Sweden, and United Kingdom.
- Strong presence of resistant strains in Denmark, Germany, Sweden, and United Kingdom, whereas in Austria, France, and Italy low presence was detected and very low in the Netherlands and Poland.

4.3. Grey mould (*Botrytis cinerea*) on raspberry

- Presentation of monitoring data: Bayer CropScience
- Limited monitoring in Norway in 2014 showed high frequency of resistant strains.
- Monitoring in 2015 in the Netherlands showed moderate frequency of resistance.

4.4. Recommendations for the use of KRIs (changes 2015 in bold):

- Use KRIs only protectively.
- Use KRIs only in strict alternation, **no block application.**
- Solo product as part of alternation programmes:
 Spray programmes with a maximum of 3 treatments per season: max. 1 application with KRIs
 Spray programmes with 4-5 treatments/season: max. 2 applications with KRIs
 Spray programmes with 6 and more treatments: at the maximum one third of all Botryticide-applications
- Use in mixtures:
 Both partners - if applied alone at the dose used in the mixture - must have sufficient activity against Botrytis. Not more than 50% of all Botryticide-treatments should be made with KRIs-containing mixtures.

5. NEXT MEETINGS

Next annual meeting is planned for December 16, 2016.

The content or data found in this document is copyright protected by the Fungicide Resistance Action Committee. © Copyright 2016 Fungicide Resistance Action Committee.