SBI Working Group

FRAC
FUNGICIDE RESISTANCE ACTION COMMITTEE

STEROL BIOSYNTHESIS INHIBITOR (SBI) WORKING GROUP

Annual Meeting 2016 on December 16, 2016, 08:30 - 16:00
Update on Telephone conference March 07, 2017, 09:00 - 09:55
Protocol of the discussions and recommendations of the SBI working group of the Fungicide Resistance Action Committee

Participants of the SBI WG Meeting on Dec 16, 2016 and Telco March 07, 2017

ADAMA	Martin Huttenlocher (+ TelCo)
BASF	Martin Semar (+ TelCo) Gerd Stammler (+ TelCo)
Bayer	Frank Goehlich (+ TelCo) Andreas Mehl (+ TelCo) Klaus Stenzel (+ TelCo)
Dow	Greg Kemmitt
Du Pont	Jean-Luc Genet Mamadou Mboup
Sumitomo	Norio Kimura (excused) Yves Senechal Ippei Uemura
Syngenta	Steve Dale (+ TelCo) Helge Sierotzki (+ TelCo) Stefano Torriani (+ TelCo) Birgit Forster (+ TelCo)
FRAC Brazil (for ASR discussion via Skype)	Rogerio Augusto Bortolan (Bayer; chairman) Luis Demant (Ihara; vice-chair)
Guest (until 10 am)	Dietrich Hermann (Syngenta; Chairman Global FRAC SC)
Venue of the meeting:	Lindner Congress Hotel, Frankfurt /Telephone Conference
Hosting organization:	FRAC/Crop Life International

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 / Septoria tritici*)

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

- Disease pressure in 2016 in Europe was variable from low to high in dependence on the regions.

- 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, Bulgaria, Czech Republic, Denmark, France, Germany, Hungary, Italy, Ireland, Latvia, Netherlands, Poland, Russia, Slovakia, Spain, Sweden, 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).

- In 2016 the sensitivity of the populations was overall stable on an European level with regional differences also based on different disease epidemics. In regions with lower sensitivity in 2015 the sensitivity of the populations was stable and in some areas even partially increased.

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

In 2016 the disease pressure was low to moderate across Europe.

DMIs

Presentation of monitoring data: Bayer

- 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 for 2016 confirmed that the situation was overall stable within the range of variability detected during the last 20 years. Differences in the sensitivity are a.i. and regionally dependent. Higher resistance factors were observed only for particular DMIs in Belgium, France, Germany, Poland and UK.

Amines

Presentation of monitoring data: Bayer

- 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 in 2016 was stable remaining in the range of variability seen over more than 25 years.

1.1.3. Wheat brown rust (*Puccinia triticina*)

No monitoring in 2016 and 2015. Next monitoring planned in 2017.

Presentation of monitoring data in 2014: Bayer, BASF

- Brown rust disease pressure was moderate in most of the countries in Europe (2014, 2015, 2016).
- Good field performance of DMIs against rust has been maintained (2014, 2015, 2016).
- 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 and 2016 monitoring data under analysis. Incidence of eye-spot has increased in 2016 in comparison to previous years. Field performance was good.

Presentation of monitoring data for 2014: Bayer.

- 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 2014 to 2016.

1.1.6. Yellow rust (*Puccinia striiformis*)

Presentation of monitoring data from 2015 and 2016: Bayer

- Disease pressure was moderate to high in 2015 and moderate in 2016:
- Monitoring was carried out in France, Germany and United Kingdom.
- First monitoring in 2015 showed high sensitivity and low diversity. Stable situation in 2016.

1.2. BARLEY

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

In 2016, disease pressure was low in Europe.

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

DMIs

Results from 2016 monitoring were presented by Bayer:

- 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 2016 monitoring were presented by Bayer:

Monitoring was carried out in Czech Republic, France, Germany, Italy, Poland, 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

- Disease pressure was moderate in Europe in 2016.
- Field performance of DMIs was good.
- Monitoring was carried out in France, Germany, Ireland, Poland, and United Kingdom.
- 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 2016: Bayer, Syngenta

- Disease incidence was moderate in 2016.
- Field disease control was good.
- Monitoring was carried out in Belgium, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Ireland, Latvia, Poland, Slovakia, Spain, Sweden, Ukraine and United Kingdom.
- The sensitivity of the populations in 2016 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.

Monitoring was carried out in Germany with focus on southern Germany.

- Field performance in 2015 was good.
- Some isolates were detected showing loss of sensitivity. Relevant CYP51-mutations explaining the effects have been identified.

In vivo monitoring analysis for 2016 is still ongoing (Bayer).

- Field performance in 2016 was variable in dependence on regions with some failures of control in some areas in Bavaria.
- First molecular studies on Scandinavian populations from 2016 showed occurrence of *cyp*51 target site mutations assumed to be connected with decreased sensitivity (Denmark on low to moderate frequency level, Sweden on no to low frequency level, Estonia no detection). No impact on field performance reported from those countries.

It is remarkable that individual strains have been detected showing a triple loss in sensitivity for DMIs, SDHIs, and QoIs (Southern Germany). Please refer also to the minutes of the FRAC SDHI and QoI meetings.

1.3. GENERAL RECOMMENDATIONS FOR CEREALS (DMIs AND AMINES)

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, 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. The field performance stayed stable the last three seasons.

- 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 has been observed compared to 2013/14.

- In 2015/16 the sensitivity level was stable in comparison to the last years.

- 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 cassiicola*)

First studies were carried out with isolates from season 2013/14 and 2014/15 by BASF. These initial studies showed high sensitivity to DMIs. No monitoring in 2015/16 season.

2.2. OILSEED RAPE

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

Presentation of monitoring data: Bayer (samples from season 2014/15), BASF (samples from season 2015/16).

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

- Monitoring data from 2006 to 2016 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 2015: BASF, for 2016: Bayer, Syngenta

- Monitoring was carried out in 2015 in Czech Republic, France, Germany, Hungary, Poland, Ukraine, and United Kingdom.
- Monitoring was carried out in 2016 in: Czech Republic, France, Germany, Lithuania, Poland, and United Kingdom.
- Monitoring data from 2015 and 2016 showed a stable sensitivity range as in the last years.

For recommendations see General Recommendations.

2.3. SUGAR BEET

2.3.1 Leaf spot (*Cercospora beticola*)

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

- Monitoring in 2015 was carried out in Austria, Belgium, Czech Republic, France, Germany, Italy, Netherlands, Poland, Romania, and Spain. Stable situation was observed in the last three years.
- Monitoring in 2016 was carried out in Austria, Belgium, Czech Republic, France, Germany, Italy, Netherlands, Poland, Sweden, and Switzerland. Based on this data stable situation was observed in the last years in the countries mentioned above.
- Single isolates with slightly increased EC50 values were detected, but remain at a low frequency. No indication for a shift detected in the broad scale monitoring performed in 2016.

Field performance can be affected when solo DMIs are used.

The broad range of sensitivity leads to the assumption that a shift took place before routine monitoring was set up.

For recommendations see General Recommendations.

3. DMI AND AMINES: OTHER CROPS

3.1. GRAPE VINE:

3.1.1. Powdery mildew (*Erysiphe necator*)

Monitoring data **for DMIs** were presented by Bayer (2015 and 2016), Dow (2015), and Syngenta (2015 and 2016).

- Disease pressure was moderate to high in 2015 and 2016.

- Performance of DMIs and amines was as expected.

- Monitoring was carried out in 2015 in Austria, Bulgaria, Croatia, Czech Republic, France, Germany, Italy, Portugal, Spain, and Switzerland

- In 2016, monitoring was carried out in Austria, Croatia, France, Germany, Hungary, Italy, Romania, Slovakia, Spain, and Switzerland.

- 2015 and 2016: Sensitivity for DMIs in Europe was stable and generally in the normal range of fluctuation as observed in the previous years. Population sensitivity can be seen to vary significantly between regions within individual countries.

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 2015 and 2016 were presented by Bayer:

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

Recommendations:

- DMIs 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 per mode of action. The strategy includes the use of mixtures or alternation with non-cross resistant fungicides.

- To ensure that SBIs can remain the effective basis for control of *Erysiphe necator* in grape vine, 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 2016: Syngenta, Bayer. Analysis of monitoring ongoing.

- Disease pressure in 2016 was moderate to high across Europe.

- The performance of DMIs was good on this disease in 2016 when compounds were used according to the manufacturers' and FRAC recommendations within spraying programmes.

- Results from monitoring are available for Belgium, Bulgaria, Croatia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Serbia, Slovakia, Spain, and Switzerland.

- Sensitivity in European populations remains unchanged since 2011.

- In 2016, in Aomori prefecture in Japan, reduced efficacy of DMIs connected to reduced sensitivity was observed under severe disease pressure. Further investigations are ongoing.

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 2016: Syngenta

- Performance of DMI was good.

- Monitoring was carried out in Belgium, France, Germany, Hungary, Italy, Latvia, Poland, Spain, and Switzerland.

- Monitoring was started in 2010 across Europe. No change in sensitivity comparing 2016 to 2010 was observed.

- See General Recommendations.

3.3. OTHER FRUIT TREES (e.g. plum, peach, nectarine, apricot)

3.3.1 *Monilinia spp*

First monitoring was carried out by Syngenta in 2016 in France, Italy, and Spain (ongoing analysis).

- The preliminary results indicate a stable situation with a narrow range of sensitivity.

3.4. TOMATO / POTATO

3.4.1. *Alternaria solani* and *Alternaria alternata*

Presentation of monitoring data: Syngenta, Bayer

- Monitoring was started in 2012 in Europe. Results for 2016 were presented.
- Monitoring was carried out in Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Netherlands, Poland, Romania, Slovakia, Spain, Sweden, Switzerland, and United Kingdom.
- Homogenous sensitivity of both pathogens was observed in different countries across Europe and no change occurring in 2016.

3.5. CUCURBITS

3.5.1. *Podosphaera xanthii/Sphaerotheca fuliginea*

Presentation of monitoring data: Syngenta

- Monitoring 2016 was carried out in BelgiumFrance, Italy, Netherlands, and Spain.
- No change of sensitivity has been observed from 2011 to 2016.
- In 2014 a monitoring was carried out in China. All samples were sensitive with a homogenous distribution of sensitivity.

3.6. BANANA

3.6.1. Black Sigatoka (*Mycosphaerella fijiensis*)

The conclusions and guidelines of the February 2016 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 2018.

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 (2016), Sumitomo (2015)
- Disease pressure was moderate across Europe in 2014, low to moderate in 2015, and moderate to high in 2016.
- Field performance of botryticides is most effective if embedded in sound spray programmes respecting the individual resistance management recommendations.
- In 2015, monitoring was carried out in Austria, Chile, France, Germany, Italy, and Spain, and in 2016 in Chile, France, Germany, and Italy.
- Resistant isolates were detected. High frequencies of resistant isolates were detected in Chile, moderate frequencies in Germany, low frequencies in France, and very low frequencies in Italy, Spain, and Austria.

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

- Presentation of monitoring data: Bayer (2016), Sumitomo (2015, 2016 ongoing)
- Monitoring was carried out in 2015 in Austria, Denmark, Germany, Netherlands, France, Italy, Poland, and Spain, and United Kingdom.
- High presence of resistant strains in Germany and United Kingdom, moderate presence of resistant strains in Denmark, low to moderate in Italy, low presence in Austria, France, Poland, and Spain.
- In 2016, results are available for Germany, France, and United Kingdom
- Sensitivity clearly increased with moderate resistance level in 2016 in the UK and with low levels in France and Germany.

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

- Presentation of monitoring data for 2014 and 2015: Bayer
- Limited monitoring in Norway in 2014 showed high frequency of resistant strains.
- Monitoring in 2015 in the Netherlands showed moderate frequency of resistance.
- No monitoring in 2016.

4.4 Recommendations for the use of KRIs:

- 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.

For sound resistance management, good agricultural practices, including phytosanitary measures and crop protection, should be followed carefully.

5. NEXT MEETING

Next annual meeting is planned for December 15, 2017.