

MEMBERSHIP

The working group is comprised of the following members:

| | |
|---|---------------------------|
| Helge Sierotzki (Chair) | Syngenta |
| Steve Dale | Syngenta |
| Stefano Torriani | Syngenta |
| Gina Swart | Syngenta |
| Andreas Mehl | Bayer |
| Frank Goehlich | Bayer |
| Mboup, Mamadou Kane | DuPont |
| Jean-Luc Genet | DuPont |
| Gerd Stammer | BASF SE |
| Martin Semar | BASF SE (arable crops) |
| Randall Gold | BASF SE (specialty crops) |
| Yves Senechal | Sumitomo |
| Ippei Uemura | Sumitomo |
| Special guest | |
| Dietrich Hermann (FRAC Chair) | |
| Rogério Augusto Bortolan (FRAC Brazil chairman) | |

The document contains up-dated information from the conference call meeting of the 7th March 2017

1. INTRODUCTION

The working group is responsible for global fungicide resistance strategies in the Qo inhibitor fungicides (QoI). The Qo inhibitor fungicides (QoI) all act at the Quinone 'outer' (Qo) binding site of the cytochrome bc1 complex.

The QoI fungicides are: azoxystrobin, coumoxystrobin, dimoxystrobin, enoxastrobin, famoxadone, fenamidone, fenaminostrobin, fluoxastrobin, flufenoxystrobin, kresoxim-methyl, mandestrobin, metominostrobin, orysastrobin, pyraoxystrobin, picoxystrobin, pyraclostrobin, pyrametostrobin, pyribencarb, triclopyricarb, trifloxystrobin

They are all in the same cross-resistance group and should be managed accordingly.

Companies participating in the meetings:

BASF, Bayer CropScience, DuPont, Syngenta, Sumitomo

**QoI working group of FRAC
Minutes of the meeting
All crops: December 15th, 2016
held in Frankfurt, Germany**

2. Minutes of discussions

2.1. Review of sensitivity monitoring

2.1.1. Cereal diseases

Field experience in 2016 has confirmed that, when used according to FRAC guidelines, the performance of QoI containing products within spray programmes was good. QoIs continue to contribute to overall disease management in cereals.

Powdery mildew (*Blumeria graminis* f. sp. *tritici* = *Erysiphe graminis* f.sp. *tritici*), wheat

Bayer

Disease pressure in 2016 was low to moderate across Europe.

Overall, where monitoring was carried out, there was a stable situation (Austria, Czech Republic, Denmark, Hungary, and Sweden) but also slight decrease of resistant isolates in Italy and Poland in 2016 compared with 2015.

High resistance frequencies were found in Denmark, Poland and Sweden.

Medium frequencies were found in Czech Republic.

Low resistance frequencies were found in Austria, Italy and Latvia.

No resistance has been detected in Western Russia.

Powdery mildew (*Blumeria graminis* f. sp. *hordei* = *Erysiphe graminis* f.sp. *hordei*), barley

Bayer

Disease pressure in 2016 was low across Europe.

Overall, where monitoring was carried out, there was a similar situation in 2016 as compared to 2015.

High resistance frequencies were found in Central France, Sweden and United Kingdom.

Low to medium frequencies were found in Czech Republic, Germany, Lithuania and Poland.

No resistance was detected based on limited number of strains in Belgium, Italy, Denmark, Austria and Western Russia

Septoria leaf spot (*Septoria tritici* = *Mycosphaerella graminicola* = *Zymoseptoria tritici*), wheat

BASF, Du Pont, Syngenta

Disease pressure was moderate to high in most of the European countries but regionally variable in 2016. Monitoring programmes were carried out throughout the wheat growing areas of Europe in 2016.

The status at the end of the season 2016 is as follows:

In Belgium, Denmark, France, Germany, Ireland, Netherlands, Sweden, Poland and United Kingdom: widespread resistance over all these countries at high levels were detected.

Czech Republic, Hungary, Italy, Latvia and Northern Spain: populations were showing in average moderate levels of resistance with high variability.

Bulgaria, Romania, Russia, Slovakia, Southern Spain, Lithuania, Ukraine and Eastern Ukraine: sampling in 2016 showed no to low levels of resistance.

Additional information for other countries is given in the [2015 minutes](#).

Brown rust (*Puccinia recondita* = *Puccinia triticina*), wheat

BASF, Bayer

In 2016, performance of QoI fungicides against brown rust was good. No resistant isolates were detected in widespread monitoring studies in Europe in 2016, confirming the fully sensitive picture (Belgium, France, Germany, Hungary and United Kingdom).

These findings are consistent with the reported presence of a lethal intron in several fungi making the G143A mutation unlikely to occur (see FRAC QoI Intron Document).

Brown rust / Dwarf rust (*Puccinia hordei*), barley

Bayer

No monitoring in 2015 and 2016.

During sensitivity studies with *Puccinia hordei* during 2010 to 2014, occasional isolates with slightly higher EC50 values to QoIs have been detected in Denmark, France, Germany, Sweden, and United Kingdom (in 2014 only in Denmark, France, and United Kingdom).

However, resistance factors are low and the mutations normally associated with QoI resistance were not found.

The practical relevance of these findings is not currently known. The mechanism is not known, no relevant mutations have been found.

Field performance in 2016 of QoI containing spray programmes was good.

Net blotch (*Pyrenophora teres*), barley

BASF, Bayer, Du Pont, Syngenta

Disease pressure was low to moderate but regionally variable even within European countries in 2016. Performance of QoI containing spray programmes against Net Blotch was good.

Extensive monitoring was carried out in 2016. Only the F129L mutation was found. As already observed with other pathogens, resistance factors are significantly lower in comparison with the G143A mutation and field performance of products used according to FRAC and Manufacturers' recommendations remains good (for differences between QoI mutations see also the respective FRAC document titled "Mutations associated with QoI resistance" available on the FRAC website under QoI fungicides →Quick references).

These findings are consistent with the reported presence of a lethal intron in several fungi making the G143A mutation unlikely to occur.

The situation in 2016 has again improved compared to previous years and is as follows:

France, Sweden, Belgium Germany, Netherlands Denmark, and United Kingdom - low to moderate levels.

Italy, Poland and Ukraine - low levels.

Czech Republic, Finland, Hungary, Ireland Latvia, Romania, Slovakia, Spain, Bulgaria, Lithuania and Estonia - no detection of mutations.

Leaf scald (*Rhynchosporium secalis* = *Rhynchosporium commune*), barley

BASF, Bayer, Du Pont

Performance of QoI fungicides against Leaf scald was good.

In 2016, all samples were sensitive in Belgium, France, Germany, Ireland, Poland and United Kingdom.

However, in some years since 2008 (e. g., 2012 France, 2014 UK, 2015 Spain), occasionally isolates have been found containing the G143A mutation. The frequency is always very low.

Tan spot (*Pyrenophora tritici-repentis*), wheat

BASF, Du Pont, Syngenta

Disease pressure was low to moderate in Europe in 2016.

Performance of QoI containing spray programmes against tan spot was good in 2016.

Samples containing the G143A mutation were found at the frequencies indicated below:

Moderate to high resistance frequencies were found in: Germany, Hungary, Poland, Denmark, France, Finland, Netherlands and Sweden.

Low to moderate frequencies were found in Latvia and Greece.

No to low resistance was detected in Russia and Ukraine.

Although all three point mutations known for QoIs (G143A, F129L, G137R) have been detected in the past, and can occur in the same population, the G143A mutation is now dominant in this pathogen.

Ramularia leaf spot (*Ramularia collo-cygni*), barley

No monitoring was performed in 2016

The levels of resistance found in monitoring programmes in 2014 are summarised below (Bayer, Syngenta):

High: Germany, Denmark and Sweden

No resistance: Estonia

2.1.2. Vine diseases

Downy mildew (*Plasmopara viticola*)

BASF, Syngenta

In 2016, disease pressure was high in the main grape growing areas of Europe.

The levels of resistance found in monitoring programmes **in 2015 and 2016** are summarised below:

High levels: Croatia, France (Champagne and Aquitaine) and Switzerland (Ticino, Graubunden).

Moderate Levels: Austria, Czech Republic, France (Pay de la Loire, Poitou Charentes, Languedoc Rousillon, Lorraine, Midi Pyrenees, Savoie, Franche Comte), Germany (Baden Wuerttemberg), Italy (Süd Tirol, Piemonte, Toscana, Emilia Romagna, Marche, Friuli, Veneto Abruzzo), Portugal and Slovenia.

Low to Moderate levels: Greece.

Low Levels: Spain (Galicia).

After numerous years of sensitivity monitoring carried out in Europe it has been observed the levels of resistance found are very heterogeneous, with values ranging from zero to high even between neighbouring vineyards.

Powdery mildew (*Uncinula necator* / *Erysiphe necator*)

BASF, Bayer, Syngenta

Disease pressure in 2016 was moderate to high across Europe.

The levels of resistance found in monitoring programmes in 2016 are summarised below:

High levels: France (many regions and Languedoc heterogeneous), Germany (Pfalz, Baden-Württemberg, Sachsen Anhalt) and Italy (Lazio).

Moderate levels: France (Champagne, Poitou Charentes, Midi Pyrenees, heterogeneous).

Low levels: Italy (Marken and Emilia Romagna).

No resistance: Italy (Sicilia).

Heterogeneous situation found in Spain and Portugal from zero to high levels.

Data from limited number of samples from Romania, Austria and Switzerland showed presence of resistance allele.

Additional information for other countries is given in the [2015 minutes](#).

2.1.3 Pome fruit diseases

Apple scab (*Venturia inaequalis*)

Bayer

Disease pressure in 2016 was high across Europe.

Through intensive monitoring carried out in Europe it is known that in regions where resistance is present, the levels of resistance found are very heterogeneous, with values ranging from zero to high even between neighbouring orchards.

Monitoring was carried out in 2016 - frequencies of resistance are reported below:

High: France (Southern) and Germany (Eastern and South-Western).

Low: North West France.

Heterogeneous situation found in Spain and Portugal from zero to high levels.

Resistance detected in a single sample in Italy (Veneto).

Resistance based on the G143A mutation was detected in Japan, Aomori Prefecture, under severe disease pressure. Further studies are ongoing.

Additional information for other regions is given in the [2015 minutes](#).

Apple Powdery Mildew (*Podosphaera leucotricha*)

BASF

In 2016, resistance has still not been detected as in previous years in Czech Republic, France, Germany, Greece, Italy, Netherlands, Poland, Portugal and Spain. Field performance has been good.

These findings are most likely to be related to the reported presence of a lethal intron in several fungi making the G143A mutation unlikely to occur (see FRAC document titled "Impact of Intron at G143A on Qo resistance development" located on the FRAC website under QoI fungicides → Quick references).

Information for previous years is given in the [2015 minutes](#).

Brown Rot in Stone Fruit (*Monilinia spp.*)

2016 monitoring ongoing

Monitoring data for 2014 and 2015 showed all populations to be fully sensitive (France, Greece, Hungary, Italy, Poland and Spain) (BASF, Bayer).

These findings are most likely to be related to the reported presence of a lethal intron in several fungi making the G143A mutation unlikely to occur (see FRAC document titled "Impact of Intron at G143A on Qo resistance development" located on the FRAC website under QoI fungicides → [Quick references](#)).

2.1.4. Potato/tomato diseases

Late blight (*Phytophthora infestans*)

Bayer

No resistance was detected in all isolates collected in 2016 from potato crops in Italy, Poland, Germany, Netherlands, Belgium, France, United Kingdom and Portugal.

Performance remains good.

Early blight (*Alternaria* spp.)

BASF, DuPont, Syngenta

Monitoring was carried out in potatoes and tomatoes (*Alternaria solani* and *Alternaria alternata*) in Europe in 2016.

Alternaria solani

(Syngenta, BASF, Du Pont)

Tomato

Full sensitivity monitored in Poland.

Potato

Resistance to QoI is associated to the presence of the F129L mutation.

Less sensitive isolates were found at medium frequency in samples from Belgium, Denmark, Germany Netherlands and Sweden.

Low frequencies of the F129L mutation were confirmed in Finland, Poland, Slovakia and United Kingdom.

All samples tested from Czech Republic, France, Greece, Hungary, Italy, Romania and Spain were sensitive.

As already observed with other pathogens, resistance factors are significantly lower in comparison with the G143A mutation and field performance of products used according to FRAC and Manufacturers' recommendations remains good (for differences between QoI mutations see also the respective FRAC document titled "Mutations associated with QoI resistance" available on the FRAC website under QoI fungicides → [Quick references](#)).

Alternaria alternata

(Syngenta, DuPont)

Tomato

Limited monitoring is carried out in 2016.

Resistance has been found in Bulgaria, Greece, Italy, and Poland.

Potato

Resistant isolates (bearing the G143A mutation) were found in potato samples from Belgium, Bulgaria, France, Germany, Hungary, Netherlands, Poland, Romania, Slovakia, Sweden and United Kingdom.

No mutation was found in Spain.

2.1.5. Soybean diseases

Asian Rust (*Phakopsora pachyrhizi*)

BASF, Bayer, Du Pont, FRAC Brasil, Syngenta

Intensive monitoring was carried out across Brazil during 2015/2016.

In 2014/15, isolates containing the F129L mutation were reported in a number of samples. However, sensitivity monitoring, based on bioassays, show that sensitivity has remained in the range of previous years.

(Analysis of historic samples showed that the F129L mutation was present at significant levels from at least 2012/13).

As already observed with other pathogens, resistance factors resulting from the F129L mutation are significantly lower in comparison with the G143A mutation.

(see FRAC document titled “Mutations associated with QoI resistance” available on the FRAC website under QoI fungicides →Quick references).

No samples containing the G143A mutation have been found in this pathogen. These findings are consistent with the reported presence of a lethal intron in several fungi making the G143A mutation unlikely to occur (see FRAC QoI Intron Document).

In 2014/15, the mutation F129L has been found in the majority of the samples throughout Brazil and Paraguay, which can lead to reduced sensitivity. High frequency of this mutation may affect field performance, therefore QoI must be applied with a robust partner (the multi-sites/protectants, exclusively applied together with a QoI, provide control for a limited period and, after that, may leave the QoI unprotected and may endanger sound resistance management).

In 2015/16 a similar situation has been observed as described in 2014/15.

Target Spot (*Corynespora cassiicola*)

BASF

Resistance due to the G143A mutation was detected in a significant number of samples from Brazil in 2015 and 2016.

2.1.6. Other crops

Vegetables

Cucumber powdery mildew (*Sphaerotheca fuliginea*)

No Monitoring was carried out in 2015 and 2016.

Monitoring was carried out in China during 2014. The frequency of resistance found was high (Syngenta).

Cucumber downy mildew (*Pseudoperonospora cubensis*)

No monitoring in 2016

Monitoring in the East Coast of USA showed widespread presence of resistance in 2013.

2014: Resistance was found in samples from cucumber in Spain, Greece, and Italy (Sicilia). Samples from melons collected in Italy (Piemonte) were sensitive. (Bayer, Syngenta).

Soft fruits

Gray Mold (*Botrytis cinerea*)

Bayer

Monitoring in 2015 and 2016 has been carried in Netherlands, Norway, Germany, France, United Kingdom, Italy, Denmark, Poland and Sweden.

Resistance frequencies are high in Netherlands, Germany, United Kingdom, Denmark, Poland and Sweden and moderate in Norway, France and Italy in 2015.

In 2016 resistance frequencies were still high in Germany and moderate in France and United Kingdom.

Grapes

Gray Mold (*Botrytis cinerea*)

Bayer

Monitoring in 2015 and 2016 has been carried in Germany, Italy, France and Chile.

In 2015 high frequencies of resistance strains were found in Chile and Germany, moderate frequency in France and low in Italy.

In 2016 similar situation as in 2015 in Chile.

In Italy low levels and in Germany and France moderate resistance levels were detected in 2016.

QoI sensitive (cyt b wild type) strains often could be divided in isolates carrying or not carrying the intron in the cytochrome b gene. (Add link to intron (see FRAC document titled "Mutations associated with QoI resistance" available on the FRAC website under QoI fungicides → [Quick references](#)).

Lettuce (*Bremia lactucae*)

BASF

In 2016 genetic analysis showed that all samples from Spain and Germany did not contain any known mutations potentially causing Qol resistance and were therefore classified as sensitive to Qol.

Onion (*Peronospora destructor*)

BASF

In 2016 genetic analysis showed that samples from Germany did not contain any known mutations potentially causing Qol resistance and were therefore classified as sensitive to Qol.

Oilseed Rape (Canola)

Stem Rot (*Sclerotinia sclerotiorum*) OSR

DuPont, Syngenta, BASF, Bayer, Sumitomo

Monitoring in 2016 from Austria (2015), Sweden, Denmark, Czech Republic, France, Germany, Lithuania, Poland and United Kingdom showed a fully sensitive situation.

Blackleg (*Leptosphaeria maculans*, *L. biglobosa*)

BASF

Monitoring is ongoing.

Monitoring carried out in 2014/15 in France, Germany, Hungary, Poland and United Kingdom showed a fully sensitive situation (BASF, DuPont).

Monitoring carried out in 2015/16 in France and Germany showed full sensitivity situation.

Sunflower

White Mould (*Sclerotinia sclerotiorum*)

BASF, DuPont

Monitoring carried out in Hungary and Slovakia in 2016 showed a fully sensitive situation.

Peas and Beans

White Mould (*Sclerotinia sclerotiorum*)

No data available.

All samples from 2015 tested from Netherlands and Belgium were sensitive (BASF).

Corn

Grey Leaf Spot (*Cercospora zea-maydis*)

No monitoring in 2016

Initial analysis confirmed the presence of the intron, preventing the G143A mutation. All studied strains from US in 2015 showed cyt b wild type sequence and were sensitive in bioassay (BASF).

Sugar Beet (*Cercospora beticola*)

BASF, Bayer, Du Pont, Syngenta

Intensive monitoring was carried out across Europe in 2016. The levels of resistance found were:

High levels; Austria, Belgium, France, Czech Republic, Italy, Slovakia, Sweden and Switzerland.

In Germany, Poland and United Kingdom - Overall very heterogeneous across the country from zero to high levels. Monitoring is still ongoing.

Information for previous years is given in the [2015 minutes](#).

Rice

Blast (*Pyricularia oryzae* = *Magnaporthe oryzae*)

BASF, Du Pont, Syngenta

Monitoring results from Japan in 2016 showed a stable situation with resistance in 19 prefectures (Fukuoka, Ohita, Saga, Yamaguchi, Kumamoto, Miyazaki, Kagoshima, Shimane, Tottori, Okayama, Hyogo, Ehime, Shiga, Gifu, Mie, Yamagata, Akita and Kochi). The presence of the G143A mutation was confirmed.

Resistance, based on G143A presence has been detected in Vietnam with heterogeneous frequency from zero to high in 2016 similar as observed as in 2015.

No resistance was detected in Indonesia (2016), China (2015), India (2015) and the Philippines (2016).

Monitoring was carried out in Spain and Italy in 2016 and showed full sensitivity. No resistance has been detected so far in Europe.

Sheath blight (*Rhizoctonia solani* AG1.1A)

Syngenta

Rice

Full sensitivity was monitored in 2014 and 2015 in China.

In Japan no resistance has been detected in 2015.

Samples in 2011 from a small number of fields in Louisiana, USA were found to contain less sensitive isolates. Monitoring carried out between 2012 and 2014 showed a stable situation. Only the F129L mutation has been found in these isolates.

Soybean

In 2016 a small number of fields in Louisiana, USA were found to contain less sensitive isolates.

Potato

In 2014 and 2015 less sensitive isolates were detected in China (Inner Mongolia) at low frequency.

For further known cases of QoI resistance, see the document titled “Species with QoI Resistance (2012)” on the FRAC website located under QoI fungicide → [Quick references](#).

2.2. Review of global guidelines

2.2.1 Strategies and Guidelines for the 2017 season

Strategies for the management of QoI 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 further enhanced in order to be proactive and to prevent the occurrence of resistance to QoI fungicides developing in other areas and pathogens. Specific guidelines by crop follow the general guidelines given here.

A fundamental principle that must be adhered to when applying resistance management strategies for QoI fungicides is that:

The QoI fungicides (azoxystrobin, coumoxystrobin, dimoxystrobin, enoxastrobin, famoxadone, fenamidone, fenaminostrobin, fluoxastrobin, flufenoxystrobin, kresoxim-methyl, mandestrobin, metominostrobin, orysastrobin, pyraoxystrobin, picoxystrobin, pyraclostrobin, pyrametastrobin, pyribencarb, triclopyricarb, trifloxystrobin) are in the same cross-resistance group.

- Fungicide programmes must deliver effective disease management. Apply QoI 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 QoI fungicide based products within a total disease management program must be limited whether applied solo or in mixtures with other fungicides. This limitation is inclusive to all QoI fungicides. Limitation of QoI fungicides within a spray programme provides time and space when the pathogen population is not influenced by QoI fungicide selection pressure.
- A consequence of limitation of QoI fungicide based products is the need to alternate them with effective fungicides from different cross-resistance groups (**refer to the specific crop recommendations**).
- QoI fungicides, containing only the solo product, should be used in single or block applications in alternation with fungicides from a different cross-resistance group. Specific recommendation on size of blocks is given for specific crops.
- QoI fungicides, applied as tank mix or as a co-formulated mixture with an effective mixture partner, should be used in single or block applications in alternation with fungicides from a different cross-resistance group. Specific recommendations on size of blocks are given for specific crops.
- Mixture partners for QoI fungicides should be chosen carefully to contribute to effective control of the targeted pathogen(s). The mixture partner must have a different mode of action, and in addition it may increase spectrum of activity or provide needed curative activity. Use of mixtures containing only QoI fungicides must not be considered as an anti-resistance measure. Where local regulations do not allow mixtures, then strict alternations with non-cross resistant fungicides (no block applications) are necessary.
- An effective partner for a QoI fungicide is one that provides satisfactory disease control when used alone on the target disease.
- QoI fungicides are very effective at preventing spore germination and should therefore be used at the early stages of disease development (preventive treatment).

2.2.2 Specific Crop/Pathogen guidelines

2.2.2.1. Strategies and Guidelines for cereals, 2016 season

Where the guidelines for the 2015 season were followed, field performance of QoI containing spray programmes was good. It continues to be essential to use non-cross resistant mixture partners (e.g. SBIs, multi-sites) to ensure robust disease management. This will also help to delay the evolution of resistance, especially in regions with no resistance or where resistance is at low levels.

Therefore the recommendations for the season 2016 remain unchanged.

Guidelines for using QoI fungicides on cereal crops

1. Apply QoI fungicides always in mixtures with non-cross resistant fungicides to control cereal pathogens. At the rate chosen the respective partner(s) on its/ their own has/ have to provide effective disease control. Refer to manufacturers recommendations for rates.
2. Apply a maximum of 2 QoI fungicide containing sprays per cereal crop. Limiting the number of sprays is an important factor in delaying the build-up of resistant pathogen populations.
3. Apply QoI fungicides according to manufacturer's recommendations for the target disease (or complex) at the specific crop growth stage indicated.
4. Apply the QoI fungicide preventively or as early as possible in the disease cycle. Do not rely only on the curative potential of QoI fungicides.
5. Split / reduced rate programmes, using repeated applications, which provide continuous selection pressure, accelerate the development of resistant populations and therefore must not be used.

2.2.2.2 Vine diseases

Guidelines for using QoI fungicides on vines

Apply a maximum of 4 QoI fungicide containing sprays against any disease per vine crop, and a maximum of 33% of the total number of applications.

Powdery mildew (*Uncinula necator* / *Erysiphe necator*)

1. Apply QoI fungicides according to manufacturer's recommendations for the target disease at the specific crop growth stage indicated. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.
2. Apply a maximum of 2 QoI fungicide containing sprays targeted against powdery mildew per vine crop, preferably in mixture (co-formulations or tank mixes) with effective mixture partners from different cross-resistance groups.
3. Apply QoI fungicides preventively.
4. QoI fungicides used solo should be used in strict alternation with fungicides from a different cross-resistance group.
5. Apply QoI fungicides used in mixture in a maximum of two consecutive applications in alternation with fungicides from a different cross-resistance group. In areas where resistance has been confirmed, apply QoI fungicides in strict alternation and in mixture with an effective partner.

Downy mildew (*Plasmopara viticola*)

1. Apply QoI fungicides according to manufacturer's recommendations for the target disease at the specific crop growth stage indicated. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.
2. Apply QoI fungicides preventively.
3. Apply a maximum of 3 QoI fungicide containing sprays targeted against downy mildew per vine crop, only in mixture with effective partners from different cross-resistance groups.

4. Apply Qol fungicides in single or block application in alternation with fungicides from a different cross-resistance group.

2.2.2.3 Pome fruit diseases

Guidelines for using Qol fungicides on pomefruit

Scab (*Venturia inaequalis*, *Venturia pirina*)

1. Apply Qol fungicides according to manufacturer's recommendations for the target disease (or complex) at the specific crop growth stage indicated and adapted to size of trees. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.
2. Qol fungicides must be applied only in mixture with partners contributing to the effective control of the target pathogens.
3. Apply Qol fungicides preventatively. Under high disease pressure the spray interval should not exceed 7-10 days.
4. Apply a maximum of 3 Qol containing sprays per crop. A maximum of 4 Qol fungicide applications may be used where 12 or more applications are made per crop.
5. A maximum of 2 consecutive Qol fungicide sprays is preferred. Where field performance was adversely affected apply Qol containing fungicides in mixtures in strict alternation with fungicides from a different cross-resistant group.

2.2.2.4 Potato and tomato diseases

Guidelines for using Qol fungicides on potatoes and tomatoes

Late blight (*Phytophthora infestans*)

1. Apply Qol fungicides according to manufacturer's recommendations for the target disease (or complex) at the specific crop growth stage indicated. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.
2. Where Qol fungicide products are applied alone do not exceed 1 spray out of 3 with a maximum of 3 sprays per crop. Do not use more than 2 consecutive applications.
3. Where Qol fungicide products are applied in mixtures (co-formulations or tank mixes) do not exceed 50% of the total number of sprays or a maximum of 6 Qol fungicide applications whichever is the lower. Do not use more than 3 consecutive Qol fungicide containing sprays.

Early blight (*Alternaria solani*, *Alternaria alternata*)

1. Where Qol fungicide products are applied solo do not exceed 33% of the total number of sprays or a maximum of 4. Where mixtures (co-formulations or tank mixes) are used do not exceed 50% of the total number of sprays or a maximum of 6 Qol fungicide applications, whichever is the lower.
2. Where resistance has been confirmed, Qol fungicides must be applied only in mixture with partners contributing to the effective control of the target pathogens.

2.2.2.5 Guidelines for using Qol fungicides on soybean diseases

Qol fungicides effectively control soybean diseases including rust, which is a major disease in Latin America and has been detected recently in the USA.

In order to ensure sustainable use of Qols the Working Group recommends:

Apply QoI fungicides according to manufacturer's recommendations for the target disease (or complex) at the specific crop growth stage indicated. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.

1. Use QoIs preventatively or as early as possible in the disease cycle.
2. Use QoIs preferably in mixtures (co-formulations or, **where permitted**, tank mixes) with fungicides from a different cross-resistance group. At the rate chosen each partner on its own has to provide effective disease control. Refer to manufacturers' recommendations for rates. In regions where target site mutations in key target soybean pathogens are present mixtures are mandatory.
3. Limiting the number of sprays containing QoI fungicides is an important factor in delaying the build-up of resistant pathogen populations.

Good agricultural practices must be considered to reduce disease pressure and resistance risk, e.g. avoiding multiple cropping. Rotating products of the same mode of action group does not contribute to sound resistance management (see FRAC mixtures guidance document).

2.2.2.6 Guidelines for using QoI fungicides on sugar beet

Cercospora beticola

1. Apply QoI fungicides according to manufacturer's recommendations for the target disease (or complex) at the specific crop growth stages indicated. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.
2. QoI fungicides must be applied only in mixture with partners **from a different cross-resistance group**, contributing to the effective control of the target pathogens.
3. Apply QoI fungicides preventatively. Under high disease pressure the spray interval should not be extended.
4. Do not exceed 50% of the total number of sprays with QoI containing products. In low disease pressure situations where only 1 fungicide application is required for disease control then a QoI – containing mixture (as defined above) may be used.

Where QoI fungicides are used targeting other sugar beet diseases (e.g. rust, powdery mildew, Rhizoctonia, Ramularia and Stemphylium) then the potential impact of applications on the resistance management of *Cercospora beticola* should be considered. Where *Cercospora beticola* is not a disease of importance (e.g. in a certain geography) then the general guidelines for QoI fungicides apply.

2.2.2.7 Cucurbit diseases

Guidelines for using QoI fungicides on Cucurbit Vegetables

1. Apply QoI fungicides according to manufacturer's recommendations for the target disease (or complex) at the specific crop growth stage indicated. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.
2. Apply a maximum of 3 QoI fungicide sprays per crop
3. Use a maximum of 1 QoI fungicide spray out of every three fungicide applications.
4. Do not use consecutive applications of QoI fungicides.
5. Apply QoI fungicides in alternation with fungicides from a different cross-resistance group with satisfactory efficacy against the targeted pathogen(s).
6. Continue QoI fungicide alternation between successive crops.

2.2.2.8 Guidelines for using QoI fungicides on greenhouse grown non-cucurbit vegetables

1. Apply QoI fungicides according to manufacturer's recommendations for the target disease (or complex) at the specific crop growth stage indicated. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.
2. Use a maximum of 1 QoI fungicide spray out of every 3 fungicide applications.
3. Do not use consecutive applications of QoI fungicides.
4. Apply QoI fungicides in alternation with fungicides from a different cross-resistance group with satisfactory efficacy against the targeted pathogen(s).
5. Continue QoI fungicide alternation between successive crops.

2.2.2.9 Guidelines for using QoI fungicides on other multiple spray crops (non-cucurbit field vegetables and ornamentals)

1. Apply QoI fungicides according to manufacturers' recommendations for the target disease (or complex) at the specific crop growth stage indicated. Effective disease management is a critical parameter in delaying the build-up of resistant pathogen populations.
2. Observe spray limitations in the spray guideline table shown below for programmes utilising 12 or fewer fungicide sprays per crop.

Spray guideline table:

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

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

- When using a QoI 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 QoI mixes in programs in which tank mixes or pre mixes of QoI with mixing partners of a different mode of action are utilized, the number of QoI containing applications should be no more than ½ (50%) of the total number of fungicide application per season.
- In programs in which applications of QoI are made with both solo products and mixtures, the number of QoI containing applications should be no more than ½ (50%) of the total number of fungicide applied per season.

** Mixtures are preferred.

2.2.2.10 Guidelines for using QoI fungicides on Rice

Rice Blast (*Pyricularia oryzae*, *Magnaporthe oryzae*)

1. Apply a maximum of 2 foliar treatments per season.
2. In situations where resistance has been detected or the risk is considered to be high always apply QoI fungicides in mixtures (where permitted) with non-cross resistant fungicides. At the chosen rate, the respective partner(s) on its/ their own has/ have to provide effective disease control. Refer to manufacturers recommendations for rates.
3. Apply QoI fungicides in programs with fungicides of different mode of actions.
4. Do not apply QoI fungicides for seed production.

5. Apply QoI fungicide based products at effective rates and intervals according to manufactures' recommendations.
6. To keep good field sanitation, avoid transplanting diseased seedlings, remove or destroy primary infection source e.g. left-over seedlings, infested straw and chaff.

Seed treatment applications

QoIs are and will be used as seed treatment products.

It is FRAC's objective to protect this fungicide group and integrate all uses into technical recommendations. These minutes contain a recommendation on seed treatments, including those which have efficacy on foliar pathogens.

These recommendations will be reviewed regularly and supported by monitoring. When an QoI fungicide is used as a seed treatment on rice, there should be no implications regarding QoI FRAC guidelines on the use of foliar QoI fungicides on the same crop as long as the QoI seed treatment is directed by rate and efficacy against seed and soil borne diseases or 'low risk' foliar pathogens (Link to FRAC pathogen risk classes).

QoIs used as a seed treatment in rice providing foliar efficacy against pathogens with moderate/ high resistance risk count against the total number of QoI applications.

If QoI seed treatment has been used, first foliar application have to be made with a different mode of action in the vegetative phase before subsequent QoI-based foliar sprays in the reproductive phase.

Please refer to the recommendations of Japan-FRAC www.jfrac.com link

2.2.2.11 Banana

Guidelines for using QoI fungicides on banana

Please refer to the recommendations of the banana FRAC working group: The conclusions and guidelines of the 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 spring 2018.

3. Communication plans

The above Web Pages will serve as the main communication vehicle for the group.

4. Next meetings:

All crops: December 14th 2017.

Venue: Frankfurt

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