

# Minutes of the FRAC Qil (Quinone inside Inhibitors) Working Group Meeting

27 March 2025 – 13.00 to 16:00

Frankfurt, Germany

Protocol of the discussions and use recommendations of the Qil (Quinone inside inhibitors)  
Working Group of the Fungicide Resistance Action Committee (FRAC)

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## Participants

Andy Leader (Qil Chair)	Corteva
Helge Sierotzki (Qo Chair)	Syngenta
Mamadou Mboup	Corteva
Amandine Picard	Corteva
Lorenzo Borghi	Syngenta
Irina Metaeva	Syngenta
Ranner David	Syngenta
Andreas Mehl	Bayer
Frank Goehlich	Bayer
Gerd Stammmler	BASF SE
Martin Semar	BASF SE (arable crops)
Raffaello Zito	BASF SE
Yuichi Matsuzaki	Sumitomo
Huet Gaelle	FMC
Henry Ngugi	FMC
Satoshi Araki	Ishihara Sangyo Kaisha
Yoshitake Desaki	Ishihara Sangyo Kaisha
Victor de Amorin	ISK Biosciences Europe
Yasuhiro Fukami	Nissan Chemical Europe
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Companies participating in the Qil meeting:

BASF, Bayer, FMC, Corteva, Syngenta, Sumitomo, ISK, Nissan

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## Introduction

The FRAC Qil (Quinone inside Inhibitors) Working Group was formed in 2025 and the first meeting took place in March 2025. In previous FRAC meetings, companies presented introductions to Qil molecules including baseline data and resistance management recommendations. Some Qil molecules have been available for use by growers for several years. All Qil molecules share the same FRAC Group 21 and target site C4 - Quinone 'inside' (Qi) binding site of the cytochrome bc1 (ubiquinone reductase) which inhibits fungal cell respiration in the mitochondria. However, Oomycete Qil molecules amisulbrom and cyazofamid have different crop and disease spectrums from Non-Oomycete compounds fenpicoxamid and florylpicoxamid. Amisulbrom and cyazofamid are effective against Oomycete pathogens (late blight and downy mildews) in associated target crops (potatoes, tomato, grape vine and leafy vegetables) whereas Non-Oomycete Qil molecules (fenpicoxamid, florylpicoxamid) are active against ascomycete and basidiomycete fungi in row crops (cereals, oilseeds, sugar beet), banana, ornamentals and fruit and vegetable crops with no activity on Oomycete pathogens. The lack of commonality in disease spectrum requires separate resistance management recommendations for Oomycete and Non-Oomycete Qil compounds.

The objective of the Working Group is to generate common resistance management recommendations for the fungicides amisulbrom and cyazofamid active against predominantly oomycete pathogens in potato, grape vines and leafy fruiting vegetable crops. Additionally, to generate common resistance management recommendations for the Non-Oomycete Qil fungicides (fenpicoxamid and florylpicoxamid) active against ascomycete and basidiomycete diseases.

Qil fungicides have been classified under the FRAC Code 21 C4. The resistance risk is medium to high.

FRAC Code	Target site and code	Group name	Qil Disease Spectrum	Chemical group	Common name	Comments
21	C4 - Quinone 'inside' (Qi) binding site of the cytochrome bc1 (ubiquinone reductase)	Qil fungicides (Quinone inside Inhibitors)	<b>Oomycete</b>	Sulfonamide Cyanoimidazole	Amisulbrom, Cyazofamid,	Resistance risk assumed to be medium to high (single site inhibitor). Resistance management required. Picolinamides show no spectrum overlap with Oomycete compounds amisulbrom and cyazofamid
			<b>Non Oomycete</b> Actinomycete Basidiomycete	Picolinamides	Fenpicoxamid, Florylpicoxamid	

## Qil Minutes of the 2025 discussions

### Review of sensitivity monitoring 2024 and earlier

#### 1. Introduction

The working group is responsible for global fungicide resistance strategies in the Qi inhibitor fungicides (Qil). The Qi inhibitor fungicides (Qil) all act at the Quinone 'inside' (Qi) binding site of the cytochrome bc1 complex, separated into one subgroup (FRAC code 21 C4) reflecting different binding properties from other QI fungicides (QoI and QioSI (FRAC codes 11, 11A (C3) and 45 (C8)).

The Qil FRAC code 21 C4 fungicides are: fenpicoxamid, florylpicoxamid, amisulbrom and cyazofamid. The resistance risk is classified as medium to high depending on the pathogen. As Oomycete Qil molecules amisulbrom, cyazofamid have a different crop and disease spectrum from Non-Oomycete compounds fenpicoxamid, florylpicoxamid, separate resistance management recommendations are required.

Fungicides in the code group 21 are not cross resistant to fungicides in the FRAC code group 11A and 11.

#### 2. Minutes of discussions

##### 2.1. Review of sensitivity monitoring

In the text below the categorisation of the findings ranging from “high” to “no resistance” are based on agreed frequency of resistant or adapted isolates in collections of samples from the respective countries or regions mentioned (no, no to low, low, low to medium, medium, medium to high, high, low to high, no to high resistance). Please refer to the wording in each category for more specific information.

## **Fungicides in FRAC code 21:**

### **2.1.1. Cereal diseases**

Field experience since first use in 2020 has confirmed that, when used according to FRAC guidelines, the performance of Qil Non-Oomycete containing products within spray programmes was good. Qils continue to contribute to overall disease management in cereals.

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

Companies: Corteva, Bayer

Sensitivity baseline data generated across seven years (2011, 2013, 2014, 2016, 2017, 2018 and 2019) from Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Poland, Spain, Sweden and United Kingdom showed a very narrow EC50 range and full sensitivity.

Sensitivity monitoring has continued to be conducted in 2021, 2022 and 2023 with samples from Belgium, France, Germany, Hungary, Ireland, Italy, Netherlands, Spain and United Kingdom where no changes in sensitivity were observed.

In 2024, extensive monitoring based on bioassay in Austria, Belgium, Denmark, Czech Republic, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Spain, Sweden and United Kingdom showed full sensitivity within the established base line range. No resistant isolates observed.

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

Companies: Corteva, Bayer

Sensitivity baseline data generated across three years (2015, 2016 and 2018) in Austria, Belgium, Czechia, Denmark, France, Germany, Hungary, Italy, Netherlands, Poland, Sweden and United Kingdom showed a narrow EC50 and full sensitivity.

In 2024, sensitivity monitoring based on bioassay in France, Germany, Ireland and United Kingdom showed full sensitivity. No resistant isolates observed.

#### **Yellow rust (*Puccinia striiformis*), wheat**

No data presented

#### **Net blotch (*Pyrenophora teres*), barley**

Companies: Corteva, Bayer,

Sensitivity baseline data was generated across two years (2018 and 2019) with samples from Belgium, Czechia, Denmark, France, Germany, Hungary, Italy, Poland, Sweden and United Kingdom showed a narrow EC50 and therefore full sensitivity.

In 2024, sensitivity monitoring based on bioassay in Austria, Belgium, Czechia, Denmark, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Sweden, Netherlands and United Kingdom showed full sensitivity. No resistant isolates observed.

### **Ramularia (*Ramularia collo-cygni*), barley**

Companies: Corteva,

Sensitivity baseline data generated across four years (2018, 2019, 2020 and 2021) in Czechia, Denmark, France, Germany, Hungary, Ireland and Italy showed a narrow EC50 and therefore full sensitivity. No resistant isolates observed.

## **2.1.2 Potatoes /Tomatoes**

### **Potato/tomato late blight (*Phytophthora infestans*)**

Companies: Nissan, Corteva and Syngenta

In 2024, samples from potato crops in Austria, Belgium, Czechia, Croatia, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Slovenia, Switzerland, and United Kingdom were fully sensitive. No resistant isolates were observed.

Sensitivity samples were generated across multiple years (2016 and 2023) from Belgium, Czechia, Denmark, France, Germany, Hungary, Italy, Netherlands, Poland, Sweden and United Kingdom which were fully sensitive.

No resistant isolate from field populations have been detected since introduction of Qil fungicides more than 10 years ago. *Phytophthora infestans* is classified by FRAC as a medium risk pathogen. Long-term experience with Oomycete Qil fungicides demonstrates that the resistance risk of *P. infestans* is moderate.

## **2.1.3 Grape Vine**

### **Grape downy mildew (*Plasmopara viticola*)**

Companies: ISK, Nissan, Corteva and Syngenta

In 2024 and 2023 extensive sensitivity monitoring of Oomycete Qil compounds in grape vine was carried out by bioassay or molecular methods in Austria, Croatia, France, Germany, Hungary, Italy, Portugal (only 2023), Romania (only 2023) and Spain.

Different resistance mechanisms based on target site mutations (insertions after Amino acid (AA) positions 202 \ 203, respectively, and L201S (the latter one found in single populations and low frequency)) have been reported. These mutations can impact the activity of Qil compounds to varying degrees. Overall frequency of resistance is highly variable across Europe depending on countries, regions and even across years.

France: Low to Moderate

Germany: Low, regionally moderate

Austria: Low to Moderate

Italy: Low, regionally moderate

Overexpression of alternative oxidase (AOX) is also widely encountered but considered of lower practical relevance.

Future research should evaluate in more depth the relationship between mutation frequency and sensitivity, and their distribution regionally within countries.

2019-2022

Companies: ISK and Nissan

Historical sensitivity samples baseline and monitoring were generated by companies across multiple years (2008 and 2022) from Austria, France, Germany, Greece, Italy, Spain and Portugal with 2019-2022 data reporting some different resistance mechanisms based on target site mutations and non-specific resistance mechanisms mediated by overexpression of alternative oxidase (AOX) with variability of occurrence by country and regions.

#### **2.1.4 Cucurbits**

##### **Cucurbit downy mildew (*Pseudoperonospora cubensis*)**

No data presented

#### **2.1.5 Ornamentals**

##### **Grey Mold (*Botrytis cinerea*) in ornamentals**

Companies: Corteva

Sensitivity baseline data generated in 2023 and 2024 from Columbia showed full sensitivity.

#### **Recommendations for Use**

## **General recommendations for Non-Oomycete Qil Compounds**

- Apply Qil's preventatively.
- Use Qil's as part of an Integrated Crop Management (ICM) strategy incorporating other methods of control.
- Always follow product specific label recommendations for resistance management.
- When mixtures are used for Qil 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 and must have a different mode of action.

## **Recommendations for cereals**

- Apply a maximum of 1 Qil containing spray per crop.
- Qil's should always be applied in mixture (co-formulation or tank mix) with a partner(s) from a different cross-resistance group which provide(s) robust control.

## **Recommendations for bananas**

- See most recent FRAC banana WG use recommendations - summary table.

## **Recommendations for ornamentals**

- Apply a maximum of 5 Qil containing sprays per year or a maximum of 33% of total sprays (1/3 of spray program) whichever is lower.

## **General recommendations for Oomycete Qil Compounds**

### **Recommendations for Grape Vines: *Plasmopara viticola* – Grape downy mildew**

*Plasmopara viticola* is classified by FRAC as a high risk pathogen. The resistance risk of *P.viticola* to Qil fungicides is moderate to high and can be managed through appropriate use strategies.

- Always apply Qil fungicides in mixture with effective partners such as multi-site or other non-cross resistant fungicides in high risk areas/regions.
- Apply Qil fungicides preferably in a preventive manner.
- Apply a maximum of 50 % of the total number of intended applications for disease control not exceeding a total of 4 Qil fungicides sprays during one crop cycle. In areas of high resistance, the total number should not exceed a maximum of 3 applications during one crop cycle.
- Alternation with fungicides having other modes of action is recommended in spray programs.
- Apply Qil fungicides according to manufacturers' instructions.

### **Recommendations for Potatoes: *Phytophthora infestans* – Potato late blight**

For effective resistance management a precautionary strategy has to be implemented.

- Apply Qil fungicides preferably in a preventive manner.

- Apply a maximum of 50 % of the total number of intended applications for late blight control during one crop cycle.
- Alternation with fungicides having other modes of action is recommended in spray programs.
- Apply Qil fungicides according to manufacturers' instructions.