Minutes of the FRAC QioSI Working Group Meeting

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1. Introduction

The FRAC QioSI (Quinone inside and outside inhibitor, stigmatellin binding mode) Working Group was formed in 2025 and the first meeting took place in March 2025. Currently, ametoctradin is the only registered fungicide with this mode of action.

QioSI fungicides control oomycete plant pathogens by inhibiting both ubiquinone binding sites at complex III (Zhu et al. 2015, Fehr et al. 2016). To date, two resistance mechanisms have been identified in *Plasmopara viticola* that affect ametoctradin sensitivity: overexpression of the alternative oxidase, which impacts all complex III inhibitors, and the S34L mutation in the cytochrome *b* gene, specific to ametoctradin. The S34L mutation occurs in the inner binding site but does not impact QiI fungicides. Resistance mechanisms for QoI (G143A and F129L) or QiIs (L201S, inserts at 203/204) do not influence the sensitivity to ametoctradin.

QioSI fungicides have been classified under the FRAC Code 45. The resistance risk is assumed to be medium to high.

FRAC Code	Target site and code	Group name	Chemical group	Common name	Comments
45	C8 complex III: cytochrome bc1 (ubiq. reductase) at Qi and Qo site (stigmatellin binding mode)	QioSI fungicide (Quinone inside and outside inhibitor, stigmatellin binding mode)	triazolo-pyrimidylamine	ametoctradin	not cross-resistant to QoI fungicides, resistance risk assumed to be medium to high (single site inhibitor) Resistance Management required

The working group collects sensitivity monitoring data and recommends resistance management strategies.

References

Zhu X., Zhang M., Liu J., Ge J., Yang G. (2015) Ametoctradin is a potent Qo site inhibitor of the mitochondrial respiration complex III. J Agric Food Chem, 63, 3377−3386, DOI: 10.1021/acs.jafc.5b00228

Fehr M., Wolf A., Stammler G. (2016) Binding of the respiratory chain inhibitor ametoctradin to the mitochondrial bc1 complex. Pest Manag Sci 2016, 72, 591–602. DOI: 10.1002/ps.4031

2. Resistance monitoring

2.1. *Plasmopara viticola*

Companies: BASF, Corteva

Main resistance mechanisms are the overexpression of the alternative oxidase and the target site mutation S34L in the cytochrome *b*. Sensitivity monitoring methods include biotests (detached leaf tests, zoospore release tests) and molecular genetic methods for detection of target site mutation S34L.

The overexpression of AOX has been recognized for over 15 years, exhibiting regional variations. Research indicates that this mechanism is associated with fitness penalties, which may explain why AOX fluctuates in presence within vineyards and does not increase in prevalence across European viticultural regions.

The target site mutation S34L has first been found in the Armagnac area in France in 2016 and single cases in other areas in the following seasons.

In 2023 and 2024 extensive sensitivity monitoring with biotests and molecular genetic methods for S34L detection showed that specific QioSI resistance can be found at low frequency in in France, Italy and Spain. Single cases have been found in Hungary and Germany. Samples from Portugal, Greece and Türkiye showed full sensitivity.

2.2. *Phytophthora infestans*

Companies: BASF

Sensitivity monitoring was conducted using microtiter tests with determination of EC_{50} values.
Data from 2019 to 2024 showed a narrow range of EC_{50} values of *Phytophthora infestans* with an unimodal distribution. Single outliers with EC_{50} values outside the baseline range have been identified in 2021 and 2022. A target site mutation couldn't be identified in the cytochrome b gene of such outliers. Outliers were not detected in populations analyzed in 2023.

In 2024, all isolates tested were in the baseline sensitivity range and there was no indication of any adaptation. Isolates were taken from potatoes from Greece, Portugal, Spain, Italy, Latvia, Lithuania, Belgium, Netherlands

2.3. *Pseudoperonospora cubensis*

Companies: BASF

Sensitivity monitoring was conducted using biotests with determination of EC_{50} values. The data from 2022, 2023 and 2024 showed no indication of resistance development towards QioSI in this species. Samples were collected from Portugal, France, Italy and Spain.

3. Recommendations for Use

Resistance management strategies might differ in regions or countries because of different disease pressure or national guidelines.

Recommendations for grape downy mildew (*Plasmopara viticola*):

- Apply QioSI containing products in a preventative manner.
- Apply a maximum of 3 applications per season.
- Use always in mixture (ready-mix or tank-mix) with an effective partner
- In order to reduce selection pressure, use in alternation with a non cross-resistant product is recommended.

Recommendations for late blight *(Phytophthora infestans*)

- Apply QioSI containing products in a preventative manner.
- Apply a maximum of 50 % of the total number of intended applications for late blight control during one crop cycle.
- Mixtures (ready-mix or tank-mix) with an effective partner are recommended.
- Alternation with fungicides having other modes of action is recommended in spray programs.
- Apply QioSI fungicides according to manufacturers' instructions.

Recommendations for oomycetes occurring in vegetable crops

- Apply QioSI containing products in a preventative manner.
- Mixtures (ready-mix or tank-mix) with an effective partner are recommended.
- Alternation with fungicides having other modes of action is recommended in spray programs.
- Apply QioSI fungicides according to manufacturers' instructions.

4. Next Meeting

Next annual meeting is scheduled for 26th March 2026.