

CAA Working Group

**FRAC**  
FUNGICIDE RESISTANCE  
ACTION COMMITTEE

## Membership

The Working Group is comprised of the following members:

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## Introduction

A new FRAC Working Group has been established in order to generate common resistance management recommendations for the Oomycete fungicides dimethomorph, flumorph, iprovalicarb, bentiavalicarb and mandipropamid.

Concurrently the above-mentioned fungicides have been re-grouped under the new FRAC Code No. 40 in the revised FRAC Code List.

CODE	TARGET SITE OF ACTION	GROUP NAME	CHEMICAL GROUP	COMMON NAME	COMMENTS
40	phospholipid biosynthesis and cell wall deposition (proposed)	CAA-fungicides (carboxylic acid amides)	cinnamic acid amides	dimethomorph flumorph	Low to medium risk. Resistance management required.
			valinamide carbamates	benthiavalicarb iprovalicarb	
			mandelic acid amides	mandipropamid	

As shown in the table, the group name **Carboxylic Acid Amides (CAA)** has been chosen. This name best represents compounds from three different chemical groups.

The mode of action of CAA compounds has not yet been fully elucidated. There are proposals for inhibition of phospholipids biosynthesis and for interference with cell wall deposition.

Sensitivity monitoring studies over several years revealed that in the populations of the late blight pathogen, *Phytophthora infestans*, all isolates were fully sensitive to CAA fungicides. However, in the populations of the grape downy mildew pathogen, *Plasmopara viticola*, isolates can be found in certain regions which are simultaneously resistant to all CAA fungicides. Therefore, in the case of *Plasmopara viticola*, a positive cross resistance among all CAA fungicides is obvious for the vast majority of isolates. The degree of sensitivity covers a wide range of EC50 values with isolates being sensitive, moderately resistant and fully resistant.

Inheritance studies (Gisi et al., in preparation) showed that sexual crosses between sensitive and CAA resistant isolates of *P. viticola* lead to a co-segregation of resistance to dimethomorph, iprovalicarb, benthiavalicarb and mandipropamid, but not to the phenylamide mefenoxam which was tested in parallel as an independent marker.

Further, the inheritance studies showed that the gene(s) for resistance to CAA fungicides are inherited in a recessive manner. Therefore, the entire F1 generation of crosses between sensitive and CAA resistant isolates was sensitive, and only in the F2 progeny did CAA resistance reappear in a few isolates. These results suggest that the resistance risk can be classified as moderate (as compared to high for phenylamide and Qol fungicides) and that it can be managed by appropriate product use strategies (see below).

Overall, these results explain some characteristics of CAA resistance, especially the limited spread and propagation of resistant isolates in field populations.

## 2. Resistance Monitoring

### 2.1. *Plasmopara viticola* – Grape downy mildew

#### 2.1.1. Sensitivity Situation before 2005

Shortly after the introduction of dimethomorph, Albert et al. (1994) published that less sensitive populations towards dimethomorph had been detected in France. In 1998, iprovalicarb was introduced to the market. Long-term monitoring experience is therefore available for *P. viticola* and these two fungicides. Monitoring studies for two developmental compounds, benthiavalicarb and mandipropamid, have been initiated during the last years and generated further information.

#### France

Less sensitive populations could be detected consistently in the department Gers in South-Western France (known as part of the Armagnac region) and in the South-East (lower Rhone valley). In all other French wine-growing areas, such as Bordeaux, Loire, Champagne and in the upper Rhone valley, less sensitive populations have also been detected, but less frequently and less regularly. In addition, in these

regions the percentage of resistant strains fluctuated largely from year to year. Analyzing the resistance frequency over the years, a stable trend for either an increase or a decrease of resistant Plasmopara populations could not be detected.

## **Germany**

Less sensitive populations have been detected in some wine-growing regions of Germany, including Rhein-Hessen, Palatinate, Mosel and Franconia. As in most parts of France, a stable trend for increase or decrease of resistance has not been detected over the years.

## **Other countries**

Systematic monitoring has also been performed in the past in Italy, Spain and Portugal. Since 2000, only fully sensitive populations have been detected. In Switzerland, apart from isolates coming from trial sites, all isolates were fully sensitive.

### **2.1.2 Monitoring 2005**

#### **Disease incidence**

- In Germany high infection pressure was observed at the beginning of the season, but decreased later due to dry weather conditions
- In Italy, France, Portugal and Spain there was weak infection pressure due to dry weather conditions
- Hungary had a strong and aggressive disease season

#### **Field performance**

Field performance of registered products was good. No resistance-related complaints have been received.

#### **Monitoring results**

##### **France**

Results not yet completed, but CAA resistant isolates have been detected in the department Gers and the lower Rhone valley.

##### **Germany**

Resistant isolates have been detected in the Rhein-Hessen, Palatinate, Mosel and Main areas.

##### **Italy, Spain, Portugal, Switzerland**

Only fully sensitive strains were detected.

### **2.2. *Phytophthora infestans* – Late blight of potatoes and tomatoes**

#### **Field performance**

Field performance of CAA fungicides against late blight was good and fulfilled grower expectations. No resistance-related complaints have been received for the registered compounds.

#### **Monitoring results**

Sensitivity monitoring run by all member companies of the CAA Working Group has never detected less sensitive strains of *Phytophthora*. These studies, covering many years and all major potato and tomato growing areas, document that populations of *P. infestans* are fully sensitive to CAA fungicides.

### 3. Use Recommendations

#### 3.1. *Plasmopara viticola* – Grape downy mildew

Long-term experience with CAA fungicides demonstrates that the resistance risk of *Plasmopara viticola* to this fungicide group is moderate and can be managed.

This estimation is supported by the fact

- that resistance related complaints never became known with CAA fungicides as long as mixtures with multi-site fungicides have been used
- that the resistance frequency in the effected regions is mostly fluctuating with no clear progression over years and regions
- resistance genes are inherited in a recessive manner

#### Use Recommendations:

- Apply a maximum of 4 CAA sprays during one crop cycle
- Apply CAA fungicides always in mixture with effective partners such as multi-sites or other non cross resistant fungicides
- An effective partner for a CAA fungicide is one that provides satisfactory disease control when used alone at the mixture rate

#### 3.2. *Phytophthora infestans* – Late blight of potato and tomato

As no isolates from field populations have been found with reduced sensitivity since the introduction of CAA fungicides, no specific anti-resistance use recommendations are proposed at this stage.

For product recommendations refer to the use guidelines published by the respective CAA manufacturers.

#### 3.3. Other Oomycete Pathogens

In spite of the intensive use of some CAA fungicides for more than 10 years against a range of Oomycete pathogens, no validated reports on the occurrence of less sensitive field populations are available for pathogens other than *P. viticola*.

For product recommendations refer to the use guidelines published by the respective CAA manufacturers.

Source: [www.frac.info](http://www.frac.info)  
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