



## Membership

The CAA Working Group is comprised of the following members:

Michael Merk (chairman)	BASF, Limburgerhof, Germany
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Albert Schirring	Bayer CropScience, Monheim, Germany
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## 1. Introduction

The FRAC CAA Working Group was set up in 2005 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	bentiavalicarb 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., Plant Pathology, 2007, 56, 199-208) showed that sexual crosses between sensitive and CAA resistant isolates of *Plasmopara viticola* lead to a co-segregation of resistance to dimethomorph, iprovalicarb, bentiavalicarb 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 QoI 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 2007**

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

#### **Disease incidence**

In 2007, disease pressure was moderate to high (even severe) in the main grape growing areas of Europe. Disease management was challenging in many situations due to high disease pressure.

#### **Field performance**

Field performance of registered products was good in 2007. No resistance-related complaints have been received.

#### **Monitoring results**

(results generated by BASF, Bayer, KI-Chemical, Syngenta)

##### France

As in the years before, CAA resistant isolates have been detected consistently in all areas. Some increase of the resistant isolates was observed in Burgundy, Cognac and Champagne. A stable situation was observed in the other regions compared to 2006.

### Germany

Resistant isolates have been detected in all major vine-growing regions similar to 2006. The highest level was observed in Mosel area, moderate level was observed in Rheinhessen, Pfalz, Franken, Württemberg and very low level in Baden.

### Italy

As in 2006 no resistance was detected except in South Tyrol and Trentino where for the first time resistance isolates were detected on a very low level.

### Spain

As in 2006 no resistance was detected except in Galicia where resistant isolates were detected on a low level.

### Portugal, Switzerland, Austria

As in 2006 resistant isolates were detected at a very low level.

### Greece

No resistant isolates were detected.

### China

No resistant isolates were detected.

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

### **Disease Incidence**

Disease onset was rather early in the main growing potato areas and remained high.

### **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**

(results generated by BASF and Syngenta)

Sensitivity monitoring programs in 2007 did not detect less sensitive strains of *Phytophthora infestans* in Europe. These studies document that populations of *P. infestans* are fully sensitive to CAA fungicides and confirm the observations of previous years.

## **2.3. *Pseudoperonospora cubensis* – Downy mildew of cucurbits**

In a few sites it was possible to detect resistant isolates of *Pseudoperonospora cubensis*. There are no complaints on the performance of CAA products from commercial fields.

## **3. Use Recommendations**

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

*Plasmopara viticola* is regarded as a high risk pathogen as classified by FRAC. Long-term experience with CAA fungicides demonstrates that the resistance risk of *Plasmopara viticola* to

this fungicide group is moderate and can be managed through appropriate use strategies. This experience has been confirmed again in 2007 season and 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 affected regions is mostly fluctuating with no clear progression over years and regions
- that 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**

No resistant isolates from field populations have been found since the introduction of CAA fungicides over 10 years ago.

*Phytophthora infestans* is regarded as a medium risk pathogen as classified by FRAC. Long-term experience with CAA fungicides demonstrates that the resistance risk of *Phytophthora infestans* to this fungicide group is low to moderate. For effective resistance management a precautionary strategy has to be implemented:

- Maximum 50 % of the total number of intended applications for *Phytophthora*-control
- Alternation with other modes of action is recommended

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

### **3.3. *Pseudoperonospora cubensis* – Downy mildew of cucurbits**

*Pseudoperonospora cubensis* is regarded as a high risk pathogen as classified by FRAC.

Use recommendation:

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

### **3.4. Other Oomycete (*Peronosporomycete*) Pathogens**

Some of the downy mildew pathogens are regarded as moderate risk pathogens (e.g. *Bremia lactucae*) as classified by FRAC. In spite of the use of CAA fungicides for more than 10 years

against a range of such Oomycete pathogens, no reports on the occurrence of less sensitive field populations are available.

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

- Maximum 50 % of the total number of intended applications for disease control
- Alternation with other modes of action is recommended

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

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