



Carboxylic Acid Amides (CAA) Working Group

Annual Meeting 2012 on December 4, 2012

Protocol of the discussions and recommendations of the CAA working group of the Fungicide Resistance Action Committee (FRAC)

Participants

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Venue:

Lindner Congress Hotel, Frankfurt am Main, Germany

1. Introduction

The FRAC CAA Working Group was set up in 2005 to generate common resistance management recommendations for the Oomycete fungicides dimethomorph, flumorph, iprovalicarb, bentiavalicarb, mandipropamid, valifenalate and pyrimorph.

All of the above-mentioned fungicides exhibit cross resistance and are grouped under the FRAC Code No. 40 in the FRAC Code List.

CODE	TARGET SITE OF ACTION	GROUP NAME	CHEMICAL GROUP	COMMON NAME	COMMENTS
40	Cellulose synthesis	CAA-fungicides (Carboxylic acid amides)	cinnamic acid amides	dimethomorph flumorph pyrimorph	Low to medium risk. Resistance management required.
			valinamide carbamates	bentiavalicarb iprovalicarb valifenalate	
			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 is directly linked to the inhibition of cellulose synthesis in the Oomycete plant pathogen (Blum et al., Molecular Plant Pathology, 2009). Uptake studies with ¹⁴C labeled Mandipropamid (MPD) showed that this Oomycete control agent acts on the cell wall and does not enter the cell. Furthermore, ¹⁴C glucose incorporation into cellulose was perturbed in the presence of MPD. Gene sequence analysis of cellulose synthase genes in laboratory mutants, insensitive to MPD, revealed two point mutations in the *PiCesA3* gene, known to be involved in cellulose synthesis. Both mutations in the *PiCesA3* gene result in a change to the same amino acid (Glycine-1105) in the protein.

Sensitivity monitoring studies over several years revealed that in populations of the late blight pathogen, *Phytophthora infestans*, all isolates were fully sensitive to CAA fungicides. However, in populations of the grape downy mildew pathogen, *Plasmopara viticola*, isolates can be found in certain regions, which are resistant to all CAA fungicides.

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 some 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).

2. Resistance Monitoring 2012

2.1. *Plasmopara viticola* – Grape downy mildew

Disease incidence

In 2012, disease pressure was moderate to high in the main grape growing areas of Europe.

Monitoring results

(Results generated by BASF, Bayer, Isagro, KI-Chemical, Syngenta)

France

As in the years before, CAA resistant isolates have been detected consistently in all areas. High frequency of resistance was detected in Cognac, Armagnac, Gascogne, Bordeaux and Champagne.). The frequency of resistance was heterogeneous ranging from low to high in Val de Loire, Bourgogne, Languedoc and Sud Est and was low in Alsace.

Germany

High frequency of resistance was observed in Mosel and moderate levels were detected in Rheinhessen, Pfalz and Baden.

Italy

High resistance levels were observed in Alto Adige, Trentino, Veneto and Piemonte. Low levels have been found in Lombardia, Emilia Romagna, Toscana and Marche.

Spain, Portugal

No resistance was detected in Galicia and Portugal.

Switzerland

A high level of resistance was observed in Buendner Herrschaft, moderate in Lake of Geneva and low levels in Valais and Tessin.

Austria

No resistance was detected in Wachau and Burgenland and low levels were observed in the Weinviertel and Steiermark.

Hungary

No resistance was detected.

Field performance

Field performance of registered products was good in 2012.

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

Monitoring results

(Results generated by BASF, Isagro, KI Chemical, Makhteshim and Syngenta)

Sensitivity monitoring programs in 2012 did not detect less sensitive strains of *Phytophthora infestans* in Europe. These studies document that populations of *Phytophthora infestans* are fully sensitive to CAA fungicides and confirm the observations of previous years.

Field performance

Field performance of CAA fungicides against late blight was very good.

2.3. Other Oomycete pathogens

No sensitivity monitoring studies were conducted in 2012.

3. Use Recommendations

3.1. *Plasmopara viticola* – Grape downy mildew

Plasmopara viticola is classified by FRAC as a high risk pathogen. 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.

Use Recommendations:

- Apply CAA fungicides preferably in a preventive manner
- Apply a maximum of 50% of the total number of applications not exceeding a total of 4 CAA fungicide sprays during one crop cycle
- Always apply CAA fungicides in mixture with effective partners such as multi-site 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
- Alternation with fungicides having other modes of action is recommended in spray programs

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

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 15 years ago.

Phytophthora infestans is classified by FRAC as a medium risk pathogen. 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.

Use Recommendations:

- Apply CAA fungicides preferably in a preventive manner
- Maximum 50 % of the total number of intended applications for late blight control
- Alternation with fungicides having other modes of action is recommended in spray programs

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 classified by FRAC as a high risk pathogen.

Use Recommendations:

- Apply CAA fungicides preferably in a preventive manner
- Maximum 50 % of the total number of intended applications for disease control
- Alternation with fungicides having other modes of action is recommended in spray programs; do not use more than 2 consecutive applications of CAA fungicides
- In areas where resistant strains have been detected in commercial fields, apply CAA fungicides only in mixture with effective partners such as multi-site 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

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

3.4. Other Oomycete pathogens

Some of the downy mildew pathogens are classified by FRAC as moderate risk pathogens (e.g. *Bremia lactucae*). In spite of the use of CAA fungicides for more than 15 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.

Use Recommendations:

- Apply CAA fungicides preferably in a preventive manner
- Maximum 50 % of the total number of intended applications for disease control
- Alternation with fungicides having other modes of action is recommended in spray programs

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

4. Next Meeting

Next annual meeting is planned for December 10, 2013.