Copper replacement in organic viticulture – state of the art in legislation and research

Ersatz von Kupferspritzungen im ökologischen Weinbau – Stand in Wissenschaft und Gesetzgebung

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Abstract

In European viticulture, downy mildew (*Plasmopara viticola* (Berk. & Curt.) Berl. & de Toni) is one of the most dangerous diseases affecting grapes, causing significant damage and severe decreases of product quality.

European organic viticulture is predominantly based on copper applications to control this disease. Due to environmental problems incurred by copper applications, the European Commission decided to limit the use of certain copper products in organic viticulture. This should be achieved by the year 2002 (cf. EC 1488/97). Therefore, the Commission recommends testing alternative strategies in downy mildew control in line with EC 2092/91.

In the last decade, specific actions were realized to investigate, apply and support alternative control measures. These are based on microbial antagonists, plant extracts and inorganic, naturally occurring compounds. Studies on modes of action should help to characterize markers indicating effective resistance inducers.

Apart from the introduction of newly developed control agents, field trials focused on copper reduction strategies and new products with extremely low copper concentrations.

Nevertheless, a multidisciplinary approach is highly recommended in order to help solving one of the major problems of organic viticulture.

Keywords

Plasmopara viticola, ecotoxicology, antagonists, plant extracts, systemic induced resistance, vinification, residues

Ecotoxicological aspects of copper applications

Agriculture in general and plant protection measures in particular are always characterized by deliberate intervention in ecological systems. The use of copper leads to particular environmental problems: besides the **toxicity on water and soil organsims** the substance is characterized to accumulate in the soil with high persistence properties (Müller, 2000). Aware of these environmental problems associated with copper, a number of national associations for organic viticulture, including Austria, Germany and Switzerland, limited the use of copper to 2-4 kg per ha and year. The copper application practice of other European countries is without any restriction (actual copper expense: 5–30 kg per ha and year). This inevitably leads to its accumulation in the soil and, subsequently, to an **unacceptable pollution of the vineyard** (Gärtel, 1957).

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Registered plant health improving agents and non-registered inorganic compounds

The efficacy of registered and accepted alternatives, so called **plant health improving agents** like Ulmasud® and Myco-Sin®, is not always sufficient, especially when secondary infection cycles are strong and continuous and additionally overlapped by infectious soil borne oospores, which germinate not only at the beginning of the growing period (primary infection) but several times during summer (Anonymous, 2000).
Other agents of inorganic origin, such as phosphoric acid or polyphosphates, can serve as excellent control measures, but, thus far, not all of them have been yet discussed by European legislation for plant protection purposes in organic agriculture and viticulture. In addition, the use of phosphoric acid raises problems by virtue of an excess of phosphorus plant nutrition and also by some distinct **residues in the wine** (Speiser et al., 1993).

Concomitant research for alternative agents

Alternatives are given by the use of single **biological agents** or their combination. Such as microbial antagonists, plant extracts, inorganic substances and naturally occurring compounds which can act **antibiosis, parasitism, competition on space and/or nutrients and induced resistance** as mode of action (Baker & Dunn, 1990). In the last decade fundamental research was conducted in the isolation, characterization and improvement of antagonists on the one hand (Tilcher, 1996) and of plant extracts on the other (Schmitt et al., 1995; Blaeser, 1999; Kast, 2001). In both cases, potential agents were found to control *P. viticola* with efficiency levels between 60 and 100 % in a leaf disc bio-assay and on potted vines. REM and microscopic studies on **mode(s) of action** indicated that sporangia germination as well as zoospore behavior were significantly affected. Over and above these studies will serve as basis to characterize markers indicating effective resistance inducers. This knowledge will allow targeted detection, combination and optimization of biological control agents (Deloire et al., 1998). However, due to an insufficient number of field trials and the lack of on-farm research only some of these biological agents have been further developed and/or exploited by organic wine growers.

Field tests and on-farm research

Problems arise when new agents are applied in the vineyard. **Field tests for the assessment of effects and side-effects** of newly developed agents have to be conducted on organic vineyards of research institutes according to European guidelines (cf. EPPO PP 1/31 [3]). For this purpose, biological agents require the addition of adjuvants or formulation additives in order to prevent their disturbance by radiation, rapid degradation and/or dehydration. The addition of these substances has to be in line with the issue for the production of organic merchandise. Over and above, application with practically used application facilities must be possible. The scale up from laboratory to field test level often raises problems with the required amount of biological compounds; this is especially true for plant extracts when application in high doses is required.
In order to determine possible influences of the newly developed agents on fermentation, vinification and analyses of residues will be performed additionally.
The final assessment of alternative biological agents is their **application in practice**. Actually, this important part of the development of new compounds serving as copper replacement agents needs much more consideration.

Outlook

At the moment, the second and third step of the development of new agents seems to be the bottle neck and needs, therefore, special attention and support in future research proposals. It has to be stressed, that a **multidisciplinary approach** is highly recommended for the successful introduction of efficient alternative compounds selected from the extensive pool of agents isolated at laboratory level.
In line with the directions of the 5th European Framework Programme (Quality of Life and Management of Living Resources) the extensive request for research has been expressed and proposed to the Commission in the year 2001 (proposal acronym: Plasmovit). If realized, the results of this European project will provide a valuable scientific basis for Community legislation.

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