How to improve disease control in European organic viticulture?

VINEMAN.ORG

Organic agriculture and, in particular, organic viticulture have grown considerably in the last decade, nonetheless organic farming still has a huge potential for innovation and improved solutions. The research project VineMan.org (www.vineman-org.eu) aims at improving disease control, which is one of the main and most difficult tasks in organic viticulture, by integrating plant resistance against fungal pathogens, vineyard management practices, and the use of biological control agents according to optimized outbreak forecasting systems.

Bunch sampling in the Italian experimental vineyard.

Scaphoideus titanus second instar nymph parasitized by the entomopathogenic fungus Lecanicillium lecanii.

Global consumption of organic wine continues to grow despite recent years of crisis and consequently, more and more grape growers are keen to adopt organic vine production. Organic viticulture faced more than a 4-fold increase world-wide between 1998 (48'600 ha) and 2010 (217'634 ha) (www.organic-world.net/); Europe covers most part of this surface. Nonetheless, organic grape-producers face several issues, one of the most crucial being how to maintain healthy plants. In organic viticulture, there are five main principles of plant protection (Trioli and Hofmann, 2009): i) soil fertility and health; ii) viticulture practices, selection of appropriate varieties and training systems; iii) timing of protection measures and application methods; iv) enhancement of natural defense mechanisms; and v) biological pest control and habitat management. Considering that the Council Regulation (EC) No 834/2007 requires the progressive reduction of copper fungicides, the development of new and efficient strategies for controlling grape diseases based on environmentally friendly and durable methods is necessary and will provide new opportunities for European grape growers in the organic sector. Achieving this is the main goal of the VineMan.org project. The different research topics of the project have been studied by different authors in the past, but have not yet been combined into an overall vineyard management strategy. In addition, the project focuses on the impact of organic cropping methods on the general microbial community structure of the vineyard, which has been poorly investigated as well.

In the first year of the project, the partners carried out research on four different aspects of disease control in organic viticulture and a first overall strategy for organic vineyard management was proposed.

Enhancement of plant resistance

All plants have an innate immunity against pathogenic fungi and oomycetes that is triggered by pathogen associated molecular patterns (PAMPs) which comprise soluble molecules from the pathogen cell wall such as oligosaccharides, peptides, and lipids. Repeated application of these molecules or their structural analogues can activate and enhance the innate defense response against a following infection. This can lead to an early and effective defense response also in susceptible plants. Several methods have been developed to test PAMPs for triggering defense responses in grapevine and some resistance inducing molecules have already been characterized.

Modification of canopy and cluster structure

Different methods for manipulating vegetative growth, canopy density, and fruit exposure were evaluated as a means for making the microclimate less favorable to pathogens and more ideal for the ripeness of the grapes. Primary leaves and second shoots developing from nodes 1 to 6 were removed at pre-flowering (ELR) and at pre-veraison and compared to control vines, in Italian, Spanish and Austrian vineyards. ELR was effective in reducing bunch sensitivity to grey mold by reducing bunch compactness and increasing berry skin thickness. The beneficial effect of ELR was more evident in Austrian vineyard, where the weather was conducive to the disease. Both treatments did not affect the titratable acidity of the musts while ELR increased the tartaric acid suggesting the possibility to obtain more balanced wines by preserving acidity.

Above-bunch-zone leaf removal applied at pre- and post-veraison was also tested on potted vines and compared to untreated vines. The seasonal carbon/yield ratio did not differ between treatments and neither berry fresh mass nor relative growth of skin, flesh and seeds were affected by treatments. Above-bunch-zone defoliations were effective in temporarily delaying technological maturity without affecting bunch color and the content of phenoles.

Leaf removal in the Austrian experimental vineyard.

Environment and disease development

Existing models for predicting plant disease outbreaks/epidemics were evaluated for their ability to support decision-making about crop protection, based on the presence of favorable environmental conditions and/or biological information concerning the disease and/or the host plant. Mechanistic, weather-driven models for downy and powdery mildews (Rossi et al., 2008; Caffi et al., 2011 and 2013) were implemented in a web-based platform provided by Horta s.r.l., able to produce decision aids for crop protection in organic viticulture. For downy mildew, the model was able to reduce the amount of copper by 20% as average of 18 vineyards, with a maximum of 73%.

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Experimental vineyard in Northern Italy.

Improve fitness and efficacy of BCAs

Fitness and efficacy of biocontrol agents, representing formulations of bacteria and fungi already registered in Europe, were evaluated in relation to grape pests and disease control under organic practices. For instance, the entomopathogenic fungus *Lecanicillium lecanii* was used against the leafhopper *Scaphoideus titanus*, the vector of the phytoplasma causing flavescence dorée. *L. lecanii* proved to be virulent to the second instar nymphs of the grasshopper.

Overall strategy for organic vineyard management

Based on the results obtained in the first year of the project, two innovative management strategies will be tested in the experimental vineyards in the second year. The first strategy is more conservative, i.e. risk-adverse strategy, while the second one is more risk-seeking.

The risk-adverse strategy is based on the combination of: i) fall treatments with the hyperparasite *Ampelomyces* spp. for the reduction of the overwintering cleistothecia of *Erysiphe necator*, ii) the web-portal with models for the prediction of downy and powdery mildews to schedule copper and sulphur treatments at label dose during the season; iii) usage of BCAs for the control of grey mold. The risk-seeking strategy is based only on: i) dose minimized copper and sulphur applications according to the models and ii) early leaf removal for the control of grey mold.

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Project partners at the Kick-off meeting, held in Piacenza (Italy) in January 2012.