Development of a new strategy for the control of Flavescence dorée disease based on a multiannual model of *Scaphoideus titanus* and a landscape analysis

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Abstract: Flavescence dorée (FD), a quarantine phytoplasma disease caused by "*Candidatus Phytoplasma vitis*", belonging to the Elm Yellows or 16Sr-V group, is transmitted epidemically by *Scaphoideus titanus*, a monovoltine leafhopper accidentally introduced to France from North America in the 1950s. FD appeared for the first time in Switzerland in 2004 in the vineyards located in Cantone Ticino, in the South of the Alps. Despite the 13 years application due to mandatory control, FD was consistently diagnosed during a time interval between 4 and 13 years in the 12.7% of the infected vineyards without the presence of populations of its epidemic vector.

Some studies let suppose that the FD epidemiological cycle could be more complex than the simple transmission from grapevine to grapevine by *S. titanus*. *Ailanthus*, *Alnus* and *Clematis* are known to be FD plant hosts. It was also demonstrated the capacity of *Dictyophara europaea* to transmit the FD from *Clematis vitalba* to grapevine and, recently, the capability of the leafhopper *Orientus ishidae* to transmit 16SrV group phytoplasmas to grapevine (Lessio et al., 2016).

The aim of the work if to test if the FD complex could be considered as an open system by investigating the presence of putative vectors and host plants in the vineyard agro-ecosystem.

A study was carried out during 2013-2015. In 2013 and 2014 we worked in a test vineyard of Chardonnay located in Stabio and, on the basis of the results, we extended in 2015 the analysis to six other vineyards distributed in the different winegrowing area of Ticino and cultivated with Chardonnay, Pinot noir and Cabernet franc. The survey of the leafhoppers population was carried out using yellow sticky traps and the beating tray method. Symptomatic grapevine plants were found between July and September. Furthermore, leaf samples were also collected from symptomless plants as well as woody and shrubby plants that showed symptoms, possibly caused by the presence of phytoplasma.

Six leafhoppers were found positive to the FD: *Hyalesthes obsoletus*, *Thamnotettix dilutior*, *Graphocephala fennahi*, *Thamnotettix* sp., *Japananus hyalinus* and *Orientus ishidae*. *O. ishidae* was the most abundant in all studied vineyards, but with varying population densities, followed by *J. hyalinus*. Contrary to *O. ishidae*, which transmit 6SrV group phytoplasmas to grapevine (Lessio et al., 2016), the ability of the other leafhopper species to transfer the FD to grapevines is still to be demonstrated. Due to the scarce population density of *S. titanus*, the epidemic level of the FD in the infected vineyards remained low. *Corylus avellana* and *Salix* sp. are the preferred host plants of *O. ishidae* and they were also found positive to FD (Casati et al., 2017). *C. avellana* is particularly important because of the wide distribution in Ticino and positive individuals were present in all analysed vineyards.

It is reasonable to hypothesize that the ecological cycle of FD could be related not exclusively to the grapevine-specific feeding diet of *S. titanus*, but it could include other insect vector(s) and/or plant host(s). Therefore, the FD ecology appears to be a much more opened system than previously thought (Casati et al., 2017). The landscape surrounding the vineyards plays an important role determining which alternative plant host(s) and potential alternative leafhopper vector(s) are present. The current control strategy, based on the eradication of FD, is challenged and must be reassessed with the aim to find a long-term coexistence with this disease.

In order to deal with complex problems high in uncertainty like the FD-system, an adaptive management (AM) strategy was developed (Jermini et al., 2013). A multiannual infestation model for *S. titanus* (Rigamonti et al., 2014) is the basis of this strategy and it will be associated with a landscape analysis to quantify the secondary factors affecting the FD spread. The aim is to rationalize pest management and to learn how the pest population system works.
We started in 2016 a project in three vineyards cultivated with Merlot with the aim to develop a strategy for a coexistence with the FD. The first step was to stop the mandatory control against *S. titanus* to assess the annual increase of its populations. These data will be used to validate the multiannual model. Simultaneously, a landscape analysis method coupled with a survey of leafhopper population was developed to observe the presence of FD symptoms in the plots and in the woody and shrubby plants surrounding the vineyards.

Key words: alternative host vectors, host plant, landscape

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