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INTRODUCTION

Many species of mealybugs (*Pseudococcidae*) and soft scales (*Coccidae*) living on grapevine have been shown to vector grapevine leafroll ampeloviruses (e.g. GLRaV-1 and -3) and 'rugose wood'-associated vitiviruses (e.g. GVA) in throughout grape-growing regions in the world (Herrbach et al., *in press*) and they represent a non negligible way of virus dispersal over short distances. It has been demonstrated that some mealybug species are able to spread rapidly leafroll from infected plots to new plantations (Cabaleiro et al., 2008; Le Maguet, 2012 ; Le Maguet et al., *submitted*), but the dispersal and virus spreading by soft scales in the vineyard is not documented.

Several ways of natural dispersal can be observed in the vineyard. Larvae can easily crawl from one leaf to the other, and then to adjacent plants. They can also be transported by winegrowers and their engines during the different winegrowing works. Scale-attending ants, that carry crawlers from vine to vine, may also contribute to the spread of viruses (Daane et al., 2007; Mgocheki and Addison, 2010). However, the main factor of passive dispersal is probably the wind, as previously observed for several scale species (Greathead, 1997, Grasswitz and James, 2008). In addition, wind dispersal of fallen leaves bearing larvae is also possible (Lo et al., 2005-2006).

Parthenolecanium corni (Bouché) is a soft scale that thrives in northern European vineyards and is able to vector GLRaV-1 as well as GVA (Hommay et al., 2008). The establishment of a new plantation between plots being both virus-infected and *P. corni*-infested offered the opportunity to evaluate whether nymphs may be detached from their support by the wind, during their active dispersal after hatching ('crawler' phase) and during their migration as second instars (L2) down the stocks to hibernate. The aim of this study was to assess whether nymphs can be transported by the wind and carry leafroll viruses or GVA, susceptible to contaminate new stocks.

MATERIALS AND METHODS

The young vine plot was planted in Nothalten (Alsace, north-eastern France) at spring 2008 with certified rootstocks (34 EM), on a strip of 94 m x 11 m. The plot was arranged in four rows, south-north oriented along the slope. The plantation was surrounded by plots infested by *P. corni* and infected by GLRaV-1, -2, -3 and GVA in various combinations, the plot to the west being the most heavily infested.

Sticky traps consisted of transparent PVC cylinders (height 30 cm, diameter 14 cm), wrapped up with a 30 cm x 45 cm transparent polythene sheet sprayed with glue (Soveurode™) and staked at a height of *ca*. 1.2 m (i.e. approximately at the level where larval density was the highest on the neighboring plots). A grid of such traps was set up in the young plot: five (2009) or six (2010 and 2011) traps placed at 20 m intervals within each of the four rows of plantation. From July 2009, a control trap was placed on a neighboring plot at *ca*. 50 cm height close to a highly infested vine infected by GLRaV-1, -3 and GVA. Traps were checked every week during the crawler phase and during autumnal migration of L2. The egg-laying period of females was controlled in order to settle traps just before the first hatchings. Sheets were examined under binocular microscope and nymphs were marked and counted on a grid divided into eight sectors corresponding to wind directions.

Trapped crawlers were then collected from the glue, if possible in samples of min. 20 individals, and tested in a quadriplex RT-PCR for the presence of GLRaV-1, -2, -3 and GVA (Beuve et al., *submitted*). Populations of L2 larvae were counted at spring on each vine of the first two first rows of the neighboring plots. Infection of the most infested vines was checked by ELISA.

In spring 2011 and 2012, distribution of L2 was controlled on the young plantation. In 2011, larvae and winter canes of the most infested vines were tested by the same quadriplex RT-PCR procedure. Mean temperatures, rainfall, maximal wind speed and wind direction were obtained from a meteorological station situated at *ca*. 12 km from the experimental plot.

RESULTS AND DISCUSSION

The total number of *P. corni* crawlers caught in spring 2009, 2010 and 2011 was respectively 145, 251 and 611 in all traps set up in the young plot (7, 10 and 25,5 in average per trap). The distribution of catches in the young plot seemed to be related to the main prevailing winds and to population density in the immediate vicinity. However, the settling of *P. corni* on the young plot displayed no significant structure. In Autumn, very few L2 nymphs were caught, probably because their heavier weight.

About 30% of crawlers batches and 50% of L2 batches carried by the wind contained one virus or more. There is therefore a possibility that wind-borne larvae could contaminate young vines, provided they are able to attain a plant and feed on it. However, the relative part of such a way to disperse a virus is unknown. Moreover, our detection tests could not reveal the presence of either virus transmitted by *P. corni* (GLRaV-1 and GVA) in the colonized vines in the young plot. It is possible that the number of larvae is too low (less than 20 L2 on the most infested young vines) or that the virus, if transmitted, was not yet detectable. New monitorings are underway in 2012, as well as virus detection tests in young vines.

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