

Influence of the distribution and infection rates of psyllids on the vectoring ability of European stone fruit yellows in Switzerland

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Abstract

European stone fruit yellows (ESFY) is caused by the phytoplasma '*Candidatus Phytoplasma prunorum*', which is transmitted from plant to plant by insects of the genus *Cacopsylla*. Better knowledge of vector distribution in the orchards and on wild host plants is crucial for controlling the disease and preventing its spread. *Cacopsylla pruni* is known as the vector of ESYF. Recently, a second psyllid, *Cacopsylla pinihimata*, has been identified as a vector; however, its vectoring capacity for ESYF phytoplasma is still unknown. The objective of this study was to map the distribution of psyllids in Switzerland and to determine the percentage of infested adults. The occurrence of psyllid species was monitored by sweeping techniques, and the percentage of infested adults was analyzed by nested PCR. Psyllid monitoring revealed that *C. pruni* is present in every Swiss region, with a similar population density in the different locations. In contrast, *C. pinihimata* was only captured in Valais (southwest), the main apricot production area. This is probably due to the presence of specific conifers, which are the overwintering hosts for *C. pinihimata*. Infested psyllid adults were found in half of the monitored regions. The percentage varied between 1.3 and 18.2% and was not higher in the apricot production area. Surprisingly, in 2013, ESYF infestation was only found in *C. pruni* and not in *C. pinihimata*. However, in 2012, *C. pinihimata* was also infested by '*Ca. P. prunorum*'. The capacity of the two psyllids in ESYF vectoring, their importance in ESYF epidemiology and the consequences on ESYF control strategies are discussed.

Keywords: *Prunus armeniaca*, *Prunus spinosa*, psyllid monitoring, sweeping techniques, '*Candidatus Phytoplasma prunorum*'

INTRODUCTION

European stone fruit yellows (ESFY) is caused by the phytoplasma '*Candidatus Phytoplasma prunorum*'. This quarantine disease is an important concern in Europe, including Switzerland, and causes important economic losses in apricot production (Marcone et al., 2010). In Valais, the main Swiss production region, orchards are highly infested with ESYF and up to 4% have to be replaced every year (M. Genini, pers. commun.).

'*Ca. P. prunorum*' is transmitted from plant to plant by *Cacopsylla pruni* (Carraro et al., 1998, 2001; Jarausch et al., 2001a; Jarausch and Jarausch, 2010). *C. pruni* completes one generation per year strictly on *Prunus* spp., overwinters as an adult on conifers and then moves back to *Prunus* spp., where the transmission of '*Ca. P. prunorum*' occurs (Thébaud et al., 2009). Observations in different European countries have shown the importance of wild *Prunus* spp. in the spread of ESYF (Jarausch et al., 2001b; Carraro et al., 2002; Ramel and Gugerli, 2004). These studies revealed a high density of *C. pruni* on wild *Prunus*, such as *Prunus spinosa*. On the contrary and despite a high ESYF susceptibility of *Prunus armeniaca*, low population levels of *C. pruni* were found on apricot cultivars.

Recently, a second psyllid, *Cacopsylla pinihimata*, has been identified (Sauvion et al., 2007). The occurrence and distribution of the two psyllids in different countries in Europe and in Switzerland needs to be investigated, as well as their vectoring ability.

Therefore, the objective of this study was to explore the presence of psyllids in



different Swiss regions, to map the distribution of psyllid species in Switzerland and to determine the percentage of ESFY-infested adults.

MATERIALS AND METHODS

The occurrence of psyllid species was monitored on *P. spinosa* by sweeping techniques (three hits on 40 branches) in nine locations in 2012 and in 14 locations in 2013, representing 13 Swiss cantons. Psyllid biotypes A and B were determined by morphological identification and were confirmed by PCR. In addition, the presence of ESFY phytoplasma in psyllids was analyzed by nested PCR (fO1/rO1) (Peccoud et al., 2013).

RESULTS AND DISCUSSION

Distribution of psyllids in Switzerland

The psyllid monitoring on *Prunus spinosa* revealed that plum psyllids are present in every Swiss region, with different population density (Table 1). The number of psyllids varied between 28 and 357 in 2012 and between 4 and 201 in 2013. *C. pruni* (biotype B) was present in every Swiss region. On the other hand, *C. pinhiemata* (biotype A) was mainly captured in Valais, the main apricot production area (and in Le Landeron in 2012). However, the presence of biotype A was not related to the surrounding apricot orchards, but moreover to the presence of conifers of the genus *Pinus*, which are the overwintering hosts for biotype A *C. pinhiemata*. In Valais, the proportion of biotype A varied between 8% (Conthey in 2012) and 69% (Martigny in 2012) of the total psyllid population. The Swiss distribution of both biotypes is in accordance with studies from France (Sauvion et al., 2007), where only biotype B *C. pruni* is present in the continental climatic zone of France. Furthermore, the importance of wild plants surrounding apricot orchards in the propagation of ESFY has been described previously (Jarausch et al., 2001b; Carraro et al., 2002).

Determination of the psyllid species and of the percentage of ESFY-infested adults

ESFY is largely present in every Swiss region (Table 1). Infested psyllid adults were found in eight out of nine locations of the monitored regions in 2012 and in seven out of 14 locations in 2013. In Valais, the captured *C. pruni* were infested by 'Ca. P. prunorum', as well as *C. pinhiemata* in 2012, but surprisingly, *C. pinhiemata* was not detected in 2013. The percentage of infested psyllids varied between 1 and 15% in 2012 and between 1.3 and 18% in 2013. The infection rate was not higher in Valais, the apricot production area. The infection rate in Switzerland was comparable with studies conducted in other European countries (Carraro et al., 1998; Jarausch et al., 2007; Lethmayer et al., 2011).

CONCLUSIONS

C. pruni was found on *P. spinosa* in every monitored location in Switzerland, but the second vector, *C. pinhiemata* was only found in Valais. Infested psyllid adults were found in 15 monitored locations; the percentage of infested psyllid adults ranged from 1 to 18%. The infection rate was not higher in Valais, the apricot production area. This suggests that infestation by 'Ca. P. prunorum' in a specific region is highly influenced by the presence of wild *Prunus* (and conifers, as overwintering hosts), but not by the presence of apricot orchards.

Valais is the only ESFY-contaminated zone in Switzerland, despite the large presence of ESFY in every Swiss region. According to our results, the definition of the ESFY-contaminated zone should be revisited in Switzerland and be based on the presence of ESFY and not on the presence of apricot orchards.

The control of the wild host by removal of every *P. spinosa* tree in the surroundings of apricot orchards appears to be difficult to implement. Therefore, the control of the vectors is an important measure to prevent disease spread and to develop a general management strategy.

Table 1. Determination of psyllid species and percentage of infested adults (biotype A, *Cacopsylla pinihemata*; biotype B, *Cacopsylla pruni*).

Location	Number of psyllids per biotype	Number of adults tested	Number of ESFY-infested adults (%)
Rotkreuz ZG (2013)	36 (B)	20	2 (10%)
Maienfeld GR (2013)	96 (B)	20	2 (10%)
Buchs SG (2013)	17 (B)	17	0
Wädenswil ZH (2013)	28 (B)	28	0
Breitenhof BL (2013)	29 (B)	20	0
Berneck SG (2013)	114 (B)	20	0
Fruthwilen TG (2013)	4 (B)	4	0
Bertschikon ZH (2013)	12 (B)	11	2 (18%)
Dättwil AG (2013)	26 (B)	20	1 (5%)
Diegten BL (2013)	41 (B)	20	0
Kleinwangen LU (2013)	47 (B)	40	0
Nyon VD (2013)	119 (B)	80	1 (1.3%)
Vétroz/Conthey VS (2013)	115 (B); 95 (A)	29 (B); 24 (A)	3 (10%); 0
Sierre/Loèche VS (2013)	27 (B); 43 (A)	27 (B); 13 (A)	1 (4%); 0
Berne BE (2012)	31 (B)	31	0
Riedholz SO (2012)	53 (B)	53	3 (6%)
Le Landeron NE (2012)	52 (B); 7 (A)	52 (B); 7 (A)	1 (2%); 0
Nyon VD (2012)	34 (B)	34	5 (15%)
Baulmes VD (2012)	28 (B)	28	1 (4%)
Termen VS (2012)	155 (B); 31 (A)	155 (B); 31 (A)	18 (12%); 0
Leukerbad VS (2012)	131 (B); 226 (A)	131 (B); 226 (A)	8 (6%); 3 (1.3%)
Conthey VS (2012)	181 (B); 16 (A)	181 (B); 16 (A)	16 (9%); 1 (6%)
Martigny VS (2012)	48 (B); 109 (A)	48 (B); 109 (A)	6 (12.5%); 1 (1%)

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