

# Symptom remission and recovery in 'bois noir' infected grapevines

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## Abstract

The disease progress of 'bois noir' has been studied from 1996 to 2010 in two vineyards of the middle Rhine valley in Germany. This period was characterized by two severe outbreaks in 1997 and 2007, followed by endemic periods with decreasing incidence. Although the highest yearly incidence was 50% in cv. Riesling and 14% in cv. Pinot noir, the cumulative incidence reached 91% and 40%, respectively. The mean rates of symptom remission were 38% (Riesling) and 59% (Pinot noir), and the average duration of the symptomless period was 3.3 years and 6.6 years, respectively. Based on the comparison of the probabilities to develop disease symptoms it is proposed to deem vines in the first and second asymptomatic year to be temporary free of symptoms (symptom remission), while they should be considered recovered thereafter.

**Key words:** 'Bois noir', disease progress, remission, recovery.

## Introduction

The disease progress of 'bois noir' (BN) is subject to the antagonistic influence of new infection and to the disappearance of symptoms from infected vines. This interaction leads to a considerable temporal variation of disease incidence. Occasional outbreaks of the disease are followed by rather endemic periods with constant or decreasing levels of disease. The spontaneous disappearance of symptoms from infected vines is typical for grapevine yellows (Caudwell, 1961) and related to physiological alterations in the recovering vines (Musetti *et al.*, 2007). Various attempts aim to promote the spontaneous recovery of infected vines by pruning, other cultivation practices, or the stimulation of grapevine defense mechanisms (Romanazzi *et al.*, 2009). It is necessary for the sound interpretation of field and laboratory results to distinguish between the temporal remission of symptoms (latent infection) and the complete recovery of previously diseased vines. A long term study is carried out in different vineyards of the middle Rhine valley, one of the most affected German wine growing areas, with the aim of a better understanding of the temporal aspects of BN disease progress. The data presented here are derived from a subset of the monitoring plots that had been analyzed before for a shorter period (Maixner, 2006).

## Materials and methods

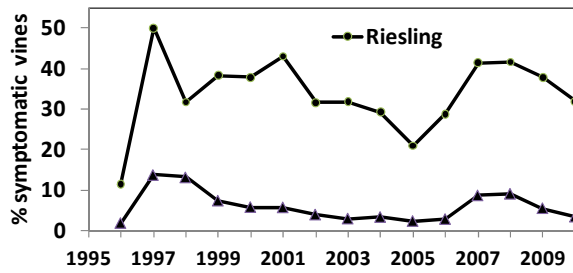
The two vineyards were established by the same grower in 1994 with cv. Pinot noir (PN, 819 vines) and cv. Riesling (RI, 611 vines). After the only sporadic occurrence of symptoms in 1995 the systematic monitoring by visual inspection of all vines started in 1996 and was carried out since then every year in September. The yearly disease incidence was calculated as the ratio of symptomatic to all vines, while the rate of new infection was estimated as the proportion of symptomatic vines in the group of previously healthy plants. The rate of re-

mission is the ratio of asymptomatic vines in the group of previously symptomatic ones. Based on previous observations (Maixner, 2006) and the results of the current study, vines were considered to be recovered from BN when they stayed symptomless for more than two years. Vines were grouped according to their diseases history to study the influence of previous symptomatic or asymptomatic periods on the disease. Group data of different years were combined. The data were analyzed by ANOVA with the arcsin-transformed proportions as dependent variables. Tukey's HSD test was applied for multiple comparisons of means. Some parameters were compared between 'endemic' (decreasing or constant incidence) and 'epidemic' years (increasing incidence).

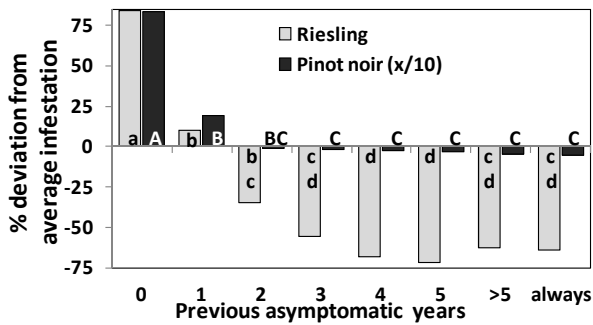
## Results and discussion

Two severe outbreaks of BN were observed in the period between 1996 and 2010 (figure 1), and an additional peak was observed in 2001. Peak incidence levels in Riesling were 50%, 42%, and 43% in the respective years. Rates of new infection reached 47%, 25%, and 20%. The average disease incidence was significantly lower in the less susceptible cv. Pinot noir (5.9%) compared to Riesling (34%), but the fluctuations were synchronous. The maximum incidence in the Pinot noir vineyard was observed in 1997 (13.7%). The cumulative incidence from 1995 to 2010 was much higher with 40% (Pinot noir) and 91% (Riesling). The differences between the levels of current and cumulative incidence underline the importance of the spontaneous recovery of infected vines.

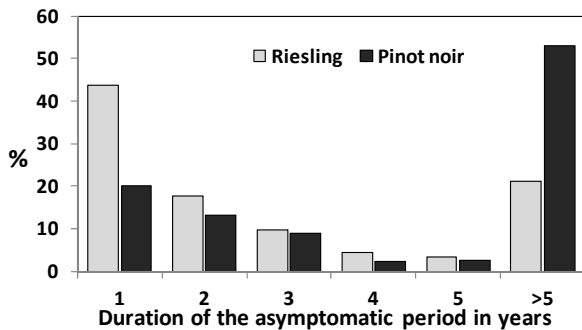
Endemic and epidemic years did not differ significantly with respect to BN incidence in Riesling but in Pinot noir, probably because the range between minimum and maximum disease levels was lower in Riesling (factor 4.3) compared to Pinot noir (7.7). In both cultivars the rates of new infection were significantly higher in epidemic years (factor 2.2 to 3.0) while the values for remission were significantly lower. Recovery



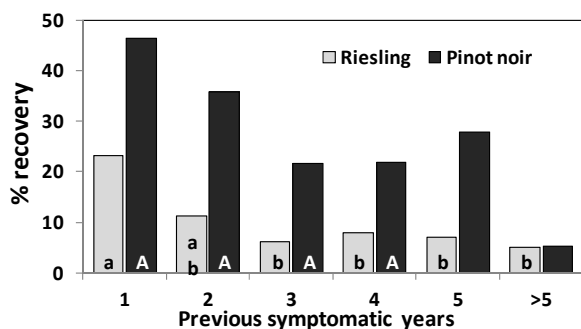
**Figure 1.** Temporal variation of ‘bois noir’ incidence between 1996 and 2010 in two vineyards of the middle Rhine valley.



**Figure 2.** Influence of preceding asymptomatic periods on symptom expression. The within-group incidences are compared to the average incidence of all vines.



**Figure 3.** Frequency distributions of Riesling and Pinot noir vines showing symptom remission with respect to the duration of the asymptomatic period.



**Figure 4.** Influence of the length of the preceding symptomatic period on the recovery of vines.

was slightly reduced in epidemic years by 22 and 27%, but the differences were not significant. The strongly varying infection pressure (rate of new infection) seems to be the primary factor for the variability of BN incidence.

The rates of symptom expression were calculated separately for different cohorts according to the previous asymptomatic periods (figure 2). A single asymptomatic year reduced the probability of symptom expression significantly in both cultivars, although it still exceeded the average value of the whole plot. In all other groups the incidence was less than the mean, but it was not significantly different between the groups of one and two asymptomatic years. From the third asymptomatic year the groups were not significantly different nor could be distinguished from the vines that were always healthy before. These results support the previous suggestion to consider a minimum asymptomatic period of three years as a mark to distinguish between temporal remission and permanent recovery of BN infected vines (Maixner, 2006).

The risk of symptom expression of plants with four and five asymptomatic years was less than in the always healthy vines, though not significantly different. More data need to be analyzed to confirm this observation, because it could indicate a reduced susceptibility to new infection after recovery due to physiological changes in recovering and recovered grapes (Musetti *et al.*, 2007).

The rates of remission and recovery averaged 38% (15%) in Riesling and 59% (39%) in Pinot noir, while the mean duration of the asymptomatic period was 3.3 years and 6.6 years, respectively. Most of the recovered vines (asymptomatic period  $\geq 3$  years) stayed free of symptoms for more than five years (figure 3).

As shown in figure 4 the rate of recovery decreased with the increasing duration of the previous symptomatic period. The chance of Riesling vines to recover was significantly higher after one symptomatic year compared to longer periods. This is probably related to the initially limited distribution of the phytoplasmas in the infected plants that might favor their elimination by pruning.

## References

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