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Influence of Rootstock on Resistance of *Vitis* cv. 'Albariño' Clones to Downy Mildew

S. Boso, J.L. Santiago and M.C. Martínez
(Misión Biológica de Galicia, Consejo Superior de Investigaciones Científicas, Pontevedra, Spain)

Summary

Resistance of leaves and fruit clusters of *Vitis vinifera* 'Albariño' clones to downy mildew (*Plasmopara viticola*) using non-grafted plants and plants grafted on 110-R. All the experimental plants had been growing since 1993 at the Misión Biológica de Galicia, Spain. Both in terms of their leaves and clusters, some clones were more resistant to infection than others. Some were more susceptible to primary attack than secondary attack, while others showed the opposite characteristics. The degree of susceptibility to disease was independent of the rootstock used or indeed of whether the plant had been grafted or not.

Key words. downy mildew – rootstock – *Vitis vinifera* – clone – 'Albariño' – resistance

Introduction

Downy mildew is one of the most common cryptogamic diseases of grapevines. According to numerous authors (Ravaz 1914; Boubals 1959, 1961; Ribereau-Gayón and Peynaud 1971; Galet 1977, 1995; Staud and Kassemeyer 1995; Wang et al. 1995; Ypema and Gubbler 2000) the members of the genus *Vitis* show a wide range of resistance to fungal pathogen, *Plasmopara viticola*. *Vitis vinifera* is, in general, much more susceptible than other species (Boubals 1959; Galet 1995; Pearson and Goheen 1996). For example, *V. aestivalis* and *V. labrusca* are less sensitive, and *V. cordifolia*, *V. riparia, V. rupestris* and *V. rotundifolia* are relatively resistant. Susceptibility to downy mildew can even vary between different clones of a single variety (Pérez Marín 1992; Ravaz 1994; Boso et al. 2004b).

Varieties or clones that show a degree of natural resistance are an important method managing against grapevine diseases. The north and northeast of Spain is an area where it is still possible to find centuries-old specimens of many of the area's traditional cultivars (Martínez et al. 2005). With respect to cv. 'Albariño', the Misión Biológica de Galicia (CSIC) has a collection of 11 different clones, all of which are derived from centuries-old material. In previous studies we showed that some of these clones are more resistant to downy mildew than others, both in the field (Boso et al. 2004b) and in the laboratory (Boso et al. 2006), and that these differences are maintained from one year to another.

It has been observed in citrus crops that the rootstock used can have a moderate influence on fruit quality and production (Joublan and Nelson 2002). With respect to grapevines, several authors (Reynier 1987; Hardie and Cirami 1988; Hidalgo 1993; Main et al. 2002; Boso et al. 2005) have shown that the rootstock used influences resistance to nematodes, tolerance to excess soil calcium and potassium, plant vigour, yield, fruit composition, and wine pH and quality etc. Some authors (Reynier 1987; Hidalgo 1993) even indicate that the rootstock can influence a vine's overall resistance to fungal disease, although this has never been clearly demonstrated.

In studies on clones of cv. 'Chardonnay' (Chambre d'Agriculture de l'Aude 2004), rootstock type appeared to have no influence on resistance to powdery mildew (*Uncinula necator* Schw. Burril.). However, those rootstocks that allowed plants to develop with greater vigour seemed also to leave them more susceptible to infection with *Botrytis cinerea* Pers. (English 1989; Cristinzio et al. 2000).

The aim of the present work was to establish whether the differences in resistance to downy mildew observed in some cv. 'Albariño' plants [both in the field (Boso et al. 2004b) and laboratory (Boso et al. 2006)] is due to their having been grafted, and to determine any influence of rootstock type.

Materials and Methods

Plant materials

Field trial design was completely randomised and the studie was carried out in three consecutive years (2001–2003). The experimental material included five non-grafted plants of cv. 'Albariño' clones MBG-1, MBG-2, MBG-7, MBG-9 and MBG-10, five of each that had been grafted onto 110-R rootstocks, and five of each grafted onto SO4 rootstocks. All had been growing since 1993 at the Misión Biológica de Galicia in the Province of Pontevedra (NW Spain), the heart of the Rías Baixas Appelation Contrôlé region. In this area, 75 % of the vines under cultivation are of the 'Albariño' type. All plants were subject to the same edaphoclimatic conditions and cultivation practices, pruned according to the "sylvoz" system, and grown "en espalier".

Sampling method

Leaf and cluster resistance to downy mildew were measured in each of the clones following the method of Boso et al. (2005).

Leaf sampling. Sampling was performed twice. The first samples (S1) were taken when early symptoms (light yellow "oil spots" with clear boundaries) appeared on the leaves, and the second (S2) when later symptoms (mosaics of small, dark brown spots) appeared. Natural infections were used since the disease reliably appears every year in the study location. Fifty arbitrarily selected mature leaves with symptoms of downy mildew were examined from the five plants of each clone (ten leaves per plant). These leaves were chosen from the upper and lower and interior and exterior parts of the canopy. At S1, each of these leaves was marked with a number (1–50). These leaves were not picked; rather, digital photographs were taken and analysed using analySIS 3.0 software (Soft Imaging System GmbH, 1998). The number of spots per leaf was recorded and their boundaries marked. The leaf area occupied by each spot was then determined. Total leaf surface area was also determined.

When later symptoms (mosaic symptoms) were evident (S2), photographs were taken of the same leaves. The total surface area of each leaf, the area occupied by the spots, and the number of the spots were again recorded.

From these data, the following relationships were calculated: incidence of leaf infection (number of infected leaves with respect to total number of leaves), severity of leaf infection (sum of the surface area of all spots / leaf surface area), and the intensity of leaf infection (number of spots on each leaf / leaf surface area).

Grape cluster sampling. Five plants per clone and rootstock, 2 clusters per plant and 10 clusters per clone were examined. Cluster sampling was performed during ripening. The number of healthy and diseased clusters on every vine was counted. Whole clusters were weighed, as were the parts of each that were affected by disease. From these data, the severity of cluster infection (sum of the weight of the diseased portions on each vine / total weight of the clusters of each vine [g]) and the incidence of cluster infection (number of diseased grape clusters per vine / total number of grape clusters examined) were calculated.

Statistical analysis

The results were analysed by ANOVA. The sources of variation for the leaf samples were clone, rootstock, year, sampling time and all possible interactions between them. For clusters, the following sources of variation were considered: clone, rootstock, year, and the interaction *clone x year*. 'Year' was considered as a random factor. For each variable, Fisher's protected test (least significant difference [LSD] method) was used to determine which clones were the most resistant and which the most susceptible. All calculations were performed using SAS V8.1 software (2000).

In order to visualise the response of the clones with respect to rootstock and in terms of leaf and cluster differences, a series of graphs were plotted using the mean values for the three years of the study (Fig. 1, 2 and 3). For the leaves, the mean results for S1 and S2 were used.

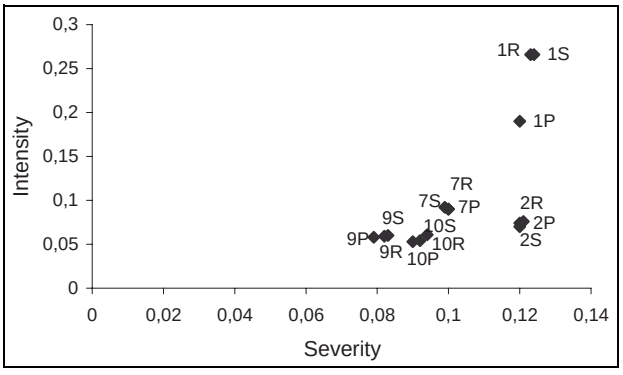


Fig. 1. Mean intensity and severity values for all non-graft and clones grafted on two rootstocks (x, y) of disease in leaf for the three years of the study (combining the two sampling times). R: 110-R rootstocks; S: SO4 rootstocks; P: non-grafted. MBG-1R: 1R; MBG-1S: 1S; MBG-1P: 1P; MBG-2R: 2R; MBG-2S: 2S; MBG-2P: 2P; MBG-7R: 7R; MBG-7S: 7S; MBG-7P: 7P; MBG-9R: 9R; MBG-9S: 9S; MBG-9P: 9P; MBG-10R: 10R; MBG-10S: 10S; MBG-10P: 10P.

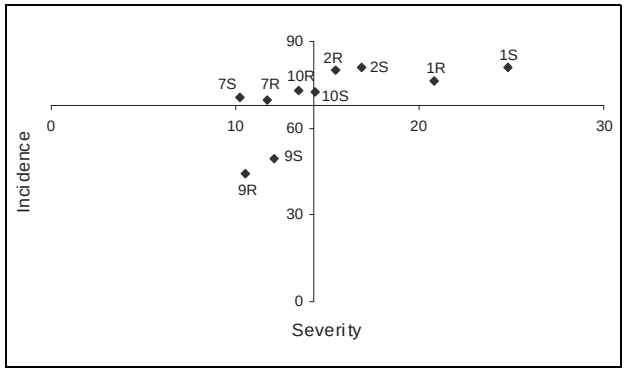


Fig. 2. Mean incidence and severity values of 3 years for fruit cluster disease for all clones on both types of rootstock (R: 110-R rootstocks; S: SO4 rootstocks). MBG-1R: 1R; MBG-1S: 1S; MBG-1P: 1P; MBG-2R: 2R; MBG-2S: 2S; MBG-2P: 2P; MBG-7R: 7R; MBG-7S: 7S; MBG-7P: 7P; MBG-9R: 9R; MBG-9S: 9S; MBG-9P: 9P; MBG-10R: 10R; MBG-10S: 10S; MBG-10P: 10P.

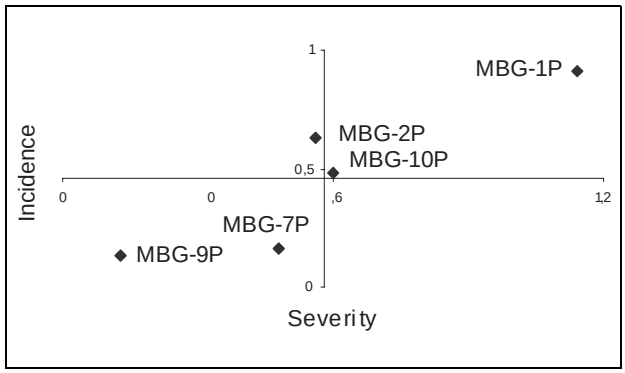


Fig. 3. Mean incidence and severity values in fruit cluster disease of 3 years for all clones non-grafted (P: non-grafted).

Results

Leaves

Table 1 shows the ANOVA results for the different variables analysed. Table 2 and Table 3 show the mean values for each variable per clone and rootstock and for the three years of the study. The MDS values are also shown.

Significant differences were seen between the clones in terms of disease severity (P<0.05), intensity (P<0.001) and incidence (P<0.01). No significant differences were seen in either variable between the results for S1 and S2, although a significant difference in incidence was recorded (P<0.01).

No significant differences were seen with respect to any variable between the clones with 110-R and SO4

Table 1. Analysis of variance results for severity, intensity, and incidence of leaf infections of five clones of cv. 'Albariño' on two rootstocks (110-R, SO4) for three years (2001, 2002 and 2003).

Source of variation	Severity		Intensity		Incidence	
	D. f.	M. S.	D. f.	M. S.	D. f.	M. S.
1st Sampling time (S_1)						
Clone	4	0.01080*	4	0.00001864*	4	2174.910***
Rootstocks	2	0.00015 ns†	1	0.0000005 ns	1	107.611 ns
Year	2	0.07856**	2	0.0000991***	2	190.010*
Clone×year	8	0.00650*	8	0.00000584***	8	22.730*
Clone×rootstocks	8	0.00001 ns	4	0.00000029 ns	4	13.902 ns
Rootstocks×year	4	0.00017 ns	2	0.00000125 ns	2	1.746 ns
Clone×rootstocks×year	16	0.00009 ns	8	0.00000026 ns	8	5.180 ns
Error	1463	0.00271	1463	0.00000083	120	85.560
2nd Sampling time (S_2)						
Clone	4	0.42891*	4	0.00112341***	4	1150.930*
Rootstocks	2	0.00055 ns	1	0.00000012 ns	1	132.910 ns
Year	2	1.85060**	2	0.00027923 ns	2	117.520 ns
Clone×year	8	0.06790*	8	0.00019443*	8	88.139*
Clone× rootstocks	8	0.00008 ns	4	0.00000074 ns	4	34.700 ns
Rootstocks×year	4	0.00773 ns	2	0.00000015 ns	2	1.002 ns
Clone×rootstocks×year	16	0.00021 ns	8	0.00000003 ns	8	11.570 ns
Error	1310	0.02830	1310	0.00008618	120	128.890
Combination of S_1+S_2						
Clone	4	0.19761*	4	0.00048312**	4	3055.570*
Rootstocks	2	0.00067 ns	1	0.00000004 ns	1	239.860 ns
Sample	1	12.23491 ns	1	0.00079412 ns	1	30655.936**
Year	2	1.28612 ns	2	0.00007881 ns	2	257.996 ns
Clone×year	8	0.05141 ns	8	0.00010323 ns	8	57.063 ns
Clone×rootstocks	8	0.00002 ns	4	0.00000016 ns	4	43.330 ns
Clone×sample	4	0.27612*	4	0.00070342***	4	270.283*
Sample×rootstocks	2	0.00007 ns	1	0.00000052 ns	1	0.667 ns
Rootstocks×year	2	0.00521 ns	2	0.00000111*	2	0.393 ns
Sample×year	2	0.85562***	2	0.00031100 ns	2	49.536 ns
Sample×rootstocks×year	2	0.00291***	2	0.00000025 ns	2	2.351 ns
Clone×sample×rootstocks	4	0.00007 ns	4	0.00000012 ns	4	5.272 ns
Clone×rootstocks×year	8	0.00008 ns	8	0.00000011 ns	8	3.451 ns
Clone×sample×year	8	0.02733***	8	0.00010512***	8	53.802 ns
Clone×sample×year×rootstocks	8	0.00015 ns	8	0.00000018 ns	8	13.301 ns
Error	2773	0.01484	2773	0.00004110	240	107.231

D. f.: degrees of freedom; M. S.: mean square;
†ns: not significant; *, **, and ***: designate statistical significance at P≤0.05, P≤0.01 and P≤0.001, respectively.

Table 2. Means value of each clone non-grafted on both rootstocks for severity (0-1) and intensity (0-1) of leaf infection at sampling times S1 and S2 and average for three years (2001, 2002 and 2003).

	S1		S2		Average (S1+S2)	
Severity						
MBG-9S	0.050	a‡	0.115	e	0.083	de
MBG-9R	0.049	a	0.114	e	0.079	de
MBG-9P	0.043	b	0.110	e	0.080	de
MBG-7S	0.042	b	0.175	cd	0.100	bc
MBG-2S	0.042	b	0.203	ab	0.121	a
MBG-2R	0.042	b	0.202	ab	0.120	ab
MBG-2P	0.041	bc	0.190	ab	0.120	ab
MBG-7R	0.041	bc	0.168	cd	0.099	d
MBG-7P	0.040	c	0.165	cd	0.100	d
MBG-1S	0.035	d	0.216	a	0.124	a
MBG-10S	0.035	d	0.155	c	0.092	de
MBG-1R	0.035	d	0.214	a	0.124	a
MBG-1P	0.034	d	0.200	a	0.120	a
MBG-10R	0.034	d	0.154	c	0.091	de
MBG-10P	0.034	d	0.150	c	0.090	de
LSD (0.05)	0.011		0.040		0.020	
Intensity (x 100)						
MBG-7R	0.091	a	0.088	b	0.089	b
MBG-7S	0.087	ab	0.094	b	0.090	b
MBG-7P	0.086	ab	0.090	b	0.090	b
MBG-2R	0.073	abc	0.076	b	0.074	b
MBG-2S	0.072	bcd	0.079	b	0.076	b
MBG-2P	0.070	cde	0.070	b	0.070	b
MBG-9S	0.063	cde	0.060	b	0.060	b
MBG-9R	0.062	cde	0.055	b	0.059	b
MBG-9P	0.060	cde	0.050	b	0.058	b
MBG-10R	0.052	ef	0.075	b	0.061	b
MBG-10S	0.038	fg	0.076	b	0.054	b
MBG-10P	0.038	fg	0.076	b	0.053	b
MBG-1R	0.024	g	0.514	a	0.266	a
MBG-1S	0.024	g	0.515	a	0.266	a
MBG-1P	0.022	g	0.500	a	0.190	a
LSD (0.05)	0.0002		0.002		0.001	

‡Means in columns followed by the same letter are not significantly different at ≤0.05
†R: 110-R rootstocks; S: SO4 rootstocks; P: non-grafted
LSD: least significant difference

Table 3. Means value of each clone non-grafted on both rootstocks for incidence (%) of leaf infection at sampling times S1 and S2 and average for three years (2001, 2002 and 2003).

Incidence	S1		S2		Average (S1+S2)	
MBG-2S	41.378	a‡	57.842	a	49.610	a
MBG-2R	41.040	a	58.226	a	49.633	a
MBG-2P	40.010	a	50.970	b	49.001	a
MBG-10S	36.863	b	50.976	b	43.919	bc
MBG-10R	35.793	b	51.038	b	43.416	bc
MBG-10P	33.012	bc	55.045	ab	42.600	b
MBG-1S	33.890	bc	56.949	ab	45.425	b
MBG-1R	32.110	bc	53.273	ab	42.697	b
MBG-1P	31.145	bc	54.568	ab	47.859	ab
MBG-7S	29.007	c	53.838	ab	41.422	b
MBG-7R	27.666	c	52.059	ab	39.863	b
MBG-7P	25.536	c	52.035	ab	40.324	bc
MBG-9S	20.817	d	43.918	c	32.367	d
MBG-9R	16.875	d	40.840	c	28.194	d
MBG-9P	11.258	d			25.120	d
LSD (0.05)	6.408		7.686		4.981	

‡Means in columns followed by the same letter are not significantly different at ≤0.05
†R: 110-R rootstocks; S: SO4 rootstocks; P: non-grafted
LSD: least significant difference

rootstocks, in any year of the study. MGB-1 and MBG-2 were always the most susceptible in terms of disease severity, intensity and incidence, irrespective of their rootstock type or whether they had been grafted or not.

Some clones were more susceptible to primary than to secondary attack, while others showed the opposite characteristics. MBG-9, non-grafted or on either rootstock, showed the worst disease incidence at S1 and S2. MBG-1 (non-grafted or on either rootstock) showed low disease severity at S1 but one of the worst at S2 (Table 2, 3).

Table 2 and 3 show that at both S1 and S2, MBG-2 (non-grafted or on either rootstock) had the worst incidence of disease, while MBG-9 (non-grafted or on either rootstock) had the least incidence of disease.

MBG-9 (non-grafted or on either rootstock) was differentiated from the rest of the clones at S1 by having the highest disease severity index, and by having the lowest at S2.

With respect to disease intensity at S1, clones MBG-7 and MBG-2 (non-grafted or on either rootstock), showed the highest mean values. At the opposite extreme were clones MBG-1 and MBG-10. At S2, however, clone MBG-1 showed the highest disease intensity values, whether non-grafted or on either rootstock. Thus, this clone is more susceptible to secondary attack and more resistant to primary attack.

Fig. 1 shows the grouping of the different clones, both non-grafted and on either rootstock. Generally the results for each clone lay close together irrespective of whether the plants were grafted or not. For example, MBG-1, non-grafted or on either rootstock, lies at the upper right with the highest overall values for disease severity and intensity. At the bottom of the graph appear MBG-9, MBG-10 and MBG-7 on both rootstocks and non-grafted; these clones showed low disease severity and incidence (high resistance) indices.

Grape clusters

Table 4 shows the ANOVA results for the two variable analysed. Table 5 shows the mean values for each of the

Table 4. Analysis of variance results for severity, and incidence of grape cluster infections of five clones of cv. 'Albariño' on two rootstocks (110-R, SO4) for three years (2001, 2002 and 2003).

Source of variation	Severity		Incidence	
	D. f.‡	M. S.	D. f.	M.S.
Clone	4	692.466*	4	5475.928***
Rootstocks	1	59.823 ns†	1	190.654 ns
Year	2	574.761*	2	891.276 ns
Clone×year	8	166.682**	8	295.746 ns
Clone×rootstocks	4	29.112 ns	4	49.097 ns
Rootstocks×year	2	26.851 ns	2	16.236 ns
Clone×rootstocks×year	8	12.331 ns	8	39.060 ns
Error	119	83.642	120	399.531

‡D. f.: degrees of freedom; M. S.: mean square
†ns: not significant; *, **, and ***: designate statistical significance at P≤0.05, P≤0.01 and P≤0.001, respectively.

clones on the two rootstocks plus the LSD values. Table 6 shows the mean values for the same variables but for plants that were not grafted. The non-grafted plants were less fertile – in some cases failing to produce clusters. This is why the mean disease severity and incidence values for the non-grafted plants were much lower than for their grafted counterparts.

Significant differences in disease severity (P<0.01) and incidence (P<0.05) were seen between the different clones. No significant differences were seen for either variable with respect to rootstock type, the interaction *clone x rootstock*, *rootstock x year*, or *clone x rootstock x year*. MBG-1 and MBG-2, (non-grafted or on either rootstock) were differentiated from the rest by having the highest disease incidence and mean severity indices. At the opposite extreme, with the lowest mean values for these variables, was MBG-9 (non-grafted or on either rootstock).

Table 5. Means value of each clone for severity (%) and incidence (%) of grape cluster infections of five clones of cv. 'Albariño' for three years (2001, 2002 and 2003).

Clone	Severity		Incidence	
MBG-1S	24.782	a‡	80.864	a
MBG-1R	20.789	a	76.243	a
MBG-2S	16.841	ab	80.973	a
MBG-2R	15.471	ab	80.167	a
MBG-10S	14.344	bc	72.717	ab
MBG-10R	13.429	bc	73.119	ab
MBG-9S	12.108	d	49.505	d
MBG-7R	11.755	d	69.752	c
MBG-9R	10.513	cd	44.155	d
MBG-7S	10.219	cd	70.651	bc
LSD (0.05)	6.838		14.710	

‡Means in columns followed by the same setter are not significantly different at P≤0.05
†R: 110-R rootstocks; S: SO4 rootstocks

Fig. 2 shows the mean values of the three years for disease incidence plotted against those of severity, for all clones on both types of rootstock. As with the leaves, rootstock had no influence on disease susceptibility. MBG-1 showed high disease severity and incidence, and can be considered the most susceptible of all the clones at both the leaf and cluster level. At the bottom of the graph, MBG-9 appears (on both rootstocks with the lowest disease severity and incidence values.

Fig. 3 shows the mean values of the three years for disease incidence plotted against those of severity for all clones – but this time for non-grafted plants. The arrangement of the clones on the graph is the same as in Fig. 2, but the scale is lower since these plants had fewer clusters.

Discussion

Few studies have been performed on the field resistance of vine cultivars to downy mildew. Most attempts to quantify resistance to cryptogamic disease have been made under laboratory conditions (on *in vitro* cultured plants or greenhouse-maintained potted plants), and then only with respect to leaves. In no case has rootstock

Table 6. Means value of each clone cv. 'Albariño' non-grafted for severity (%) and incidence (%) of grape cluster infections for 3 years (2001. 2002 and 2003).

Clone†	Severity		Incidence	
	Mean	S.D.‡	Mean	S.D.
MBG-1P	1.14	2.08	0.91	0.16
MBG-2P	0.56	0.74	0.63	0.22
MBG-7P	0.48	0.87	0.16	0.14
MBG-9P	0.13	0.40	0.13	0.10
MBG-10P	0.60	0.73	0.48	0.02

‡S.D.: Standard deviation
†P: non-grafted

type been taken into account. Some data are available on the resistance of certain vines and rootstocks, but in a separate manner; this is the first to investigate the behaviour of vine/rootstock combinations. Though many authors indicate that the behaviour of these combinations can be different in many respects, and even with respect to disease susceptibility, no work was found that actually verified these affirmations. Certainly, our group is the only one investigating the differences in resistance to downy mildew in different clones of a single vine cultivar (Boso et al. 2004a, 2006). In previous work (Boso et al. 2004b) we showed that the clones used in the present work showed different susceptibilities to this disease.

The present results confirm the existence of interclonal variability with respect to susceptibility to downy mildew. They also show that the degree of susceptibility of the leaves and clusters is independent of whether the clone is grafted or not, and that having a 110-R or SO4 rootstock has no influence either. Although some authors (Huglin 1987; Reynier 1987; Hidalgo 1993) report that SO4 confers more vigour upon clones (which was shown by the present authors in earlier work with the same clones as those used here [Boso et al. 2004a]), susceptibility to downy mildew does not appear to be influenced.

The non-grafted clones were much less fertile than those on either rootstock. In some cases they produced only 3 clusters per plant compared to the 20 of their grafted counterparts. This is clearly reflected in the disease incidence and severity indices for the clusters (which were fewer and smaller in the non-grafted plants). However, the most susceptible clones were always MBG-1 and MGB-2, whether the plants had been grafted or not. With respect to leaf susceptibility, no great differences in disease incidence or severity within clones were seen between grafted and non-grafted plants since all had a similar number of leaves.

MBG-9 (non-grafted or grafted on either rootstock) was one of the most susceptible clones at S1, showing a high disease severity index. AT S2, however, it showed the lowest disease severity (although disease incidence was still the greatest). In other words, this clone is quite susceptible to primary attack, and quite resistant to secondary attack, irrespective of its rootstock. In contrast, MBG-1 (non-grafted or grafted on either rootstock) was the least susceptible at S1 (low disease intensity and severity) but one of the most susceptible at S2. This clone is therefore more resistant to primary attack and more susceptible to secondary attack, irrespective of its rootstock (and indeed of whether it is grafted or not).

MBG-1 (non-grafted or grafted on either rootstock) was the most susceptible at the grape clusters level. It was distinguishable from the rest by having the greatest number of affected clusters, and by having the largest affected areas (greatest disease incidence and severity). MBG-9 (non-grafted or grafted on either rootstock), in contrast, was the most resistant. This clone showed the lowest number of clusters affected, and the smallest affected areas (lowest incidence and severity).

Clone MBG-1 was one of the most susceptible to primary attack, one of the most susceptible to secondary attack on the leaves, and the most susceptible to secondary attack on the clusters. MBG-9 showed quite different behaviour; this clone was one of the most susceptible to primary attack, the least susceptible to secondary attack on the leaves, and the most resistant to secondary attack on the clusters.

The present results agree with those of previous field studies (Boso et al. 2004a) involving grafted plants. They also agree with results obtained in laboratory studies (Boso et al. 2006) involving non-grafted plants.

Conclusions

The results of this work allow us to prove that resistance to downy mildew is not influenced by rootstock type or the fact whether the plant is grafted or not. This is a preliminary study and these data cannot be interpreted without keep in mind the edaphoclimatic characteristics of the plot where the study has been carried out. A comparison between clones grafted in the same rootstock but growing in different conditions is requested for future works on this topic.

References

Boso, S., J.L. Santiago and M.C. Martínez 2004a: Intravarietal agronomic variability in the cv. 'Albariño' (*Vitis vinifera* L.). Am. J. Enol. Vitic. **55**, 279–282.

Boso, S., J.L. Santiago and M.C. Martínez 2004b: Resistance of eight different clones of the grape cultivar 'Albariño' to *Plasmopara viticola*. Plant Dis. **88**, 741–744.

Boso, S., J.L. Santiago and M.C. Martínez 2005: A method to evaluate downy mildew resistance in grapevine. Agronomie **25,** 163–165.

Boso, S., M.C. Martínez, S. Unger and H.-H. Kassemeyer 2006: Evaluation of foliar resistance to downy mildew in different cv. 'Albariño' clones. Vitis **45**, 23–27.

Boubals, D. 1959: Contribution á l`étude des causes de la résistance de Vitacées au mildiou de la vigne *(Plasmapora viticola* (B. et C.) Berl. et de T.) et de leur mode de transmission héréditaire. Thèse de doctorat dés sciences. Ann. Amélior. Plantes **11**, 1–236.

Boubals, D. 1961: Etudes des causes de la résistance des Vitacées à l'oïdium de la Vigne *Uncinula necator* (Schw.) Burr. Et de leur mode de transmission héréditaire. Ann. Amerlior. Plant. **11**, 401–500.

Chambre d 'Agriculture de l'Aude 2004: Comportement du 'Chardonnay' en fonction du porte-greffe. Progr. Agric. et Vitic. **10**.

Cristinzio, G., C. Jannini, G. Scaslione and M. Boselli 2000: Effect of rootstocks on *Botrytis cinerea* susceptibility of *Vitis vinifera* cv. 'Falanghina'. Adv. in Hort. Sci., Italy, **14**(2), 83–86

English, J.T., C.S. Thomas, J.J. Marois and W.D. Gubler 1989: Microclimates of grapevine canopies associated with leaf removal and control of Botrytis bunch rot. Phytopath. **79**, 395–401.

Galet, P. 1977: Les maladies et les parasites de la vigne. Tome I: Les maladies dues á des végétaux . Imp. Le Paysan du Midi., Montpellier.

Galet, P. 1995: Précis de Pathologie viticole. 2éme édition. Imprimerie JF Impression, Montpellier.

Hardie, W.J. and R.M. Cirami 1988: Grapevine rootstocks. In: Coombe, B.G.C. and P.R. Dry (eds): Resources in Australia. Australian Industrial Publishers, Adelaide. Viticulture **1**, 154–176.

Hidalgo, L. 1993: Tratado de viticultura general. Ed. Mundi-Prensa, Madrid.

Huglin, P. 1987: Biologie et écologie de la vigne. Ed. Payot Lausanne, París.

Joublan, J.-P. and C. Nelson 2002: Comportamiento de algunos cítricos sobre diferentes portainjertos, en su tercera temporada de crecimiento, Quillón VIII Región, Chile. Agric. Téc. **62**, 469–479.

Main, G., J. Morris and K. Striegler 2002: Rootstock effects on 'Chardonnay' productivity, fruit, and wine composition. Am. J. Enol. Vitic. **53**, 1–5.

Martínez, M.C., S. Boso and J.L. Santiago 2005: Los clones de Albariño (*Vitis vinifera* L.) seleccionados en el Consejo Superior de Investigaciones Científicas. Departamento de Publicaciones del CSIC, Biblioteca de Ciencias, Nº **19** Ma-

drid. ISBN: 84-00-08323-7, 143 p.
Pearson, R.C. and A.C. Goheen 1996: Plagas y enfermedades de la vid. Ed. Mundi-Prensa, Madrid.
Pérez Marín, J.L. 1992: Los parásitos de la vid. Estrategias de protección razonada. Ministerio de Agricultura, Pesca y Alimentación. Ed. Mundi-Prensa, Madrid.
Ravaz, L. 1914: Le mildiou. Masson éd, París.
Ribereau-Gayon, J. and E. Peynaud 1971: Traité d`ampélologie. Sciencies et Techniques de la vigne. Tome I: Biologie de la Traité vigne, sols de vignobles. Ed. Dunot, París.
Reynier, A. 1987: Manual de Viticultura. 4 edición, Ed.Mundi-Prensa, Madrid.
Staudt, G. and H.-H. Kassemeyer 1995: Evaluation of downy mildew (*Plasmopara viticola*) resistance in various accessions of wild *Vitis* species. Vitis **34**, 225–228.
Wang, Y., Y. Liu, P. He, J. Chen, O. Laminkara and J. Lu 1995: Evaluation of foliar resistance to *Uncinula necator* in Chinese wild *Vitis* species. Vitis **34**, 159–164.
Ypema, H.L. and W.D. Gubler 2000: The distribution of early season grapevine shoots infected by *Uncinula necator* from year to year: A case study in two California vineyards. Am. J. Enol. Vitic. **51**, 1–6.

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Addresses of authors: S. Boso, J.L. Santiago and M.C. Martínez, Misión Biológica de Galicia, Consejo Superior de Investigaciones Científicas, Apartado de Correos 28, 36080 Pontevedra, Spain, e-mail: susanab@mbg.cesga.es.