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Evaluation of susceptibility to powdery mildew (*Erysiphe necator*) in *Vitis vinifera* varieties

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Summary

Susceptibility to grape powdery mildew (*Erysiphe necator* Schwein.) was studied in 159 *Vitis vinifera* foreign and native grape varieties grown in Spain. The relationship between morphological features of vines and their susceptibility to the disease was also studied. The infection was evaluated under natural conditions on leaves and bunches. A total of 35 cultivars were very susceptible to the disease (very low to low resistance on bunches), while another 83 showed low susceptibility (high to very high resistance on bunches). Results provide useful information for grape growers and breeders for the selection of varieties less susceptible to powdery mildew.

K e y w o r d s : *Erysiphe necator*, morphology, *Oidium*, susceptibility, *Vitis vinifera.*

Introduction

Fungal diseases are a major problem in the cultivation of grapevine, and one of the most threatening pathogens is the fungus *Erysiphe necator* Schwein., the causal agent of powdery mildew. This biotrophic ascomycete invades host epidermal cells and colonizes leaves, rachis, and grapes, causing a decrease of vine growth, yield, and quality of grapevine production (Pool *et al*. 1984, Calonnec *et al*. 2004). The incidence of powdery mildew has increased in recent years in Europe. Climatic conditions and reduced efficacy of fungicides have been suggested as possible reasons (Staudt 1997). Fungicide treatments increase economic costs and negatively affect the environment. Furthermore, fungal strains are developing resistance to some commonly used fungicides (Savocchia *et al*. 2004). Thus, the possibility of selecting less-susceptible, high-quality cultivars is an alternative management strategy of great importance. Although the most commonly cultivated species, *V. vinifera*, has proved to lack resistance to powdery mildew, the degree of susceptibility varies with the cultivar and the environmental conditions (Li 1993, Péros *et al*. 2006). The aims of the present study were to analyse the susceptibility of 159 cultivars of *V. vinifera* to powdery mildew and to determine whether morphological features may influence this response on the vine.

Material and Methods

M a t e r i a l : This study was conducted for four years (2006-2009). Vines were located in the *Vitis* Germplasm Bank "Finca El Encín" (IMIDRA, Alcalá de Henares, Spain). Some clones of each variety were studied to determine the degree of susceptibility to powdery mildew, resulting in 473 samples from 159 cultivars (2-7 clones per cultivar, 4 plants per clone; Table). All plants were grafted onto 41B and were almost 30 years old. The plantation compass was 2.5 m × 2.5 m. Repetitions of the cultivars were randomly arranged in the same plot. Therefore, all the cultivars were subjected to the same edaphoclimatic conditions and traditional management practices. They were cultivated in dry land, with a training vessel and had no phytosanitary treatment during the period of study. 'Mazuela' (synonyms 'Cariñena', 'Carignan Noir') was used as the susceptibility control and it was regularly distributed in twelve different locations along the plot to control the uniformity of the infection.

M e t h o d s : Climatic data were recorded for the years of the study. Evaluation of natural infection was performed from June to September (about 3 weeks after onset of flowering for leaves and before vintage for bunches). Infection levels were visually estimated following the descriptors OIV-455 and OIV-456 of the International Organization of Vine and Wine (OIV 2007), which refer to the degree of resistance on leaves and bunches, respectively, using a 1 to 9 scale (1 = very low resistance, 9 = high resistance). The cultivars were classified into three classes, depending on the level of these descriptors, as follows: levels 1-3, a low or very low degree of resistance (high susceptibility); level 5, a medium degree of resistance (medium susceptibility); and levels 7-9, a high to very high degree of resistance (low susceptibility).

The following morphological characters of leaves and bunches were selected from the OIV descriptors list (OIV 2007) to identify factors associated with resistance to powdery mildew: (I) Young leaf: OIV-051 and OIV-053, (II) Mature leaf: OIV-065, OIV-072, OIV-075, OIV-084 and OIV-087, (III) Bunch: OIV-202, OIV-203, OIV-204 and OIV-208, and (IV) Berry: OIV-220, OIV-221 and OIV-223. Spearman Rho coefficients for ranked data were calculated to detect all possible correlations between morphological and disease variables. All statistical analyses were performed with the statistical program SPSS v.15.

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T a b l e

Modal data of maximum degrees of resistance to powdery mildew on bunches (B) and leaves (L) of *V. vinifera* cultivars, according to OIV descriptors 455 and 456: l (low) = 1,3; m (medium) = 5; h (high) = 7, 9. The cultivars are listed in order based on the resistance to the fungus on bunch, following by the resistance on leaf and alphabetical order

Variety	B	L	Variety	B	L	Variety	B	L
Beba	l	l	Doña Blanca	m	m	Listán Negro	h	m
Benedicto de Aragón	l	l	Garnacha Roja	m	m	Mantúo	h	m
Brancellao	l	l	Garrido Fino	m	m	Mantúo de Pilas	h	m
Cabernet Sauvignon	l	l	Garrido Macho	m	m	Merseguera	h	m
Castellana Blanca	l	l	Graciano	m	m	Monastrell	h	m
Espadeiro	l	l	Listán del Condado	m	m	Moravia Agria	h	m
Forastera	l	l	Macabeo	m	m	Morenillo	h	m
Garnacha Blanca	l	l	Merenzao	m	m	Moristel	h	m
Garnacha Tintorera	l	l	Morate	m	m	Moscatel de Angüés	h	m
Gualarido	l	l	Puesto Mayor	m	m	Negramoll	h	m
Cayetana Blanca	l	l	Rojal Tinta	m	m	Pardillo	h	m
Malvasía Aromática	l	l	Rufete	m	m	Rayada Melonera	h	m
Marfal	l	l	Savagnin Blanc	m	m	Sinsó	h	m
Mazuela	l	l	Tetona	m	m	Sousón	h	m
Mencía	l	l	Treixadura	m	m	Tinto Velasco	h	m
Moscatel de Grano Menudo	l	l	Verdejo	m	m	Tortosí	h	m
Parraleta	l	l	Verdejo Tinto	m	m	Trepat	h	m
Planta Fina	l	l	Bastardo Negro	m	h	Vijariego Blanco	h	m
Rocía	l	l	Bobal	m	h	Xarel.lo Rosado	h	m
Salceño Blanco	l	l	Excursach	m	h	Albillo Real	h	h
Sumoll	l	l	Fernandella	m	h	Blanquiliña	h	h
Tempranillo	l	l	Gabriela	m	h	Carrasquín	h	h
Verdil	l	l	Tarragoní	m	h	Cuatendrá	h	h
Vidadillo	l	l	Alcañón	h	l	Doradilla	h	h
Benedicto	l	m	Batista	h	l	Eperó de Gall	h	h
Cariñena Blanca	l	m	Cabernet Franc	h	l	Fogoneu	h	h
Garnacha Tinta	l	m	Derechero	h	l	Forcallat Tinto	h	h
Godello	l	m	Garnacha Peluda	h	l	Gorgollasa	h	h
Morisca	l	m	Grumet	h	l	Legiruela	h	h
Palomino	l	m	Hebén	h	l	Listán Prieto	h	h
Palomino Fino	l	m	Malvar	h	l	Loureira	h	h
Picapoll	l	m	Maturana Blanca	h	l	Malvasía Volcánica	h	h
Rey	l	m	Moscatel de Grano Gordo Rosa	h	l	Mandón	h	h
Sabro	l	m	Prieto Picudo	h	l	Mansés de Tibbus		h
Torrontés	l	m	Puerto Alto	h	l	Manto Negro	h	h
Albillo Mayor	m	l	Verdejo de Salamanca	h	l	Mondragón	h	h
Beba Roja	m	l	Xarel.lo	h	l	Morrastel-Bouschet	h	h
Cagarrizo	m	l	Albariño	h	m	Ondarrabi Beltza	h	h
Cañorroyo	m	l	Allarén	h	m	Pampolat de Sagunto	h	h
Chasselas Doré	m	l	Argamusa	h	m	Pampolat Girat	h	h
Moscatel de Alejandría	m	l	Beba Negra	h	m	Parduca	h	h
Juan García	m	l	Moravia Dulce	h	m	Parellada	h	h
Pedro Luis	m	l	Caíño Tinto	h	m	Pedrol	h	h
Pedro Ximénez	m	l	Caíño Bravo	h	m	Perruno	h	h
Planta Nova	m	l	Callet	h	m	Petit Bouschet	h	h
Salvador	m	l	Chasselas Rosé	h	m	Quigat	h	h
Zalema	m	l	Cherta	h	m	Sabaté	h	h
Airén	m	m	Ferrón	h	m	Santa Magdalena	h	h
Alarije	m	m	Folle Blanc	h	m	Señá	h	h
Albillo de Albacete	m	m	Fumat	h	m	Trobat	h	h
Albillo Real de Granada	m	m	Giró	h	m	Verués de Huarte	h	h
Borba	m	m	Jaén Rosado	h	m	Vinaté	h	h
Chenín Blanc	m	m	Jaén tinto	h	m			

Results and Discussion

For all of the years, the climatic conditions seem to be favourable for *E. necator* development (Figure). Intraspecific variation in the susceptibility to powdery mildew has been found among the studied *V. vinifera* cultivars as other authors have reported (Doster and Schnathorst 1985, Li 1993, Eibach 1994). The most frequent level of susceptibility observed was the medium level (35-50 % of the varieties, depending on years), which corresponds to leaves with attacked patches, usually limited to a diameter of 2 to 5 cm, many attacked berries (up to 30 %), and most clusters moderately attacked. Between 13 % and 52 % of the varieties were very susceptible to powdery mildew on bunches, showing many berries of all clusters attacked and many cracked berries. On the other hand, between 13 % and 36 % of the cultivars showed bunches with low susceptibility. In these cases, only a few berries of all clusters were attacked.

The maximum degree of resistance for each cultivar and year was calculated, and the modal data were obtained for the whole period (Table). A total of 35 cultivars (22 %) were very susceptible to the disease (very low-low resistance on bunches), while another 83 (52.2 %) showed low susceptibility (high to very high resistance on bunches).

The variety used as the susceptibility control, Mazuela, has proved to be very susceptible to powdery mildew, as other authors have found (Doster and Schnathorst 1985, Li 1993, Péros *et al*. 2006). Li (1993) and Péros *et al*. (2006) also noted a high susceptibility of 'Cabernet Sauvignon', close to the response of 'Mazuela' and the same results were obtained in this study. On the other hand, 'Grenache' (synonym 'Garnacha Tinta') has been reported to be less susceptible than 'Cabernet Sauvignon' (Boubals 1961, Li 1993); however, our results corroborated this finding only in the case of susceptibility on leaves because both cultivars showed the same results for bunches. Péros *et al*. (2006) found likewise that 'Grenache' was not always distinguished from very susceptible cultivars in laboratory tests. Results for 'Folle Blanc' (syn. 'Folle Blanche'), 'Monastrell' (syn. 'Mourvèdre'), 'Macabeo' (syn. 'Maccabeu'), and 'Garnacha Tintorera' (syn. 'Alicante Bouschet') have been also reported by 'Li' (1993). We agree with his findings that 'Folle Blanc' and 'Monastrell' showed a medium level of susceptibility with respect to 'Mazuela', which was lower in the case of 'Garnacha Tintorera'. In contrast to values obtained by 'Li' (1993), we observed a minor level of susceptibility for 'Macabeo' relative to the control, which could be due to the existence of diverse homonyms for 'Macabeo'. Results showed that the degree of resistance to powdery mildew on leaves correlates positively with resistance on bunches. This correlation was high in 2008 (ρ = 0.75), when the degree of infection was also higher, probably because of the most favourable climatic conditions having occurred in that year. The coefficient of determination indicated that 56 % of the variation in the berry resistance could be explained by variation in the leaf resistance in that year. However, this correlation was smaller in 2007 (ρ = 0.52) and 2009 (ρ = 0.38), verifying that the relationship between variables is not sufficiently consistent in time and may depend on the fungal infection pressure.

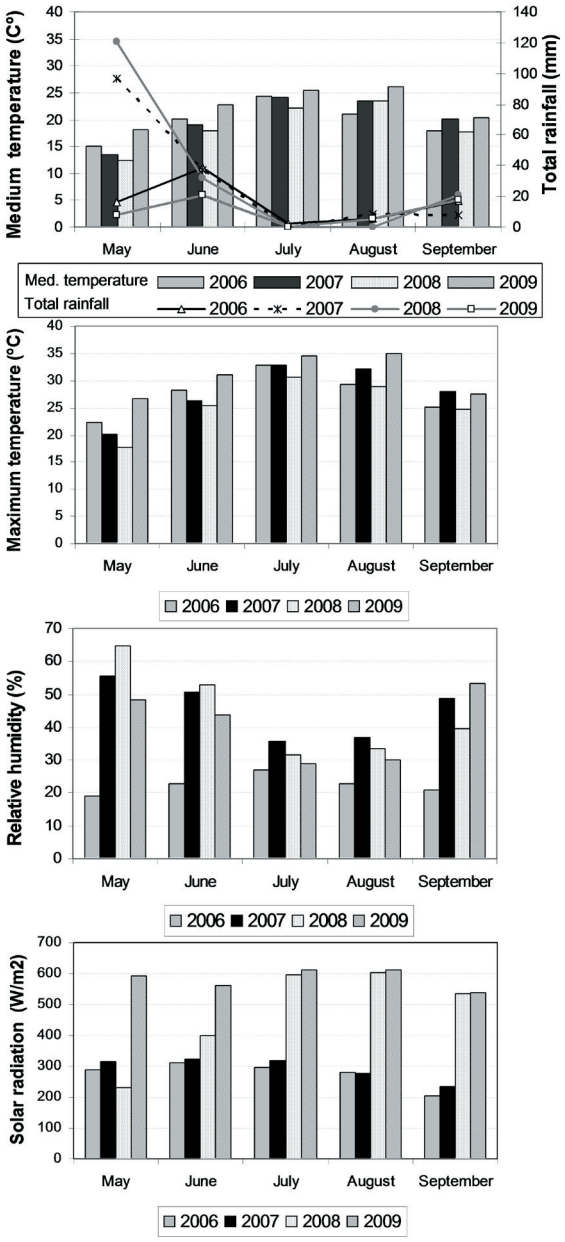

Figure: Climatic data during the period of study (2006-2009).

Previous studies have demonstrated a relationship between morphological features and the susceptibility of *V. vinifera* cultivars to powdery mildew. In our study, only two out of the fourteen ampelographic characters studied were significantly correlated with resistance to powdery mildew. We detected a significant negative correlation between the degree of resistance on leaves and the goffering of blades (ρ = -0.16 to -0.22) and between bunch density and the degree of resistance on berries (ρ = -0.17). These two effects could be related with lower ventilation of these types of leaves and bunches altering microclimatic conditions to favour fungal development. However, the low correlations obtained do not show a strong relationship. Therefore, the selection of these morphological characters will not assure resistance in the selected cultivars.

Conclusions

Knowledge about the degree of susceptibility of each variety makes the selection of less susceptible cultivars possible for grape growers. This is an important advantage, especially in areas where climatic conditions are often favourable for the disease, such as the Mediterranean region. Thus, fungicide treatments may be substantially reduced in an important number of cultivars, enabling a reduction in economic and environmental costs.

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