

## Resistance of hybrid wine grape breeding forms to downy mildew (*Plasmopara viticola* Berkeley et Curtis)

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### Abstract

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In the period 2014–2016, at the experimental vineyard of the Institute of Agriculture and Seed Science “Obraztsov Chiflik” – Rousse, the resistance of hybrid wine grape breeding forms to downy mildew with causative agent *Plasmopara viticola* (Berkeley et Curtis) oomycetes fungus was studied. Objects of the study were the hybrids: 25/12 (Pamid Rousse 1 × Kaylashki Misket), 5/51 (Naslada × Chardonnay) and 5/83 (Naslada × Chardonnay). Misket Otonel cultivar was chosen as control. The aim was the reaction of hybrid wine breeding forms of vine to downy mildew caused by *Plasmopara viticola* (Berkeley et Curtis) to be determined. The phytopathological assessment of the attack of *Plasmopara viticola* on leaves was carried out according to the OIV 452 scale, and on berries and clusters – according to the OIV 453 scale, where the resistance was represented in 5 grades 1–3–5–7–9, as 1 was maximum resistance. The following traits were registered: index of attack (%), correlation coefficient between disease progression and yield obtained, weight of cluster (kg), maturation period, sugar content (%), acid content (g/l). Hybrid 25/12 (Pamid Rousse 1 × Kaylashki Misket) showed maximum resistance, while 5/51 (Naslada × Chardonnay) and 5/83 (Naslada × Chardonnay) were moderately resistant.

**Keywords:** wine grapes; downy mildew; *Plasmopara viticola*; resistance

### Introduction

Diseases are a factor determining yields and quality of grape production (Genov, 2012). The most common fungal disease on vine is *Plasmopara viticola* (Berkeley et Curtis) (Wilcox et al., 2015). It was first observed in 1834 by Schweinitz on the *Vitis aestivalis* in the southeast of the United States.

*Plasmopara viticola* reduces the quality of production and yields obtained (Aziz et al., 2003; Bellin et al., 2009; Armijo et al., 2016; Yin et al., 2017), and indirectly it reduces the qualities of wines (Cilindre et al., 2007).

This disease develops on all green parts of the plant. Affected areas become yellow, then turn into brown spots with

white deposits on the underside of the leaves, causing early defoliation. The leaves and grapes dry out and gradually fall. Economic losses reach up to 50% under favorable conditions (Hesler & Whetzel, 1917).

In years with a high infectious background, the crop can be totally compromised (Ivanov & Kostadinova, 2007), suitable for the development of the disease and climatic conditions and inefficiently carried out plant protection measures.

Despite varietal variety, a large number of cultivars show increased sensitivity to *Plasmopara viticola* (Ivanov et al., 2002).

The development of resistant varieties is of great importance for the control of disease. This is a highly efficient, economical and environmentally friendly method in modern

plant protection (Karzhin et al., 1999; Ivanova & Dyakova, 2007). The aim of the study is to establish the reaction of hybrid breeding varieties to the fungus *Plasmopara viticola* (Berkeley et Curtis).

## Material and Methods

The study included hybrids: 25/12 (Pamid Rouse 1 × Kaylashki Misket), 5/51 (Naslada × Chardonnay) and 5/83 (Naslada × Chardonnay). The control was Misket Otonel variety due to the white coloration and the muscat aroma of the grapes of the selection forms that is non-resistant to *Plasmopara viticola*.

The control variety Misket Otonel and the hybrids are planted at a distance of 2.50/1.20 m (333 vines per hectare) and are formed on average 60 cm of improved Guillaume. The applied pruning is mixed.

The pathogen is isolated from infected vine leaves collected from diseased vines in the test vineyard by the Wong and Wilcox (2000) method.

During the vegetation period, the attack from *Plasmopara viticola* has been repeatedly reported. The attack index is calculated by the formula of Kenney in % (Josifovich, 1956). It is an indicator of the average attack rate of a plant. Through it it is possible to estimate objectively the size of the attack in separate areas of the plantation. The correlation coefficient between the development of the disease and the yield obtained is calculated by Mihailova (1982) and is a proof of the relationship between the studied signs.

The assessment of the resistance to *Plasmopara viticola* in the leaves was done on a 5-ball scale OIV (International Organization of Vine) 452 and on grapes and grains on OIV 453. The resistance is presented in five stages as follows:

Grade 1 – downy leaf necrosis or no symptoms, no fruit bodies and mycelium; no attacks on the grapes;

Grade 3 – poor cloudiness on the leaves, few fruit bodies, little mycelium; some grapes are poorly attacked, with no effect on grape harvest;

Grade 5 – limited leaves on the leaves, 1 to 2 cm in diameter with more or less mushroom-shaped bodies, hammering mycelium development; 20 to 30% of grapes are attacked with grape yield;

Grade 7 – extensive, unlimited leaf patches, pathogen fruit bodies, multiple mycelium, leaf droppings are not as early as grade (9); a very large percentage of grapes are severely damaged or destroyed;

Grade 9 – unlimited attack, extensive attack spots or completely attacked leaf surfaces with pathogen fruit bodies, pronounced thick mycelium; very early leaf pad; all grapes are severely damaged or destroyed – it has an effect on yield.

The following indicators were also observed: grain weight (g), maturation period, sugar content (%) and acids (g/l), grafting, attack index (%). The sugar content was determined by the Dujardin's method. The content of acids was determined by titration with 0.1 % NaOH.

## Results and Discussion

Data on weather conditions during the survey years are comparatively favorable for the growth and development of the vine (Fig. 1). They directly affect the development of the vine and associated pathogens. The importance of the different components of the climate in the development of the disease lies in the fact that they are necessary for the running of the different phases of the infectious process and determine the seasonal development of the disease.

Temperature is one of the main factors determining the possibility of the disease and the degree of its harmfulness. The optimum temperature for the development of the disease and profound contractility is in the range of 18-25°C. In 2014, the occurrence of oily spots (Fig. 2 a, b) was observed in the first ten days of July when the precipitation amount was 67.3 mm/m<sup>2</sup> at a rate of 67.4 mm/m<sup>2</sup> and the temperature sum was 701.6°C, with 697.7°C average for the period 1896-2005.

In the next 2015 year, the best conditions for the development of the disease were observed in August, when the precipitation amount repeatedly exceeded the norm for the period 49.4 mm/m<sup>2</sup> and was 204.7 mm/m<sup>2</sup>, and the temperature sum was close to the norm of 715.7°C.

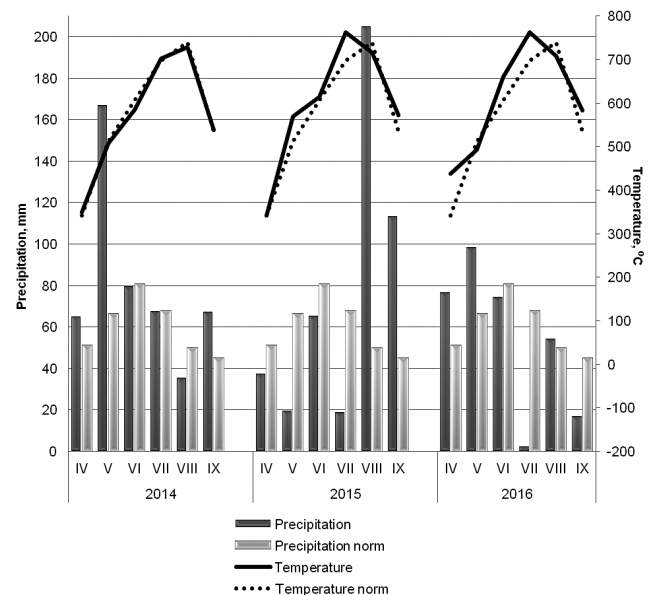


Fig. 1. Climate characteristic of 2014-2016

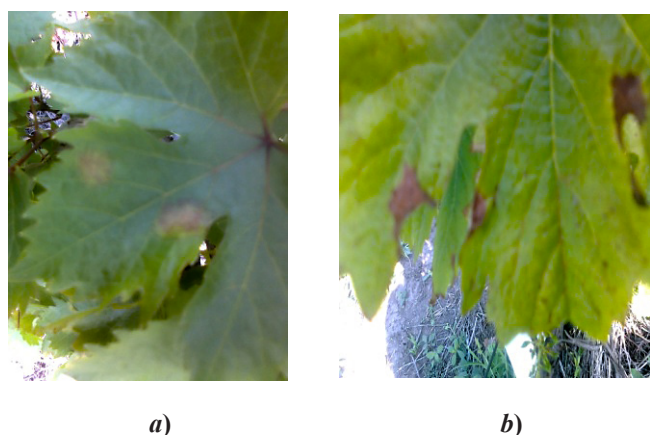


Fig. 2. Leaves attacked by *Plasmopara viticola*

In the year 2016 the best conditions for development of *Plasmopara viticola* were observed in May and June, when the precipitation amounts were 98.3 mm/m<sup>2</sup> and 74.2 mm/m<sup>2</sup>, respectively, with values of 66.1 and 80.5 mm/m<sup>2</sup> for the multi-year period. The temperature sum was in the range of 493.2 to 660.7°C, with values for 10-year periods of 512.2 and 606.6°C.

Phytopathological records were performed in June, July, August and September during the three years. During the survey period (2014-2016), the control variety Misket Otonel showed strong susceptibility to downy mildew – grade 9. During the various years of observation, the studied wine elite forms showed varying degrees of resistance due to varied climatic conditions, with precipitation and relatively cool summer being the most suitable for testing the reaction to downy mildew.

The summarized data for 2014, 2015 and 2016, reflecting the invasion of *Plasmopara viticola* in the control

Table 1. Reaction of grape wine forms to *Plasmopara viticola*, 2014-2016

| Variety /hybrid                 | 2014                        |                             | 2015                        |                             | 2016                        |                             | Degree of resistance (OIV 452/453) | Category of sustainability |
|---------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------------|----------------------------|
|                                 | Index of attack (leaves), % | Index of attack (grapes), % | Index of attack (leaves), % | Index of attack (grapes), % | Index of attack (leaves), % | Index of attack (grapes), % |                                    |                            |
| Misket Otonel                   | 65.00                       | 68.50                       | 70.20                       | 50.11                       | 73.00                       | 58.50                       | 9                                  | S                          |
| 5/51 Naslada/ Chardonnay        | 37.00                       | 40.10                       | 40.05                       | 43.00                       | 58.00                       | 40.10                       | 5                                  | MR                         |
| 5/83 Naslada/ Chardonnay        | 32.50                       | 35.30                       | 35.60                       | 38.20                       | 43.50                       | 35.30                       | 5                                  | MR                         |
| 25/12 Pamid Rousse 1/ K. Misket | 26.23                       | 28.60                       | 25.10                       | 28.00                       | 26.00                       | 28.60                       | 1                                  | R                          |

S – Sensitive; MR – Medium resistant; R – Resistant

Table 2. Indicators of grape wine forms, average for 2014-2016

| Indicators                          | Candidate varieties                |   | Elite form Naslada/ Chardonnay | Control variety Misket Otonel |
|-------------------------------------|------------------------------------|---|--------------------------------|-------------------------------|
|                                     | M. Viking 5/51 Naslada/ Chardonnay | Kristalen 25/12 Pamid Rousse 1 / Kaylashki Misket |                                |                               |
| Grape: yield per vine, kg           | 3.800                              | 4.233   | 2.763                          | 2.232                         |
| Grape: dimensions, cm               | 17.29/8.73                         | 16.87/10.85                                       | 12.48/8.45                     | 12.03/7.83                    |
| Grape: average mass, g              | 128                                | 206   | 164                            | 117.4                         |
| Grain: dimensions, cm               | 15.26/14.82                        | 16.15/14.95                                       | 12.53/11.84                    | 11.33/9.70                    |
| Grain: resistance to compression, g | 569                                | 755   | 667                            | 560                           |
| Grain: average mass, g              | 1.48                               | 2.85  | 1.92                           | 1.50                          |
| Grain: tear resistance, g           | 250                                | 255   | 290                            | 137                           |
| Sugar content, %                    | 22.62                              | 23.00   | 21.00                          | 19.00                         |
| Content of titrable acids, g/l      | 9.65                               | 6.31  | 7.54                           | 7.51                          |
| Number of seeds in 100 g            | 190                                | 300   | 180                            | 159                           |
| Mass of 100 seeds, g                | 2.78                               | 3.09  | 3.45                           | 2.08                          |
| Date of analysis                    | 16.09                              | 17.09   | 16.09                          | 14.09                         |

samples and vines exhibited the highest attack score in the control Misket Otonel: respectively 73% on the leaves and 68.5% on the bunches in 2014. The hybrids 5/51 and 5/83, obtained by crossing the varieties of Naslada and Chardonnay, have responded as medium resistant. The attack ranges from 32 to 58% on the leaves and from 35.3 to 43.5% on the grapes. At hybrid 5/83 it was respectively from 32.5 to 43.5% on the leaves and from 35.3 to 38.2% on the grapes.

As a resistant, the hybrid 25/12 with the lowest attack index reaches 25.10% to 26.23% invasive leaves and 28.60% clusters in the three years of the study and can be used in the selection of the vine as a source of resistance.

As can be seen from Table 1, all three elite wine forms are superior to the M. Otonel variety.

A strong correlation ( $r = -0.744$ ) was established between the yield obtained and the development of the disease. The highest grape yield per vine for the period 2014-2016 was obtained with the sustainable selection (form 25/12 – 4.233 g) and the lowest grape yield was obtained for the sensitive variety Misket Otonel – 2.232 g (Table 2).

Along with the development of the disease, differences in the sugar content of the grapes have been observed (Table 2). The lowest is for the sensitive variety Misket Otonel (19%) and the highest is for the selective form 25/12 – 23%. This has an impact on the quality of the output.

The test forms also differ in the content of titratable acids in the grapes. The lowest is their content for the selection form 25/12. The grain mass is highest at 25/12 – 206 g, and the lowest at Misket Otonel – 117.4 g.

## Conclusions

The form 25/12 (Pamid Rouse 1 × Kaylashki Misket) is found to be resistant to *Plasmopara viticola* and 5/51 (Naslada × Chardonnay) and 5/83 (Naslada × Chardonnay) are moderately resistant. The three elite wine forms are superior to the Misket Otonel variety. Sustainable selection forms can be included as donors for sustainability in selection programs. As a result of the development of the pathogen, there is a tendency to reduce the sugar content.

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