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NEW WHITE RESISTANT WINE GRAPE CULTIVARS FROM HYBRID FAMILY RINOT X BV-7-6-2

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Abstract:

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In this study we evaluated the hybrid family Rinot x BV-7-6-2 derived from different resistance donors, such as French-American hybrids and *Vitis amurensis*, in Czech Republic. The objective of this breeding program was to obtain white wine cultivar of high resistance and high quality level, suitable for high density plantations and production of sparkling wines, low-alcoholic or non-alcoholic wines, grape juices and concentrates. The cross combination was performed in 2003. In this population 54 seedlings were obtained. 13 promising genotypes with high resistance level to the main fungal diseases and high grape and wine quality were selected for further investigation. Genotype Markus was found to be the most interesting and is currently under registration in national catalogue. The new resistant cultivar is suitable for integrated and organic viticulture due to significantly reduced number of pesticide applications.

Keywords: resistant grape cultivar, Vitis amurensis, powdery mildew, downy mildew, organic viticulture, wine

INTRODUCTION

The grape breeding in the Czech Republic has a long history. It had started late in the 19th century with phylloxera invasion along with introduction of powdery and downy mildews in the region. The current breeding program had started early in 1980th in collaboration with the leading CIS and European Viticulture Research Stations. Since then 6 new resistant cultivars were registered in Czech Republic (Sedlo and Ludvíková, 2014). The breeding program continues and currently the 4th and 5th hybridization waves are under evaluation (Michlovský and Khafizova, 2015). The Viticulture Breeding Station (that belongs to Vinselekt Michlovský Company) is situated in Perná, South Moravia.

Global climate change sets new goals to grape breeding. The viticulture areas gradually shift to northern regions (such as Denmark, Netherlands, Scandinavian and Baltic countries, Russian regions north to Krasnodar) that have their own peculiarities. In our breeding program we select high quality resistant genotypes that retain higher acidity levels and winter hardiness. In our hybrids we are pyramidizing more than one resistant gene against downy and powdery mildews for durable resistance. Along with French-American hybrids, the carriers of *Rpv3* (Di Gaspero *et al.*, 2012) and *Ren3* (Welter *et al.*, 2007) resistance genes, *V.amurensis* progeny was used as a donor of cold hardiness and downy mildew resistance. It is known that several resistance genes (*Rpv10, Rpv12*) against downy mildew were introgressed from *V. amurensis* (Schwander *et al.*, 2012; Venuti *et al.*, 2013).

The obtained varieties are suitable for biological viticulture, although we still recommend 1-2 sprays during the season; they are also suitable for high density plantations (1.2 × 0.8 m) and production of fresh aromatic wines that have to be consumed within 1–2 years.

MATERIALS AND METHODS

A hybrid family named BV-11 was obtained from the cross between new white resistant cultivar Rinot and complex *V. amurensis* hybrid BV-7-6-2. The cross

was performed in 2003 in the frame of 4th wave of hybridization combining North American and Asian resistance donors. The conventional methods of hybridization were used.

The female parent Rinot is a high quality cultivar with high level of resistance to *Plasmopara viticola* and *Uncinula necator*, which was inherited from highly resistant French-American hybrids SV 12375 and SV 5276. Rinot is early ripening cultivar that is gaining popularity in biological viticulture in northern countries (such as Denmark, Netherlands, northern regions of Germany and the Czech Republic). It retains high acidity levels (total acidity) even with higher sugar accumulation, and produces wines closer to Pinot blanc in style (Khafizova, 2012; Sedlo and Ludvíková, 2014). Wine "Rinot 2013" obtained silver medal (89 points) on PIWI international wine competition in Germany in 2015. The male parent is a hybrid of *V. amurensis,* highly resistant to downy mildew and with high level of winter hardiness.

The pedigree of the Rinot x BV-7-6-2 cross population is indicated in Fig. 1.The hypothetical genealogical analysis (the data presented is calculated on average) showed that the heritage basis of the population BV-11 included 12.5 % of East Asian species *V. amurensis,* 17.95 % of six American species (*V. rupestris, V. lincecumi, V. aestivalis, V. cinerea, V. berlandieri, V. labrusca)* and 69.55 % of *V. vinifera*. Pinot gris contributes 31.25 % of the heritage basis, Riesling, Malvasia rose and Merlot contributed 6.25 % each. Further 19.55 % of the heritage basis was contributed by other *V. vinifera* cultivars.

Rhine Riesling cultivar was chosen as susceptible, and Malverina cultivar – as resistant control. Seedlings and propagated plants were evaluated in the field conditions with 2 fungicide applications through the following years, except for susceptible control that had 4 fungicide applications through the year. Selection for downy and powdery mildew resistance as well as the berry and wine quality assessment were performed at the Viticulture Breeding Station in Perná, South Moravia, the Czech Republic.

The multiplied vines were grafted onto SO4 rootstock and planted on heavy clayish slightly alkaline soils the year after selection, and began fruiting usually in the third year after planting. The vines were trained to single Guyot and pruned to 8–10 bud canes annually. Vines were spaced 0.8 m and rows 1.2 m.

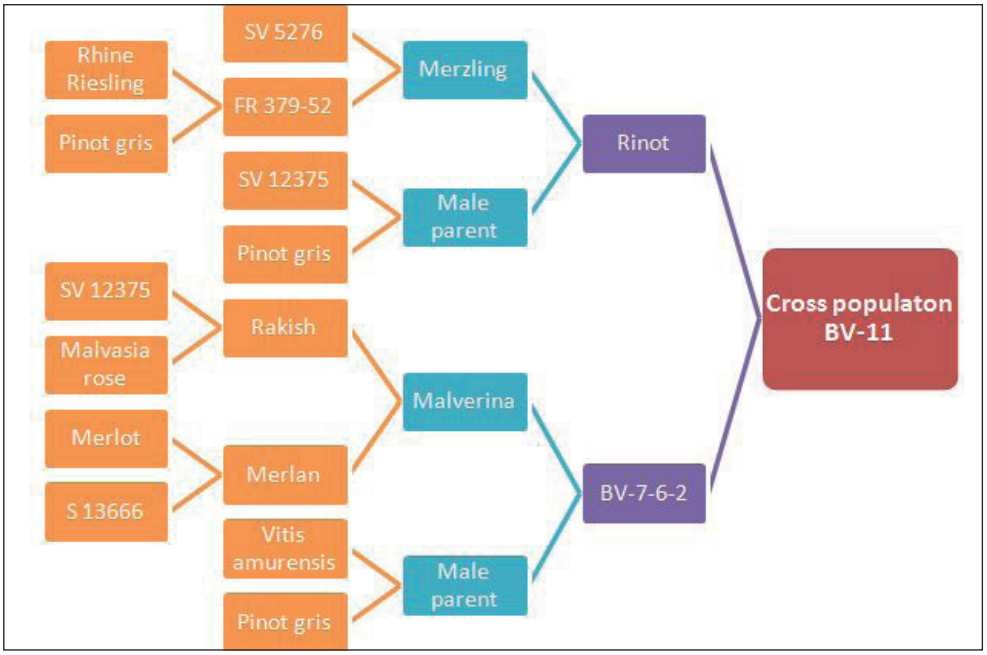
During the selection process the further characteristics were evaluated (Khafizova, 2012; Michlovský, 2004): resistance level to biotic and abiotic stresses (winter hardiness, downy and powdery mildews, grey rot etc.), phenological data (budburst, flowering, ripening, harvest date), vigor, berry shoot, grape yield, berry quality (sugar content, total acidity, pH), wine quality (alcohol content, total acidity, pH, volatile acidity, malic acid content, tartaric acid content, non-reducing extract) and sensory wine evaluation.

Data were analyzed using STATISTICA software. Means and standard deviations were evaluated using ANOVA with subsequent Tukey's test at $P > 0.95$ significance level.

RESULTS AND DISCUSSION

Population of seedlings

We obtained 54 seedlings in this cross. All seedlings had white skin, medium to high vigor,



1: *Pedigree of the cross population Rinot x BV-7-6-2*

good level of wood lignification, and higher content of total acids in must. The level of resistance both to downy and powdery mildews varied across the progeny from 4 (rather susceptible) to 9 (resistant). The level of *Botrytis cinerea* on berries depended on the genotype. Based on resistance and quality level we have chosen and multiplied (up to 20 plants each) 13 genotypes suitable for quality wine production in the frame of organic viticulture. Some of those genotypes were used further in the program. No symptoms of downy and powdery mildews were observed on the berries of chosen genotypes. The powdery mildew infection on leaves was observed late in the season after the harvest. The downy mildew infection occurred on leaves during the season creating small necrotized localized dots.

The study of chosen genotypes

Resistance to fungal diseases

The resistance level of studied genotypes to downy and powdery mildews, as well as to grey rot was higher than that of resistant and susceptible control cultivars. The resistance for downy mildew of some studied genotypes and resistant control is only slightly increased when compared to Rhine Riesling which is probably due to low pathogen pressure in most of the years of the study and increased number of fungicide applications on the susceptible control. Although the MAS did not show the presence of *Rpv10* or *Rpv12*, the high level of resistance suggests the presence of unknown resistance genes from *V. amurensis*.

2: *The cluster of Markus cultivar*

Agronomical characteristics

Most of studied BV-11 genotypes ripen earlier than the susceptible control cultivar. All selected genotypes had medium vigor and good wood lignification. Characteristic trait of that cross is higher acidity levels (total acidity) and early ripening of almost all genotypes. Lower resistance to grey rot (5.5–6.0) was observed on genotypes BV-11-2-8 and BV-11-3-5. Higher susceptibility to berry shot had genotypes BV-11-2-3 (6.5) and BV-11-2-8 (5.5). The average cluster weight in most of the cases was about 150–200 g. The harvest time of most of the genotypes was in the end of September, except for the genotype BV-11-3-5, which ripened in the end of August and had loose clusters (average cluster weight is 60 g). Most of the genotypes had lower yield when compared to control cultivar.

I: *Resistance to fungal diseases on leaves**, mean values for the 5 years of evaluation (2009–2013)*

Cultivar	*Plasmopara viticola*	*Uncinula necator*	*Botrytis cinerea**
BV-11-1-9	9,0 ± 0,0 ab	9,0 ± 0,0 c	8,0 ± 0,0
BV-11-2-2	8,3 ± 0,3 a	8,0 ± 0,6 b	7,3 ± 1,2
BV-11-2-3	7,0 ± 0,0 ab	8,0 ± 1,0 bc	7,0 ± 0,0
BV-11-2-8	7,5 ± 0,5 ab	8,0 ± 1,0 bc	5,5 ± 1,5
BV-11-3-5	9,0 ± 0,0 a	9,0 ± 0,0 c	6,0 ± 1,0
BV-11-4-10	9,0 ± 0,0 a	9,0 ± 0,0 c	7,0 ± 0,0
BV-11-5-7	8,0 ± 0,0 ab	8,7 ± 0,3 c	7,0 ± 0,6
BV-11-6-4	8,0 ± 1,0 ab	7,5 ± 0,2 b	6,5 ± 0,5
BV-11-7-10	9,0 ± 0,0 a	9,0 ± 0,0 c	9,0 ± 0,0
Rhine Riesling	6,3 ± 0,5 a	6,5 ± 0,6 a	5,0 ± 0,8
Malverina	7,3 ± 0,3 ab	7,0 ± 0,6 ab	6,3 ± 0,9

* non significant
** Level of resistance according to UKZUZ descriptors: 1 – susceptible; 9 – resistant

II: *Grape yield and quality, mean values for the 5 years of evaluation (2009–2013)*

Cultivar	Harvest date	Cluster weight, g	Yield per plant, kg	Sugar content*, NM	Total acidity*, g l^{-1}
BV-11-1-9	27.9	114,9 ± 14,7 ab	1,3 ± 0,4 a	21,0 ± 1,7	9,4 ± 2,4
BV-11-2-2	24.9	175,9 ± 5,0 abc	1,7 ± 0,1 a	19,3 ± 2,8	9,8 ± 1,9
BV-11-2-3	24.9	134,5 ± 20,2 abc	0,9 ± 0,4 a	20,9 ± 0,9	10,4 ± 1,4
BV-11-2-8	25.9	100,3 ± 19,7 ab	0,9 ± 0,3 a	23,5 ± 1,5	7,3 ± 0,4
BV-11-3-5	25.8	61,3 ± 0,0 a	0,5 ± 0,0 a	21,0 ± 0,0	8,3 ± 0,0
BV-11-4-10	3.10	168,6 ± 21,4 abc	1,1 ± 0,5 a	21,3 ± 1,5	8,3 ± 1,8
BV-11-5-7	27.9	220,5 ± 8,5 abc	2,3 ± 0,4 ab	20,7 ± 1,2	5,7 ± 1,2
BV-11-6-4	1.10	105,5 ± 22,5 ab	0,5 ± 0,1 a	23,3 ± 1,8	6,7 ± 0,5
BV-11-7-10	16.9	259,5 ± 0,0 bc	0,5 ± 0,0 b	17,5 ± 0,0	7,6 ± 0,0
Rhine riesling	4.10	123,5 ± 25,2 ab	1,3 ± 0,3 a	20,9 ± 0,6	10,1 ± 1,3
Malverina	28.9	238,1 ± 21,8 b	2,2 ± 0,1 ab	18,4 ± 1,1	8,9 ± 1,6

* non significant

Wine quality

Sensory evaluation of small-plot wine samples showed that the resistant control cultivar Malverina in most of the cases had significantly higher evaluation of wine quality (85.3 points), whereas the susceptible control had the lowest wine evaluation (69.8 points) probably due to high rate of grey rot infection. For other wine indexes no significant differences were observed between the mean values of control cultivars and studied genotypes. Most of the wines were of good quality, with aromas typical to Rhine Riesling or parental cultivars. Genotypes BV-11-1-8, BV-11-2-2, BV-11-2-3, BV-11-3-5, BV-11-3-10, BV-11-4-3, BV-11-6-3 and BV-11-6-4 are still under evaluation, whereas genotypes BV-11-1-9, BV-11-2-8, BV-11-4-10 and BV-11-7-10 are stored in collection for further breeding. Despite the high resistance level of genotype BV-11-7-10 in all years of study, the wine quality was rather poor, therefore it is planned to use it only as a possible resistance donor in the future in combination with high quality donors. Genotype BV-11-5-7 was found to be the most interesting and is recommended for registration in national catalogue under the name Markus. The aromatic profile of that genotype is closer to Gewurztraminer with rich aromas of tropical fruits (litchi, papaya).

III: *Wine quality, mean values for the 5 years of evaluation (2009–2013)*

Cultivar	Alcohol*, % by vol.	pH*	Total acidity, g l^{-1}	Malic acid*, g l^{-1}	Tartaric acid*, g l^{-1}	Non reducing extract*, g l^{-1}	Wine evaluation (0-100)
BV-11-1-9	12,9 ± 1,0	3,0 ± 1,3	8,4 ± 0,8	3,6 ± 0,9	3,8 ± 0,9	23,1 ± 0,6	83,2 ± 2,0 cd
BV-11-2-2	11,7 ± 0,0	3,1 ± 0,0	9,7 ± 0,0	3,9 ± 0,0	2,9 ± 0,0	18,5 ± 0,0	80,7 ± 1,1 c
BV-11-2-3	11,6 ± 0,0	3,0 ± 0,0	11,4 ± 0,0	4,1 ± 0,0	3,2 ± 0,0	22,0 ± 0,0	84,2 ± 1,1 d
BV-11-2-8	14,4 ± 0,5	3,1 ± 0,1	7,3 ± 0,6	2,5 ± 0,7	3,8 ± 0,8	25,9 ± 2,1	79,2 ± 1,5 c
BV-11-4-10	13,2 ± 0,8	2,8 ± 0,2	8,2 ± 0,8	2,7 ± 0,6	4,0 ± 1,0	24,0 ± 2,0	80,1 ± 2,2 c
BV-11-5-7	13,3 ± 0,7	3,3 ± 0,2	6,1 ± 0,7	1,8 ± 0,3	3,2 ± 0,5	17,7 ± 6,2	85,3 ± 1,0 d
BV-11-6-4	14,0 ± 0,9	3,3 ± 0,2	7,0 ± 0,9	2,6 ± 1,0	3,5 ± 0,7	25,3 ± 1,4	84,5 ± 0,9 d
BV-11-7-10	12,6 ± 0,0	2,8 ± 0,0	7,8 ± 0,0	2,4 ± 0,0	2,5 ± 0,0	20,8 ± 0,0	75,6 ± 1,5 b
Rhine Riesling	12,0 ± 0,7	2,6 ± 0,2	8,9 ± 1,1 b	3,3 ± 0,9	2,7 ± 0,1	20,7 ± 1,2	69,75 ± 1,2 a
Malverina	12,0 ± 0,2	2,7 ± 0,2	8,4 ± 1,2 ab	3,4 ± 0,7	2,5 ± 0,0	20,0 ± 0,5	85,33 ± 2,3 d

* non significant

CONCLUSION

We have analyzed a successful cross population of highly resistant genotypes that combine quality and resistant traits from *V. vinifera*, *V. amurensis* and several North American species. Genotype Markus have been chosen on the basis of its resistance level, winter hardiness and wine quality to undergo national registration.

The obtained high quality hybrids are recommended to be used in further breeding. Rinot cultivar has proved to be a good high quality donor. Although the MAS did not show the presence of *Rpv10* or *Rpv12* in obtained hybrids, the high level of resistance suggests the presence of unknown resistance genes.

The new genotypes are very promising, but further study is needed to design appropriate technological procedures for the large scale production of grapes and wine, especially in terms of no- or low-alcoholic wines, juices and concentrates.

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