doi: https://doi.org/10.36812/pag.202228148-57

SHORT COMMUNICATION

Agronomic evaluation of 'Riesling Itálico', 'Chardonnay', 'Merlot' and 'Cabernet Franc' grapevine clones

Rafael Anzanello[1], Tainan Graeff Tasso[2], Cláudia Martellet Fogaça[1], Adeliano Cargnin[3], Leo Duc Haa Carson Schwartzhaupt da Conceição[3], Gabriele Becker Delwing Sartori[1], Amanda Heemann Junges[1]

Abstract - This study aimed to evaluate clones of 'Riesling Itálico', 'Chardonnay', 'Merlot' and 'Cabernet Franc' grapevines that best adapt to the edaphoclimatic conditions in Veranópolis, RS. The experiment was carried out at the State Center for Diagnosis and Research in Fruticulture - DDPA/SEAPDR. Three 'Riesling Itálico' clones (ISV-1, RI12V23, VCR-365), four 'Chardonnay' clones (INRA-95, INRA-132, INRA-548, VCR-6), four 'Merlot' clones (INRA-181, INRA-347, VCR-13, VCR-494) and seven 'Cabernet Franc' clones (INRA-212, INRA-214, ISV-8, ISV-101, VCR-2, VCR- 4, VCR-10) were evaluated. The experimental design was randomized blocks, with 4 replications and 10 plants per plot. The clones were evaluated in the 2020/2021 cycle for phenology (budburst and maturation dates), production (kg/plant, ton/ha weight/bunch) and fruit quality (soluble solids-SS, titratable acidity-AT, pH). The results showed the potentiality of the clone RI12V23 for 'Riesling Itálico', INRA-132 for 'Chardonnay', VCR-13 for 'Merlot' and VCR-10 for 'Cabernet Franc'. The 'Riesling Itálico' and 'Chardonnay' clones showed greater production precocity than the 'Merlot' and 'Cabernet Franc' clones.

Keywords: Phenology. Plant production. Fruit quality. Viticulture.

Avaliação agronômica de clones de videiras 'Riesling Itálico', 'Chardonnay', 'Merlot' e 'Cabernet Franc'

Resumo - Este estudo objetivou avaliar clones de videiras 'Riesling Itálico', 'Chardonnay', 'Merlot' e 'Cabernet Franc' que melhor se adaptam às condições edafoclimáticas de Veranópolis, RS. O experimento foi realizado no Centro Estadual de Diagnóstico e Pesquisa em Fruticultura - DDPA/SEAPDR. Avaliaram-se três clones de 'Riesling Itálico' (ISV-1, RI12V23, VCR-365), quatro clones de 'Chardonnay' (INRA-95, INRA-132, INRA-548, VCR-6), quatro clones de 'Merlot' (INRA-181, INRA-347, VCR-13, VCR-494) e sete clones de 'Cabernet Franc' (INRA-212, INRA-214, ISV-8, ISV-101, VCR-2, VCR-4, VCR-10). O delineamento experimental foi o de blocos casualizados, com 4 repetições e 10 plantas por parcela. Os clones foram avaliados no ciclo 2020/2021 quanto a fenologia (datas de brotação e de maturação), produção (kg/planta, ton/ha, peso/cacho) e qualidade de fruto (sólidos solúveis-SS, acidez titulável-AT, pH). Os resultados mostraram potencialidade do clone RI12V23 para 'Riesling Itálico', INRA-132 para 'Chardonnay', VCR-13 para 'Merlot' e VCR-10 para 'Cabernet Franc'. Os clones de 'Riesling Itálico' e 'Chardonnay' mostraram maior precocidade de produção que os clones de 'Merlot' e 'Cabernet Franc'.

Palavras-chave: Fenologia. Produção vegetal. Qualidade de fruto. Viticultura.

[1] Secretaria da Agricultura, Pecuária e Desenvolvimento Rural. *Corresponding Author: rafael.anzanello@agricultura.rs.gov.br.
[2] Universidade de Caxias do Sul.
[3] Empresa Brasileira de Pesquisa Agropecuária (Embrapa Grape and Wine).

ISSN: 0104-907. ISSN ONLINE: 2595-7686.
Received in 26 Aug. 2021. Accepted on 4 March 2022.

In Rio Grande do Sul (RS), southern Brazil, the viticulture is the main agricultural activity developed in Encosta Superior da Serra do Nordeste, an important Brazilian wine-growing hub (ANZANELLO, 2012), in which the city of Veranópolis and its micro-region are located. The *Vitis vinifera* varieties used for the elaboration of fine and sparkling wines in the State of RS occupy 6,354.40 ha, which is equivalent to 15.79 % of the area cultivated with grapevines, with 'Chardonnay' having an area of 1,011.40 ha, 'Merlot' 759 .92 ha, 'Riesling Itálico' 292.81 ha and 'Cabernet Franc' 164.36 ha (MELLO; MACHADO, 2017). In 2020, 502.5 thousand tons of grapes were processed in the State of RS, with a total of 69.3 thousand tons of *Vitis vinifera* grapes, which corresponds to 14 % of the total production (SEAPDR, 2020).

Grapevine genetic improvement programs have supported the development of Brazilian viticulture (CAMARGO *et al*., 1997). Cultivars with good characteristics of adaptation to Brazilian soil and climate conditions have been developed recently, resulting in greater productivity and resistance to the main diseases of the crop (SANTOS *et al*., 2017). However, the improvement programs have sought to meet, mainly, the demands of the productive chains of table grapes and juice to the detriment of fine grapes for the elaboration of fine and sparkling wines. The segment of fine and sparkling wines is in a process of major transformations that, potentially, can be converted into both opportunities and threats. There is a constant emergence of new production poles in regions with a temperate climate of altitude; temperate or subtropical climate with rugged relief; temperate or subtropical climate with strong continental influence; transitional climates between tropical and subtropical; and tropical climate, which demand specific cultivation technologies (SANTOS *et al*., 2017).

The environment and the clone have a great influence on the quality of the grapes (THIS; LACOMBE; THOMAS, 2006). According to Camargo *et al*. (1997), clone refers to a genetic variation occurring in an individual that results in an increase in some of the agronomic attributes of the plant, such as production, grape quality or some other factor of interest. The most appropriate choice of clones when establishing a new vineyard should focus on the specific interactions of the genotype with the environment and not just on the geographical origin of the clones and/or their aptitudes provided in the catalogs (LEWELDT; POSSINGHAM, 2008). Research in various parts of the world shows that the environment affects the performance of different clones of grape varieties for fine wines (ALLEWELDT; SPIEGEL-ROY; REISCH, 2010; REISCH; PRAT, 2016). This information regarding the interaction data with the environment is a valuable resource for choosing the best adapted clone in each location and/or with the most appropriate characteristics for the type of use.

Therefore, it is important to know the behavior, regarding the variability and potential of commercial clones of *Vitis vinifera* grapevines for cultivation in each region or specific micro-region in order to support the strengthening and development of viticulture in RS. This work aimed to evaluate and characterize commercial vine clones of the Cabernet Franc, Merlot, Riesling Itálico and Chardonnay varieties that best adapt to the soil and climate conditions of Veranópolis, RS, Brazil.

The work was carried out in the 2020/2021 production cycle, in 4-year-old plants (vineyard established in 2017) of different clones of Riesling Itálico, Chardonnay, Merlot and Cabernet Franc varieties.

Received in 26 Aug. 2021. Accepted on 4 March 2022.

The study vineyard is located in the city of Veranópolis, at the State Center for Diagnosis and Research in Fruticulture (CEFRUTI), at an altitude of 705 m, with latitude of 28°56'14” S and longitude of 51°33'11” W, belonging to the Government of the State of RS, Brazil. The plants were grafted onto the Paulsen 1103 rootstock in the field, conducted in a simple trellis and pruned in a Guyot system. The spacing used was 1.00 meters between plants and 2.50 between rows.

Three clones of 'Riesling Itálico' (ISV-1, RI12V23 and VCR-365), four clones of 'Chardonnay' (INRA-548, INRA-95, INRA-132 and VCR-6), four clones of 'Merlot ' (INRA-181, INRA-347, VCR-13 and VCR-494) and seven clones of 'Cabernet Franc' (INRA-212, INRA-214, ISV-8, ISV-101, VCR-2, VCR-4 and VCR-10) were evaluated. The experimental design was randomized blocks, with 4 replications and 10 plants per plot, totaling 40 plants per clone. The seedlings were imported from Vivai Cooperativi Rauscedo (VCR) in Italy. The clones with the acronym VCR were selected by the Cooperative itself. The INRA clones were selected by the Institut National the Recherche Agronomique (INRA) in France, the ISV clones selected by the Istituto Sperimentale per la Viticoltura, Conegliano region, in Italy, and the RI 12 V23 clone selected by the University of Milan, Italy.

For the period corresponding to the 2020/2021 cycle (April 2020 to March 2021) meteorological variables were monitored in the field (average air temperature and rainfall) from an automatic weather station belonging to CEFRUTI. Chilling hours ≤ 7.2ºC (CH) were recorded in the field from April to September.

The phenology of the different clones was monitored weekly based on the Eichorn and Lorenz scale, according to the European and Mediterranean Plant Protection Organization (1984). The phenological stages and their characterization were: budburst, when 50% of the buds of all plants were in the green tip stage; and at the end of maturation, when all bunches of all plants were harvested. The harvest point was determined by sensory evaluations of the grape (taste and odor). Ampelographic differences regarding the compactness of the bunches were also observed from photographic taken during the fruit maturation. The percentage of budburst per clone was also evaluated by the ratio between the number of sprouted buds and the total number of buds per plant at the beginning of the vegetative cycle, in ten plants per clone randomly chosen in the vineyard.

At the time of harvest, characteristics related to grape production and quality were evaluated, for the following characteristics: production per plant, in kg plant^{-1}, determined by a digital electronic scale; productivity (ton ha^{-1}); bunch weight (g), determined by electronic scale from 10 bunches per repetition/clone; iv) soluble solids (SS), in ºBrix, determined by a portable analog refractometer; titratable acidity (TA), (meq L^{-1}), determined by titration from the titration with 0.1 N NaOH solution, with bromothymol blue indicator, and pH, determined by pH meter. The SS, AT and pH values were determined by extracting the must resulting from the milling of 100 berries per replicate/clone.

The percentage of budburst and phenology variables were submitted to descriptive statistical analysis. The quantitative and qualitative production variables were submitted to ANOVA analysis of variance and the means compared by Tukey's test at a significance level of 5% probability.

The percentage of budburst of Riesling Itálico, Chardonnay, Merlot and Cabernet Franc clones are shown in Table 1. The percentage of budburst in temperate fruit plants is a variable highly related to the

Received in 26 Aug. 2021. Accepted on 4 March 2022.

amount of cold during the dormancy period (HAWERROTH *et al.*, 2010). The accumulation of chilling hours (CH) equal or below 7.2 ºC from April to September 2020 was 379 hours in the field. According to the literature, the chilling requirement is 150 CH for the Riesling Itálico and Chardonnay varieties, 300 CH for the Merlot variety and 400 CH for the Cabernet Franc variety (ANZANELLO; FIALHO; SANTOS, 2018). Therefore, the accumulation of cold that occurred in the winter period of 2020 practically supplied the chilling requirement during dormancy for all cultivars studied, resulting in a good percentage of budburst (close to 70% or more) of the clones (Table 1), the which under field conditions is already considered an adequate and satisfactory rate of budburst. For Anzanello and Lampugnani (2020) dormancy overcoming is considered when 70% or more of sprouted buds occur. The VCR-365 clone of 'Riesling Itálico' with 73.8 % of budburst, INRA-132 clone of 'Chardonnay' with 76.3 % of budburst, VCR-13 clone of 'Merlot' with 71,4% of budburst and VCR-4 clone of 'Cabernet Franc' with 82.5% of budburst were highlighted (Table 1).

As for the phenological data, the white grapes (Riesling Itálico and Chardonnay) showed greater production precocity than the red grapes (Merlot and Cabernet Franc), regardless of the clone, with the budburst of the white grapes occurring in the beginning of September while for the red grapes occurring in the middle of the same month (Table 1). This anticipation of the cycle extended until the end of maturation, with white grapes being harvested in January and early February and red grapes in early March. Such observations are compatible with those observed by Mandelli *et al.* (2003), in which 'Chardonnay' and 'Riesling Itálico' show greater precocity of production than 'Merlot' and 'Cabernet Franc' in the state of Rio Grande do Sul, Brazil.

According to Anzanello (2012) higher altitude places in the state Rio Grande do Sul are prone to the occurrence of late or spring frosts. Thus, the later the budburst of the plants, the lower the risk of production losses due to frost. In this regard, the ISV-1 clone for 'Riesling Itálico' in the white grapes and all 'Merlot' and 'Cabernet Franc' clones (especially VCR-10) in the red grapes were highlighted (Table 1), whose shoots occurred later in the field. According to Camargo, Tonietto and Hoffmann (2011), the main cause of the drop in grape production in the region where Veranópolis city is located, historically, is due to a succession of climatic factors that impair the development of grapes throughout the year, such as the occurrence of spring frosts and excessive rainfall. Therefore, the availability of later materials is important to reduce the damage caused by frost and to reduce production losses.

There was great yield variability among the clones (Table 1). The results from the 2020/2021 crop showed the potentiality of the clone RI12V23 for 'Riesling Itálico' (2.1 kg plant^{-1}, bunch weight 160.5 g, SS - 17 ºBrix, AT - 94 meq L^{-1} and pH 3, 17); clone INRA-132 for 'Chardonnay' (1.5 kg plant^{-1}, bunch weight 105.6 g, SS - 17.9 ºBrix, AT - 107 meq L^{-1} and pH 3.20); clone VCR-13 for 'Merlot' (2.3 kg plant^{-1}, bunch weight 196.2 g, SS - 19.2 ºBrix, AT - 100.7 meq L^{-1} and pH 3.47) and VCR clone -10 for 'Cabernet Franc' (2.0 kg plant^{-1}, bunch weight 181.8 g, SS - 20.1 ºBrix, AT - 100 meq L^{-1} and pH 3.32) (Table 1).

PESQ. AGROP. GAÚCHA, V.28, N.1, P. 48-57, 2022.
ISSN: 0104-907. ISSN ONLINE: 2595-7686.
Received in 26 Aug. 2021. Accepted on 4 March 2022.

Table 1. Percentage of budburst (% B), phenology (B - budburst; FM - end of maturation) and production data (P - production per plant, in kg plant^{-1}; PD - productivity, in ton ha^{-1}; BW - Bunch weight, in g; SS - Soluble Solids, in ºBrix; TA - Titratable Acidity, in meq L^{-1} and pH) of the clones of Riesling Itálico, Chardonnay, Merlot and Cabernet Franc varieties, 2020/2021 harvest. Veranópolis, RS.

Variety	Clone	% B	Phenology		Productive date					
			B	FM	P	PD	BW	SS	TA	pH
Riesling Itálico	ISV-1	65.7	09/09	01/02	2.0 a*	8.0	147.3 a	15.8 ab	99 ab	3.15 ab
	RI 12 V 23	70.3	05/09		2.1 a	8.4	160.5 a	17.0 a	94 b	3.17 a
	VCR-365	73.8	04/09		2.0 a	8.0	154.8 a	15.0 b	104.5 a	3.09 b
Chardonnay	VCR 6	75.7	05/09	19/01	1.4 a	5.6	97.5 ab	17.6 b	122.5 a	3.18 b
	INRA 95	70.5	04/09		0.4 b	1.6	72.3 b	18.4 a	101.5 b	3.26 a
	INRA 132	76.3	04/09		1.5 a	6.0	105.6 a	17.9 ab	107.0 b	3.20 b
	INRA 548	73.7	05/09		1.4 a	5.6	99.6 a	18.0 ab	127.0 a	3.22 ab
Merlot	INRA 181	69.7	13/09	01/03	1.8 b	7.2	186.9 a	19.0 ab	100.0 a	3.47 a
	INRA 347	67.7	13/09		2.5 a	10.0	209.8 a	18.4 b	101.0 a	3.32 b
	VCR 13	71.4	14/09		2.3 a	9.2	196.2 a	19.2 a	100.7 a	3.47 a
	VCR 494	67.0	12/09		2.2 a	8.8	201.8 a	17.9 b	94.0 a	3.52 a
Cabernet Franc	ISV 8	78.7	11/09	01/03	1.2 b	4.8	130.0 b	18.4 b	114.0 a	3.27 c
	ISV 101	81.2	10/09		1.2 b	4.8	148.7 b	20.0 a	109.0 ab	3.31 bc
	VCR 2	75.6	10/09		1.3 b	5.2	156.1 b	19.8 a	109.0 ab	3.31 bc
	VCR 4	82.5	08/09		1.2 b	4.8	143.9 b	20.2 a	95.0 bc	3.36 a
	VCR 10	77.0	13/09		2.0 a	8.0	181.8 a	20.1 a	100 abc	3.32 abc
	INRA 212	74.6	11/09		1.4 b	4.6	136.1 b	20.1 a	92.0 c	3.36 ab
	INRA 214	70.8	08/09		1.5 ab	6.0	147.0 b	20.4 a	92.7 c	3.35 ab

*Means followed by the same letter within each column, for clones of each *Vitis vinifera* variety, do not differ significantly by Tukey's test (p≤0.05).

Vineyards to produce grapes for fine and sparkling wines are conducted, predominantly, in a single trellis, with limited production per plant, aiming to obtain feedstock with an adequate maturation rate and higher concentration of polyphenols (ANZANELLO, 2012). The recommended yield for the production of fine and sparkling wines in a single trellis system is 1.8 to 2.5 kg plant^{-1} and a maximum of 10 ton ha^{-1} for maximum production quality and oenological properties of the grape (UVIBRA, 2015). The clones with the best productive performance showed a yield of 6 ton ha^{-1} (INRA-132 of 'Chardonnay') to 9.2 ton ha^{-1} (VCR-13 of 'Merlot') (Table 1), within the desirable yield in the single trellis system. Giovaninni (2008) suggests that the trellis system prioritizes grape quality over productivity because it maintains a lower number of buds in the plant at the time of pruning. The vegetative canopy in the vertical position results in the formation of a more aerated canopy, with a reduction in phytosanitary problems and greater sunlight available to the fruits

(FALCÃO *et al*., 2008).

Potential clones of 'Riesling Itálico', 'Chardonnay', 'Merlot' and 'Cabernet Franc' (RI12V23, INRA-132, VCR-13 and VCR-10) (Table 1) presented fruit quality within the ideal ranges for production sparkling wines (SS: 17 to 19 ºBrix; AT: 90 to 110 meq L^{-1}; pH: 3.00 to 3.20) and fine red wines (SS: 19 to 22 ºBrix; pH: 3.30 to 3, 50) (GUERRA; PEREIRA, 2018), considering its specific use. In this work, the clones of Chardonnay and Riesling Itálico varieties were destined for the production of grapes for sparkling wines and the clones of Merlot and Cabernet Franc varieties were used for the production of grapes for fine red wines. In Brazil, the cultivars Chardonnay and Riesling Itálico are thenoblest varieties for the production of white and sparkling wines (GIOVANINNI, 2008). The ‘Merlot’, ‘Cabernet Franc’ and ‘Cabernet Sauvignon’ grapevines stand out as the main varieties for red wines and can be consumed young or aged, depending on the purpose of production (FALCÃO *et al*., 2008; GRIS *et al*., 2010).

Different criteria are used to determine the ideal point of grape harvest (GUERRA; ZANUS, 2003). The stage of maturation in which the grape is harvested determines the quality and type of products obtained from it (GRIS *et al*., 2010). The most used control criterion is the glucometric degree (sugar content), which is measured in °Babo scale, which represents the percentage of sugar in a sample of must, or in °Brix scale, which represents the total solid soluble in the sample, 90% of which are sugars (FELIPPETO; ALEMBRANDT; CIOTTA, 2016). The climatic condition, especially the rainfall in the 2020/2021 crop, favored the obtaining of fruits with lower SS for Chardonnay and Riesling Itálico cultivars, which is desirable for grapes for sparkling wines. These cultivars were harvested in January and early February, coinciding with a period of high rainfall during fruit maturation (January with 363.8 mm), resulting in a greater dilution of sugars and lower °Brix of the grapes. For red grapes (Merlot and Cabernet Franc), harvested in early March, the grapes showed higher SS, which is important for the production of fine red wines. The highest SS of these cultivars was benefited by the milder rainfall in the month before the harvest of these varieties (February with 101.2 mm), providing a greater concentration of sugars in the fruits.

As for the compactness of the bunches, the RI12V23 clone of 'Riesling Itálico' presented more compact bunches and the clones INRA-132 of 'Chardonnay', VCR-13 of 'Merlot' and VCR-10 of 'Cabernet Franc' had looser bunches. According to Giovaninni (2008), grape bunch disease losses may be more significant in genotypes with compact bunches and thin-film berries because they provide conditions of lower aeration, greater propensity to berry splitting, greater retention of moisture inside the fruit and lower efficiency of phytosanitary sprays.

Regarding the phytosanitary aspects, the *Vitis vinifera* cultivars presented good sanity with the phytosanitary treatments used, regardless of the clone. The beginning of the vegetative cycle of the crop in the 2020/2021 occurred with a drier period in the field (Sep/143 mm; Oct/45 mm; Nov/73 mm), reducing the predisposition to the occurrence of fungal diseases, such as: downy mildew, anthracnose and scoriose, which are favored by high relative humidity and leaf wetness (AMORIM; REZENDE; CAMARGO, 2016). At the end of the cycle (summer maturation period), despite the high volume of rainfall, mainly in January (363.8 mm), the clones did not show damage caused by rot (grape rot, ripe grape rot and bitter rot), indicating that they are genetic materials with good resistance to these diseases.

It is worth noting that the plants used in this study are originally from Europe (France and Italy). The clones were selected and adapted to the climate and soil of the countries of origin. Therefore, it is important to evaluate the different clones of *Vitis vinifera* grapevines under soil and climate conditions of other grape producing regions in the world, such as the microregion of Veranópolis, an important production center for *Vitis vinifera* grapes in the south of Brazil. This information regarding the data on the interaction of the genotype with the environment is a valuable resource, with extreme importance, for choosing the clone, of each variety, best adapted to each cultivation site (FOGAÇA *et al*., 2020).

The varieties studied (Riesling Itálico, Chardonnay, Merlot and Cabernet Franc) are among the cultivars that present an important contribution to the production of white wines, fine wines and sparkling wines in Brazil (FOGAÇA *et al*., 2020). The diversity and potential found among clones, due to the wide variability, provide promising results to promote their indication and application to the production chain of grapes for wines and sparkling wines. This highlights the importance of evaluating and continuously monitoring the performance of the plants, through the selection research and evaluation of clones of *Vitis vinifera* varieties (LEWELDT; POSSINGHAM, 2008). It is necessary to monitor a greater number of harvests to provide greater consistency and representativeness of the data, expanding the variables evaluated. The preliminary results of this study already guide the existence of clones with great potential for the quantitative and qualitative attributes of production evaluated.

Currently, nurseries sell grapevine seedlings by variety, without knowing the genetic identity of the clone (FOGAÇA *et al*., 2020). Therefore, from this research, it will be possible to identify of promising *Vitis vinifera* clones, from propagation to planting, directed to the wine-growing area, which will be added to the genetic materials of grapevines already existing in the market, made available to the nursery segment for the seedling production and, later, for planting by the producers.

From this work, it is concluded that the clones of *Vitis vinifera* grapevines differ in the aspects of phenology and quantitative and qualitative production in the field. The clones RI 12V 23 for 'Riesling Itálico', INRA 132 for 'Chardonnay', VCR13 for 'Merlot' and VCR10 for 'Cabernet Franc' show productive potential for cultivation and elaboration of fine and sparkling wines in Veranópolis, RS, Brazil.

Acknowledgements

The authors thank EMBRAPA and the Government of the State of RS for their financial support.

Conflict of interest

The authors declare that the research was conducted in the absence of any potential conflicts of interest.

Ethical statements

The authors confirm that the ethical guidelines adopted by the journal were followed by this work, and all authors agree with the submission, content and transfer of the publication rights of the article to the journal.

ISSN: 0104-907. ISSN ONLINE: 2595-7686.
Received in 26 Aug. 2021. Accepted on 4 March 2022.

They also declare that the work has not been previously published nor is it being considered for publication in another journal.

The authors assume full responsibility for the originality of the article and may incur on them, any charges arising from claims, by third parties, in relation to the authorship of the article.

ORCID

Rafael Anzanello: https://orcid.org/0000-0002-2406-2789

Tainan Graeff Tasso: https://orcid.org/0000-0001-6215-3406

Cláudia Martellet Fogaça: https://orcid.org/0000-0001-7720-7796

Adeliano Cargnin: https://orcid.org/0000-0002-5008-0948

Leo Duc Haa Carson Schwartzhaupt da Conceição: https://orcid.org/0000-0001-6809-0047

Gabriele Becker Delwing Sartori: https://orcid.org/0000-0001-5370-2872

Amanda Heemann Junges: https://orcid.org/0000-0001-6982-7880

References

ALLEWELDT, G.; SPIEGEL-ROY, P.; REISCH, B. Grapes (Vitis). **Acta Horticulturae**, n. 290, p. 291-337, 2010. DOI: https://doi.org/10.17660/ActaHortic.1991.290.7.

AMORIM, L.; REZENDE, J. A. M.; CAMARGO, L. E. A. **Manual de Fitopatologia: Doenças de Plantas Cultivadas**. 5ª ed. Ouro Fino: Agronômica Ceres, 2016. 772p.

ANZANELLO, R.; LAMPUGNANI, C. S. Requerimento de frio de cultivares de pessegueiro e recomendação de cultivo no Rio Grande do Sul. **Pesquisa Agropecuária Gaúcha**, v. 26, n. 1, p. 18-28, 2020. DOI: https://doi.org/10.36812/pag.202026118-28.

ANZANELLO, R. Caracterização da viticultura no Rio Grande do Sul por meio da análise dos dados do Cadastro Vitícola. **Pesquisa Agropecuária Gaúcha**, v. 18, n. 1, p. 67-73, 2012. Available at: http://revistapag.agricultura.rs.gov.br/ojs/index.php/revistapag/article/view/216. Accessed: 22 May 2020.

ANZANELLO, R.; FIALHO, F. B.; SANTOS, H. P. Chilling requirements and dormancy evolution in grapevine buds. **Ciência e Agrotecnologia**, v. 42, n. 4, p. 364-371, 2018. DOI: https://doi.org/10.1590/1413-70542018424014618.

CAMARGO, U. A. *et al*. O melhoramento genético da videira na Embrapa Uva e Vinho. *In:* Simpósio Brasileiro de Melhoramento de Frutíferas, 1., 1997, Jaboticabal, SP. **Anais...** Jaboticabal: FCAV/UNESP, 1997. p. 28-30.

CAMARGO, U. C.; TONIETTO, J.; HOFFMANN, A. Progressos na viticultura brasileira. **Revista Brasileira de Fruticultura**, v. 33, n. 1, p. 144-149, 2011. DOI: https://doi.org/10.1590/S0100-29452011000500017.

EPPO. EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION. Crop growth stage keys: grapevines. **EPPO / OEPP**. **Bulletin**, v. 14, n. 2, p. 295-298, 1984.

FALCÃO, L. D. *et al.* Maturity of Cabernet Sauvignon berries from grapevines grown with two different training systems in a new grape growing region in Brazil. **Ciencia e Investigación Agraria**, v. 35, n. 3, p. 271-282, 2008. DOI: http://dx.doi.org/10.4067/S0718-16202008000300010.

FELIPPETO, J.; ALEMBRANDT, R.; CIOTTA, M. N. Maturação e composição das uvas Cabernet Sauvignon e Merlot produzidas na região de São Joaquim, SC. **Agropecuária Catarinense**, v. 29, n. 2, p. 74-79, 2016.

GIOVANINNI, E. **Produção de uvas para vinho, suco e mesa.** 3. Ed. Porto Alegre: Renascença, 2008. 368p.

GUERRA, C. C.; PEREIRA, G. E. A qualidade e a tipicidade dos vinhos finos tranquilos e espumantes brasileiros. **Territoires du Vin**, v. 9, n. 1, p. 1-10, 2018.

GUERRA, C. C.; ZANUS, M. C. **Maturação e Colheita**. *In*: Embrapa Uva e Vinho (ed.). Bento Gonçalves: Embrapa, 28, 2003. (Sistema de Produção, n. 4). Available at: https://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Uva/UvasViniferasRegioesClimaTemperado/colheita.htm. Accessed: 18 May 2020.

GRIS, E. F. *et al.* Phenology and ripening of *Vitis vinifera* L. grape varieties in São Joaquim, southern Brazil: a new South American wine growing region. **Investigación Agraria**, San Lorenzo, v. 37, n. 2, p. 61-75, 2010. DOI: http://dx.doi.org/10.4067/S0718-16202010000200007.

FOGAÇA, C.M. *et al.* **Desempenho inicial de clones de videiras de variedades *Vitis vinifera* para a microrregião de Veranópolis.** Porto Alegre: SEAPDR/DDPA, 2020. 31p.

HAWERROTH, F. J. *et al.* **Dormência em frutíferas de clima temperado**. Pelotas: EMBRAPA Clima Temperado, 2010. 56 p.

LEWELDT, G.; POSSINGHAM, J. V. Progress in grapevine breeding. **Theoretical and Applied Genetics.** v. 75, n. 1, p. 669-673, 2008.

REISCH, B. I.; PRATT, C. Grapes. *In:* JANICK, J.; MOORE, J. N. (Ed.). **Fruit breeding: vine and small fruits.** New York: John Wiley, 2016. p. 297-370.

MANDELLI, F. *et al.* Fenologia da videira na Serra Gaúcha. **Pesquisa Agropecuária Gaúcha**, v.9, n.1-2, p.129-144, 2003. Available at: http://revistapag.agricultura.rs.gov.br/ojs/index.php/revistapag/article/view/512. Accessed: 20 May 2020.

MELLO, L. M. R.; MACHADO, C. A. E. **Cadastro vitícola do Rio Grande do Sul: 2013 a 2015.** Brasília: Embrapa, 2017. 85 p. Available at: http://www.cnpuv.embrapa.br/cadastro-viticola/rs-2013-2015/dados/obracompleta.html . Accessed: 26 August 2020.

SANTOS, M. *et al.* Melhoramento e caracterização de recursos genéticos da videira: uma revisão de literatura. *In:* XXI Encontro Latino Americano de Iniciação Científica, XVII Encontro Latino Americano de Pós-Graduação e VII Encontro de Iniciação à Docência, 1., 2017, João Pessoa, PB. **Anais…** João Pessoa: Universidade do Vale do Paraíba, 2017. p. 1-6.

SEAPDR. Secretaria da Agricultura, Pecuária e Desenvolvimento Rural. **Produção de uvas e produtos vitivinícolas elaborados na safra 2020, no Estado do Rio Grande do Sul, 2020.** Available at: https://www.agricultura.rs.gov.br/secretaria-da-agricultura-divulga-dados-preliminares-atuais-da-safra-da-uva-do-rs . Accessed: 04 October 2021.

THIS, P.; LACOMBE, T.; THOMAS, M. R. Historical origins and genetic diversity of wine grapes. **Trends in Genetics**, v. 22, n. 9, p. 511-519, 2006. DOI: https://doi.org/10.1016/j.tig.2006.07.008.

UVIBRA. UNIÃO BRASILEIRA DE VITIVINICULTURA. **Manual de produção de uvas viniferas de alta qualidade.** Uvibra: Bento Gonçalves, 2015. 46p.