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Phenological development and fruitfulness level of Carolina Black Rose and Sultana table grape varieties

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Abstract: *Vitis vinifera* is the most important species for grape and wine production in Australia. The knowledge of this species' development from bud winter to leaf fall is important to determine the correct vineyard cultural practices and consequently improve its productivity. Carolina Black Rose is a table grape variety very known due to its sweetness flavor, but which has a lack of phenological descriptions in Australia. Thus, the aim of this paper was to analyze the phenological development and fruitfulness potential of Carolina Black Rose and compare with Sultanas in South Australia. Hence, eleven nodes of 10 grapevines were selected for both varieties; daily observed and recorded the quantity of primary and secondary shoots per node of each grapevine for phenological analysis. The fruitfulness potential was measured in the base of bunches/shoot, bunches/node and shoots/node produced by each variety. At the end of the analysis, Carolina Black Rose presented 16 days between stages 4 and 12 and Sultanas presented 15 days, showing that the phenology of both varieties is similar. Also, both varieties do not differ in relation to the number of bunches per grapevine. Results indicate that the correct cultural practice of the vineyard is essential for having a good productivity of grapes.
Keywords: Cultural Practices, Grape production, Plant development, *Vitis vinifera*.

Introduction

Originally from Central Europe, Mediterranean Region, and Southwestern Asia, the *Vitis vinifera* is an important species for the global grape and wine production. Within the *V. vinifera,* many different varieties exist and many others have been developed along the years to red wine production, as well as to white wine and table grape production (Chevet et al., 2011).

Temperature and rains, with other climatic elements such as sunlight, air humidity, and wind, have a direct influence on the development and, consequently, on the life cycle of a grapevine (Ferreira et al., 2004), which prefer dry seasons and temperature between 10° to 40°C. Hence, in regions with low temperature, there is only one production cycle per year, while in regions under higher temperature two production cycles are possible per year. Also, the grapes are very sensitive to winds, but can easily adapt to different type of soils (Arroyo-Garcia et al., 2006).

The knowledge of a grapevine's phenology is fundamental for the correct management of a vineyard. Information about the vine growth and the plant's adaptation to the field conditions can be observed through the phenology of the plants (Sadras & Moran, 2013). Advantages with the study of the phenology of grapevines are the reduction of cultural practices, which can be realized only with the appearance of plagues and plant diseases, and the improvement of berry quality (Murukami et al., 2002).

According to Coombe, (1995) there are three systems to evaluate the stages of phenological development of the grapevines. They are the Baggiolini, the Eichhorn and Lorenz and the BBCH system. The author describes that the Eichhorn and Lorenz system (E-L system) covers the stages from 'winter bud' to "end of leaf fall', totaling 22 stages of phenological development, and permitting the insertion of intermediate stages, reason for what this system is the most common for the evaluation of the grapevines phenology.

The identification of the phenological stage of a grapevine is essential to make decisions in relation to the management of the vineyard, such as to know the best periods for cultural operations (pruning, harvesting, etc.), or even to the conduction of

experiments that take the phenology of these plants as one of the measurements (Dry, 2000).

Besides the observation of the development of the grapevines, the fruitfulness measurement of the vines is essential to have an idea of the management have to be done in a grape production (Boss *et al.*, 2003). According to Crane et al. (2012), the fruitfulness level of a plant may be influenced by the genetic background of the plants, horticultural practices and by environmental conditions.

Dry, (2000) states that the fruitfulness measurement takes into consideration the number of shoots per node and the number of bunches per shoot. However, according to Sommer et al. (2000), the fruitfulness also depends on the type of shoot that is presented on the vine nodes. The authors point out that the nodes are formed by compound buds which have primary, secondary and in some case tertiary buds. The authors describe that shoots from the primary buds are more fruitful than those formed by secondary buds. Reason for what the spur pruning is necessary in some occasions.

In this paper, the phenological development and fruitfulness potential of the table grape variety *V. vinifera* Carolina Black Rose is evaluated and compared with the phenological development and fruitfulness of Sultanas (*V. vinifera* sp.), cultivated in South Australia in the year 2014. The data collected were statistically analyzed to determine whether there are any differences in phenological development and fruitfulness between these varieties or not.

Methods

The experiment was conducted at a grape farm located in the region of Adelaide Hills, Adelaide, South Australia (coordinates 34°52'17.1" South and 138°51'31.2" East) where the fruitfulness potential of the table grape variety Carolina Black Rose was measured and compared with the fruitfulness level of Sultanas.

Primary, eleven nodes of 10 grapevines for both varieties (Carolina Black Rose and Sultanas) were selected and analyzed in accordance with their phenological development from winter bud stage to inflorescence formation. The measurement of phenological development of the vines consisted of the daily observation of the growth of the two varieties, which were exposed to same cultural practices, such as cane pruning, daily irrigation, and application of fertilizers. The development of the vines was based on when more than 50% of the shoots reached stages 4 and 12, and also by the quantity of nodes at each stage on the recorded days.

The fruitfulness potential of the vines was measured just after vine shoots had reached the stage 12, the moment when all formed inflorescences are already clear on the vine. Then, information related to the type of shoots (primary or secondary shoot) present at each node and the quantity of bunches at each shoot were recorded during experimentation.

The data presentation and analysis consist of the mean of shoots per node, bunches per node and bunches per shoot for both varieties, Carolina Black Rose and Sultanas. These variables are crucial for fruitfulness potential analysis of the grapevines. Finally, the results for Carolina Black Rose and Sultanas were compared by ANOVA at 5% of probability.

Results and discussion

After periodic observation, the vine Carolina Back Rose variety presented 15 days between stages 4 and 12, while the Sultana variety presented 13 days between same stages. In 2014, both varieties reached stage 4 in the second week of September, what indicates that the appearing period of the first visible leaf tissue is similar as to Carolina Black Rose as to Sultanas. In addition, the reaching of stage 12 where the shoots are around 10 cm and with 5 separated leaves, happened at the end of September also for both varieties, what suggests that both plants have similar phenological characteristics.

Carolina Black Rose does not differ of Sultanas in relation to phenological development mainly because that the field conditions, such as pruning time, weather, irrigation and fertilizing on the vineyard area, were the same for all varieties. According to Crane et al. (2012), the genetic characteristics of both plants should influence phenology, however it does not seem to be an influence for Carolina Black Rose and Sultanas, once they presented same time interval between stages 4 and 12, indicating that the cultural practice of pruning is an influence on the development of vines.

Fruitfulness potential results for Carolina Black Rose and Sultanas are presented in tables 1 and 2. Table 1 expresses the quantity of nodes presenting primary and secondary shoots, as well as the quantity of nodes with no shoots.

Table 1. Mean and standard deviation of nodes presenting primary, secondary and with no shoots for Carolina Black Rose and Sultana varieties in 2014.

Variety	Primary shoot	Secondary Shoots	No Shoots
Carolina Black Rose	10,5 ± 0,87	0,75 ± 0,83	0,5 ± 0,87
Sultanas	9,5 ± 1,12	0,75 ± 0,83	1,25 ± 1,09
P-value	$0,2666^{NS}$	1^{NS}	$0,3867^{NS}$

Legend: Mean and standard deviation obtained from a total of 10 grapevines, containing 4 canes and 11 nodes, for each variety (Carolina Black Rose and Sultana). The letters 'NS' above P-values mean that there is no statistical difference between the analyzed varieties.

The variety Carolina Black Rose presented a mean of 10,5 nodes containing primary shoots while sultanas presented a mean of 9,5 nodes with primary shoots. Despite this difference, both values are not significantly different. The number of nodes with secondary shoots is similar for the two varieties, around 0,75 nodes per grapevine.

In relation to nodes with no shoots, the variety Carolina Black Rose presented a mean of just 0,5 nodes while sultanas presented a mean of 1,25 nodes with no shoots. Similar to what happened to the primary shoots, the number of nodes with no shoots does not differ between both species.

Although both varieties do not present statistical differences, Carolina Black Rose presented a higher quantity of nodes with primary shoots, and also a higher quantity of bunches per node and bunches per shoot than the Sultanas. This can be explained by the fact that Sultanas have lower bud fruitfulness at the basal nodes (Sommer et al., 2000), increasing at more distal nodes, while the Carolina Black Rose variety presented a good bud bursting and fruitfulness at both basal and distal nodes, what influences on the development of the bunches.

The fact of presenting a higher quantity of primary shoots indicates that the Carolina Black Rose may present a better quality bunches than the sultanas. In addition, Sultanas presented more nodes without shoots than Carolina, that even not presenting statistical differences may produce a lower quantity of bunches.

The table 2 shows that Carolina Black Rose variety presents a higher quantity of shoots per node than the sultanas. Same is observed for bunches/shoot and Bunches/node results.

Table 2. Mean and standard deviation of shoots per node, bunches per shoot and bunches per node for the grape table varieties Carolina Black Rose and Sultana in 2014.

Variety	Shoots/Node	Bunches/Shoot	Bunches/Node
Carolina Black Rose	1,02 ± 0,13	1,21 ± 0,18	1,25 ± 0,27
Sultanas	0,91 ± 0,11	0,90 ± 0,26	0,80 ± 0,15
P-value	$0,303^{NS}$	$0,137^{NS}$	$0,042^{NS}$

Legend: Mean and standard deviation obtained from a total of 10 grapevines, containing 4 canes and 11 nodes, for each variety (Carolina Black Rose and Sultana). The letters 'NS' above P-values mean that there is no statistical difference between the analyzed varieties.

Carolina Black Rose presents a mean of 1,02 shoots per node against 0,91 for Sultanas. The table variety Carolina Black Rose also presented a higher number of bunches per shoot (mean of 1,21 bunches) and Bunches per node (1,25 bunches) when compared to Sultanas, which has presented a mean of 0,90 bunches per shoot and 0,80 bunches per node. Despite the differences, the numbers of shoots per node, bunches per shoot and bunches per node do not differ between both varieties.

These numbers indicate that Carolina may present better productivity than Sultanas in relation to the total of bunches per grapevine. However, Sultanas is closely as productive as Carolina, once both varieties do not differ by statistical analysis.

After further observation of results, cane pruning of both varieties Carolina Black Rose and Sultanas, are necessary for a good vine development (Buttrose, 1970). According to Gray and Coombe, (2009) grapevines may use their reserves of nutrients and absorption for meristem development and growth, instead of using it for bunches and berries development. Hence, with cane pruning and harvesting of shoots with no bunches, the reserves of the plants can be directed only for bunches and berries development, consequently increasing the fruitfulness potential of both varieties.

Conclusion

Carolina Black Rose and Sultanas presented similar phenological development mainly because of the field conditions of irrigation and fertilization, and also because of the cultural procedures of cane pruning at similar days. However, Carolina Black Rose is expected to present better quality bunches than Sultanas by the fact that this variety presents more primary shoots. In fact, cane pruning seems to be a good cultural practice for increasing fruitfulness potential of both Carolina Black Rose and Sultanas varieties in South Australia.

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