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AGROMETEOROLOGY - Article

Plant parameters and must composition of 'Syrah' grapevine cultivated under sequential summer and winter growing seasons

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ABSTRACT: Plant variables and must physicochemical properties were evaluated for the grapevine 'Syrah' cultivated in sequential growing seasons (summer and winter) from 2011 to 2015. The vines were trellised in vertical shoot position, grafted on Paulsen 1103, with approximate density of 5,800 plants·ha^{-1}. They were grown under plastic overhead cover. The experimental design was completely randomized, and the following variables were measured at the harvest: number of branches, number of clusters, cluster weight and yield, soluble solids content, pH, and titratable acidity. The highest values of yield, cluster weight, and titratable acidity were observed during the summer growing season, while the highest values of soluble solids content and pH were observed during winter. These results suggest that the grapes harvested during the winter show physicochemical characteristics more suitable than those observed during the summer crops for winemaking purposes.

Key words: *Vitis* spp., soluble solids, titratable acidity, wine grape.

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INTRODUCTION

Viticulture in São Paulo State (Brazil) is based on the production of rustic table grapes as well as on the production of grapes for juice or wine. Recently, rural tourism has increased the demand for high-quality wines obtained from fine wine grapes. In this view, the 'Syrah' grapevine has been used because of its adaptability to warm regions (Orlando et al. 2008). This grapevine is also capable of presenting high content of soluble solids obtained in the southern region of Minas Gerais State (Mota et al. 2010; Fávero et al. 2008; Dias et al. 2012) and in the northeast region of the São Paulo State (Regina et al. 2011).

However, during the usual grapevine cycle, induced by the regional climate (pruning in August and harvest in January), the grape maturation period and harvest occur during the rainy months, limiting the sugar accumulation in the berries (Amorim et al. 2005; Mota et al. 2010; Fávero et al. 2008; Regina et al. 2006; Santos et al. 2011). It is also known that the rainy season in southeastern Brazil (November to March) may also negatively affect grape quality because of its influence on the phenological stages of cluster development, maturation, and harvest (Regina et al. 2011). This feature is particularly relevant for growers who produce fine wines (Regina et al. 2011).

Therefore, the displacement of the grapevine production cycle, known as double pruning or extemporaneous pruning (pruning in January-February and harvest in July), allows harvesting during the dry months (Amorim et al. 2005; Regina et al. 2011), favoring the grape ripening process. Also, according to Regina et al. (2011), the management of extemporaneous pruning, in the southeast of the State of São Paulo, tends to allow considerable oenological gain for those growers targeting high-quality wines.

The extemporaneous pruning has been used successfully in southern Minas Gerais State, where several authors (Amorim et al. 2005; Fávero et al. 2008; Mota et al. 2010) reported high soluble solids for the 'Syrah' grapevine. Also, in the State of São Paulo, Regina et al. (2011) obtained values of 24 °Brix for 'Syrah' harvested from June to July (dry months; northeast of São Paulo), while Santos et al. (2011) reported values up to 21 °Brix in the eastern region of the state. Moreover, Sato et al. (2011), in Paraná State, obtained lower values of soluble solids content (from 14 to 15 °Brix) for 'Syrah' produced in the dry season.

Despite of the above-mentioned advantages, the production of grapes in extemporaneous pruning system induces the vegetative growth during the rainy months. This potentially increases the occurrence of fungal diseases that may affect the yield. Several field experiments have been carried out with grapevines grown under plastic overhead cover in different regions of the country in order to reduce the use of pesticides under the wet conditions of this season (Chavarria et al. 2007; Mota et al. 2010).

Another drawback of extemporaneous pruning of the 'Syrah' grapevine is related to the production system currently recommended to the growers. According to this recommendation, during the winter (August), the growers should perform spur pruning leaving 2 buds in the shoot and remove all clusters to allow just vegetative growth. After this, a second pruning (January/February) is also recommended (Fávero et al. 2008; Sato et al. 2011; Santos et al. 2011). This system leads to rising costs due to summer growing season when no clusters are left for production. Therefore, we assume that it is important to allow the vines to produce grapes in 2 different/sequential cycles resulting in 2 harvests each year. Therefore, a field experiment was carried out aiming at characterizing the productive performance and the physicochemical must properties of the 'Syrah' grapevine grown under protected cultivation in sequential crop, harvested during summer and winter seasons.

MATERIAL AND METHODS

The experiment was carried out in the vineyard of 'Syrah' trained in vertical shoot position system and grown under protected cultivation (waterproof plastic with 150 micra thick) located in Vinhedo, São Paulo State, Brazil (lat 23°03′48″S; long 46°57′30″W; and altitude of 720 m). According to Köppen classification system, the regional climate ranges from Cfb (the lowest areas) to Cfa (the highest areas). The shoots of the vines were trained vertically and supported by 4 strands of wire in sequential crops of summer and winter (2011 to 2015). The vines were grafted on Paulsen 1103 rootstock and conducted with bilateral cordon. The spacing between rows was 1.7 m and the space between plants was 1.0 m, representing an approximate density of 5,800 plants per hectare.

During the summer growing season, the spur pruning was carried out leaving 2 buds per cane during the month of August, and harvest occurred during the months of January and February. For the winter growing season, the pruning was performed at the height of the second supporting wire →

during the month of February displacing harvest for the months of July and August. For both summer and winter crops, only 2 buds per cane were stimulated with Dormex® at a concentration of 4%.

Weekly phenological evaluations were performed in 10 plants randomly distributed in the vineyard. The scale proposed by Lorenz et al. (1995) was applied to establish the dates of flowering, maturity onset (veraison), and harvest.

During the maturation, 120 berry grapes were weekly sampled. The berries were extracted from the top, middle, and bottom of the clusters, following a ratio 1/2/1, respectively. The sample was divided into 4 sub-samples for evaluations of total soluble solids (TSS; digital refractometer — 0 – 32 °Brix scale); pH (bench pH meter); titratable acidity (ATT) obtained by must titration with 0.1 N NaOH solution until pH = 8.2, and the results were expressed in meq·L^{-1}. At harvest, it was evaluated the number of canes and clusters per plant in 30 grapevines randomly distributed in the vineyard. In addition, 30 clusters were collected to evaluate cluster weight. Average cluster weight and number of clusters per plant were used to estimate the final yield.

The plant variables and must physicochemical measurements were subjected to analysis of variance (ANOVA) and the average values, compared by t-test at 5% significance level, assuming equal variances in order to compare the summer and winter crops. The soluble solids content and titratable acidity values were fitted to 2nd-degree polynomial equations as a function of the number of days after pruning. The performance of this 2nd-degree equation as well as the significance of its parameters, estimated by the least square method, were assessed by both t- and F-test at the 5% level. All analyses were carried out using the R software (https://www.r-project.org).

RESULTS AND DISCUSSION

Table 1 and Figure 1 depict the plant variables measured at harvest for sequential summer and winter growing seasons. According to the Shapiro-Wilk test (Wu et al. 2007), the data are normally distributed. The t-test indicated significant differences in the phytotechnical parameters when the summer and winter seasons were compared. There was no statistical difference in the number of branches per plant, indicating uniformity in the conduction of the vineyard, once shoot thinning left one branch per spur. Cluster weight values varied between 145.1 and 163.3 g for summer crop and from 68.1 to 148.4 g for the winter growing season. Average values of 151.4 and 112.1 g were obtained for the summer and winter crop, respectively. According to the t-test, these 2 latter values are statistically different. The average number of clusters per plant was statistically different in respect to seasons. It was observed that more clusters were produced in summer crop (14.5) when compared to winter (13.0). The growing season also significantly affected the yield at 5% level (2.19 kg·plant^{-1} for the summer and 1.50 kg·plant^{-1} for the winter growing season). In addition, the results suggest that the rainfall amounts observed during the different growing seasons affected the cluster weight and yield. In order to provide further information regarding the seasonality of the variables, Figure 1 depicts the differences observed between summer and winter crops. The cluster weight and yield were compared to the amount of rainfall from flowering to the beginning of maturation. This period corresponds to the growth of berries and is critical for lack of soil water availability. According to Santos et al. (2011), →

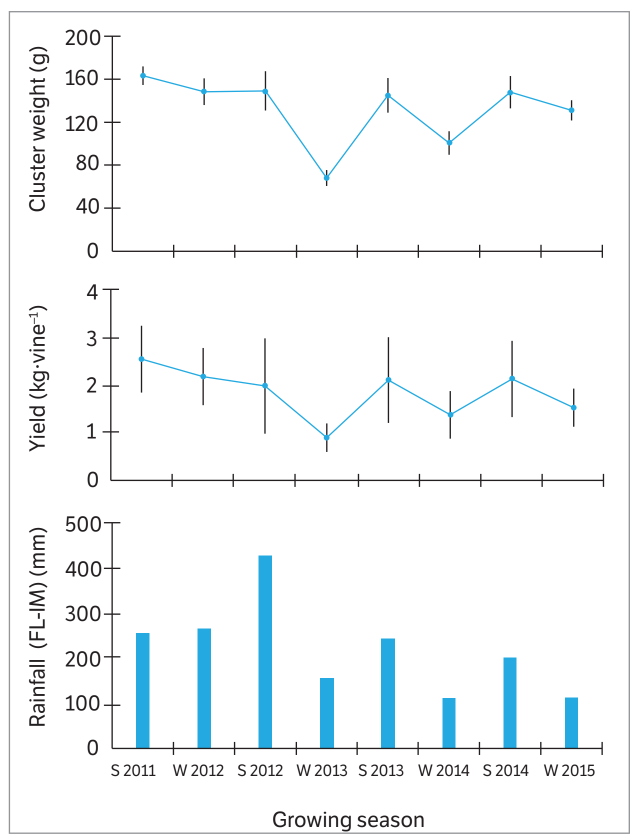

Figure 1. Cluster weight, yield, and amount of rainfall from flowering to the beginning of maturation (FL – IM) for 'Syrah' grapevine grown in sequential summer (S) and winter (W) crops in Vinhedo, São Paulo State, Brazil.

during the winter season, the formation of berries occurs under decreasing water availability in comparison to summer cultivation when the opposite occurs, i.e. there is increasing water storage as function of rainfall.

The results depicted in Figure 1 allow us to verify that the rainfall amounts affect both cluster weight and yield (Figure 1) It can be noted that, during the winter season of 2012, the unexpected high rainfall amount increased the yield leading to average cluster weight of 148.4 g. This inference is consistent with Mota et al. (2010) that also reported large cluster berries during the summer induced by high rainfall amount observed between flowering and the beginning of maturation.

The values of cluster weight of this field experiment for 'Syrah' during the summer crop were lower than those reported by Santos et al. (2011) for the region of Jundiaí, São Paulo State (199 g). In the case of winter crop, the cluster weight of this study was lower than that observed by Amorim et al. (2005) which reported values of 160 g for 'Syrah' in the southern region of Minas Gerais and lower than those observed by Dias et al. (2012) (161 – 212 g) during winter cycle in the same region. On the other hand, the values of this study were similar to those observed by Fávero et al. (2008), also in southern Minas Gerais State, which related the value of 111.2 g for cluster weight. In the case of winter crop, it should be considered that the authors who worked in the south of Minas Gerais removed all clusters during the summer crop (Amorim et al. 2005; Fávero et al. 2008) allowing the plants to accumulate more carbohydrates during the summer growing season and expressing higher yield in the winter cycle. In the present study, cluster thinning was not carried out for the sequential seasons of summer and winter.

Yield values followed the same pattern as the cluster weight, showing significant differences between summer and winter crops (Table 1). The average yield was 2.19 and 1.50 kg·plant^{-1}, respectively, for summer and winter. These values observed in the summer crop were lower than those of Santos et al. (2011) for 'Syrah' in Jundiaí, probably because from 2 to 3 branches per spur were left, while, in the present experiment, it was maintained only 1 branch per spur. The values of yield for the winter crop were similar to those reported by Santos et al. (2011) and lower than that observed by Amorim et al. (2005) for 'Syrah' in autumn-winter cycle in the southern region of Minas Gerais.

The average yields for the different seasons, considering a population of 5,800 vines per hectare, were 12.87 and 8.80 t·ha^{-1}, respectively, for the summer and winter crops. These values can be considered favorable for producing fine quality wines from 'Syrah' (Silva et al. 2009). The average yield for the winter season was similar to that reported by Fávero et al. (2008), which varied from 6.15 to 7.70 t·ha^{-1} for different years in the location of Três Corações, Minas Gerais State. According to these authors, the use of extemporaneous pruning is feasible in southern Minas Gerais for yields equal to or higher than 7 t·ha^{-1}. Consequently, the practice of double pruning can be regarded as feasible in the region of Vinhedo.

The Shapiro-Wilk test indicated that must physicochemical variables are normally distributed. In addition, it was verified that the average values of these variables, observed during summer and winter season, differ from each other at the 5% significance level. The highest soluble solids content was observed in the winter crops (21.0 °Brix) while the lowest (18.0 °Brix), in the summer crops. This reduction of soluble solids in the summer season can be explained by the occurrence of high rainfall amounts (Fávero et al. 2008) that occurred 10 days before harvesting, as shown in Figure 2. In this view, Santos et al. (2011) and Regina et al. (2011) indicated that maturation and harvest during rainy months do not favor sugar accumulation in the berries. The soluble solids values observed in the summer crop were 2 °Brix higher than those →

Table 1. Plant parameters for the 'Syrah' grapevine grown in vertical shoot position trellis under overhead plastic cover during summer and winter sequential crops in Vinhedo, São Paulo State, Brazil.

Season (year)	Cluster weight (g)	Shoot vine^{-1}	Cluster vine^{-1}	Yield (kg·vine^{-1})
Summer (2011)	163.3	11.8	15.6	2.55
Winter (2012)	148.4	12.4	14.7	2.18
Summer (2012)	149.2	11.7	13.3	1.98
Winter (2013)	68.1	11.5	13.2	0.90
Summer (2013)	145.1	11.5	14.5	2.11
Winter (2014)	100.7	11.0	13.7	1.38
Summer (2014)	148.0	11.2	14.4	2.13
Winter (2015)	131.1	11.8	10.5	1.50
Mean summer*	151.4 a	11.6 a	14.5 a	2.19 a
Mean winter*	112.1 b	11.7 a	13.0 b	1.50 b

*Means followed by the same letter in the column do not statistically differ at 5% of significance.

reported by Santos et al. (2011), in the State of São Paulo, and by Mota et al. (2010) in the State of Minas Gerais. For the winter crops, the soluble solids values were similar to those observed by these latter studies and to those reported by Amorim et al. (2005), Mota et al. (2010), and Dias et al. (2012) for 'Syrah' in southern Minas Gerais.

The pH values evaluated at the summer harvest were lower (3.31) than those evaluated at the winter harvest (3.36). Despite the statistical differences, pH values were very similar between the seasons (Table 2) and they can be considered suitable for winemaking given that the acceptable value is around 3.30 (Rizzon and Miele 2002). This result is consistent with Mota et al. (2010), which found pH values during summer (pH = 3.4) lower than those found in winter crops (pH = 3.6). Furthermore, for the 'Syrah' in winter crop, Dias et al. (2012) reported pH values greater than 3.5 for different years and rootstocks.

The lowest values of titratable acidity were also obtained for the winter growing season (Table 2). The seasonal average titratable acidity values of the different crops were 128 and 97 meq·L^{-1}, respectively, for summer and winter growing seasons. This result also agrees with that of Mota et al. (2010), which reported values of titratable acidity of around 87 and 98 meq·L^{-1} during summer and winter growing season, respectively. Also during winter season, Amorim et al. (2005) related values of approximately 100 meq·L^{-1} for 'Syrah' produced in extemporaneous pruning conditions in Minas Gerais. Fávero et al. (2008), in the same region, reported values between 88 and 97 meq·L^{-1} for 'Syrah' in autumn-winter cycle. Titratable acidity values close to 120 meq·L^{-1} may be regarded as suitable for winemaking (Rizzon and Miele 2002).

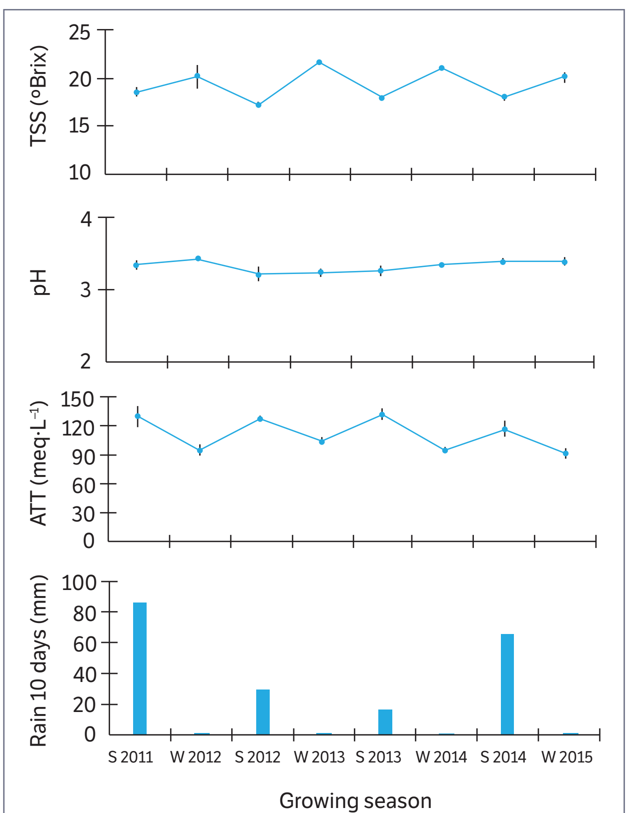

Figure 2. Total soluble solids (TSS), pH, titratable acidity (ATT), and amount of rainfall occurred 10 days before harvest for the 'Syrah' grapevine grown in sequential summer (S) and winter (W) growing seasons in Vinhedo, São Paulo State, Brazil.

Figure 3 depicts the temporal variability of the TSS and ATT values as function of the number of days after pruning; 2nd-degree polynomial models were adopted because of their high R^2 values (observed for both summer and winter crops; Figure 3) and because previous studies have already used this model. For instance, Yamamoto et al. (2011) and Silva et al. (2009) used 2nd-degree equations to model ATT values as function of days after pruning for 'BRS Clara' and 'Syrah', respectively. Both t- and F-test indicated that the coefficients of all models are significant at the 5% level.

The high R^2 values indicate the possibility of using the number of days after pruning to estimate TSS and ATT for 'Syrah' during sequential summer and winter seasons. The values of R^2 presented in Figure 3 were similar to those reported for 'Cabernet Franc' (Manfroi et al. 2004) and 'BRS Clara' (Yamamoto et al. 2011).

Table 2. Must chemical characteristics for 'Syrah' grapevine grown in vertical shoot position trellis under overhead plastic cover during summer and winter sequential crops in Vinhedo, São Paulo State, Brazil.

Season (year)	TSS (°Brix)	pH	ATT (meq·L^{-1})
Summer (2011)	18.6	3.35	131
Winter (2012)	20.2	3.43	96
Summer (2012)	17.3	3.22	129
Winter (2013)	21.7	3.24	106
Summer (2013)	18.0	3.27	133
Winter (2014)	21.1	3.35	96
Summer (2014)	18.0	3.40	118
Winter (2015)	20.8	3.41	91
Mean summer*	18.0 b	3.31 b	128 a
Mean winter*	21.0 a	3.36 a	97 b

*Means followed by the same letter in the line do not statistically differ at 5% of significance. TSS = Total soluble solids; ATT = Titratable acidity.

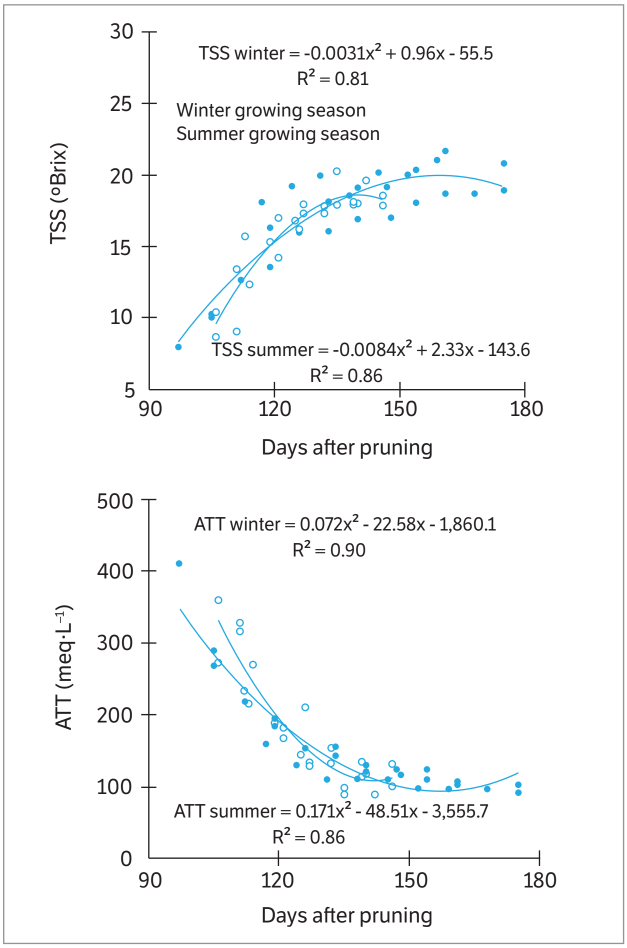

Figure 3. Relation between (a) total soluble solids (TSS), (b) titratable acidity (ATT), and days after pruning for the 'Syrah' grapevine grown in sequential summer and winter growing seasons in Vinhedo, São Paulo State, Brazil.

Naturally, due to its parabolic behavior, a 2nd-degree model presents an inflection point from which there is an inversion on the relationships between TSS and days after pruning and ATT and days after pruning. For the summer season, these limits are ~ 139 days after pruning (TSS curve) and ~ 142 days after pruning (ATT curve). For the winter season, these limits are: ~ 154 days after pruning (TSS) and ~ 157 days after pruning (ATT).

CONCLUSION

It has been found for the 'Syrah' wine grape, grown in sequential summer and winter seasons, under protected cultivation in the Vinhedo region, the following differences: (a) higher yield and cluster weight during summer crop; (b) higher levels of soluble solids for the winter season; (c) higher titratable acidity during summer crop. These results suggest that the grapes harvested during the winter show physicochemical characteristics more suitable than those observed during the summer crops for winemaking purposes. It was also found that 2nd-degree polynomial equations can be used to model soluble solids and titratable acidity as function of days after pruning.

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REFERENCES

Amorim, D. A., Fávero, A. C. and Regina, M. A. (2005). Produção extemporânea da videira cultivar Syrah, nas condições do sul de Minas Gerais. Revista Brasileira de Fruticultura, 27, 327-331. http://dx.doi.org/10.1590/S0100-29452005000200036.

Chavarria, G., Santos, H. P., Sônego, O. R., Marodin, G. A. B., Bergamaschi, H. and Cardoso, L. S. (2007). Incidência de doença e necessidade de controle em cultivo protegido de videira. Revista Brasileira de Fruticultura, 29, 477-482. http://dx.doi.org/10.1590/S0100-29452007000300014.

Dias, F. A. N., Mota, R. V., Fávero, A. C., Purgatto, E., Shiga, T. M., Souza, C. R., Pimentel, R. M. A. and Regina, M. A. (2012). Videira 'Syrah' sobre diferentes porta-enxertos em ciclo de inverno no sul de Minas Gerais. Pesquisa Agropecuária Brasileira, 47, 208-215. http://dx.doi.org/10.1590/S0100-204X2012000200009.

Fávero, A. C., Amorim, D. A., Mota, R. V., Soares, A. M. and Regina, M. A. (2008). Viabilidade de produção da videira 'Syrah', em ciclo de outono inverno, na região de Minas Gerais. Revista Brasileira de Fruticultura, 30, 685-690. http://dx.doi.org/10.1590/S0100-29452008000300021.

Lorenz, D. H., Eichhorn, K. W., Bleiholder, H., Klose, R., Meier, U. and Weber, E. (1995). Growth stages of the grapevine: phenological growth stages of the grapevine (*Vitis vinifera* L. ssp. *vinifera*) - Codes and descriptions according to the extended BBCH scale. Australian Journal of Grape and Wine Research, 1, 100-103. http://dx.doi.org/10.1111/j.1755-0238.1995.tb00085.x.

Manfroi, L., Miele, A., Rizzon, L. A., Barradas, C. I. N. and Souza, P. V. D. (2004). Evolução da maturação da uva Cabernet Franc conduzida no sistema lira aberta. Ciência e Agrotecnologia, 28, 306-313. http://dx.doi.org/10.1590/S1413-70542004000200009.

Mota, R. V., Silva, C. P. C., Fávero, A. C., Purgatto, E., Shiga, T. M. and Regina, M. A. (2010). Composição físico-química de uvas para vinho fino em ciclos de verão e inverno. Revista Brasileira de Fruticultura, 32, 1127-1137. http://dx.doi.org/10.1590/S0100-29452011005000001.

Orlando, T. G. S., Pedro Júnior, M. J., Santos, A. O. and Hernandes, J. L. (2008). Comportamento das cultivares Cabernet Sauvignon e Syrah em diferentes porta-enxertos. Ciência e Agrotecnologia, 32, 749-755. http://dx.doi.org/10.1590/S1413-70542008000300007.

Regina, M. A., Fráguas, J. C., Alvarenga, A. A., Souza, C. R., Amorim, D. A., Mota, R. V. and Fávero, A. C. (2006). Implantação e manejo do vinhedo para produção de vinhos de qualidade. Informe Agropecuário, 27, 16-31.

Regina, M. A., Mota, R. V., Fávero, A. C., Shiga, T. M., Silva, L. H. J., Souza, W. C., Novelli, F. A. D. and Souza, C. R. (2011). Caracterização físico-química de uvas viníferas cultivadas em regime de dupla-poda no nordeste do estado de São Paulo. Revista Brasileira de Viticultura e Enologia, 3, 84-92.

Rizzon, L. A. and Miele, A. (2002). Avaliação da cv. Cabernet Sauvignon para elaboração de vinho tinto. Ciência e Tecnologia de Alimentos, 22, 192-198. http://dx.doi.org/10.1590/S0101-20612002000200015.

Santos, A. O., Hernandes, J. L., Pedro Júnior, M. J. and Rolim, G. S. (2011). Parâmetros fitotécnicos e condições microclimáticas para videira vinífera conduzida sob dupla poda sequencial. Revista Brasileira de Engenharia Agrícola e Ambiental, 15, 1251-1256. http://dx.doi.org/10.1590/S1415-43662011001200006.

Sato, A. J., Jubileu, B. S., Assis, A. M. and Roberto, S. R. (2011). Fenologia, produção e composição do mosto da 'Cabernet Sauvignon' e 'Tannat' em clima subtropical. Revista Brasileira de Fruticultura, 33, 491-499. http://dx.doi.org/10.1590/S0100-29452011005000079.

Silva, L. C., Rufato, L., Kretzschmar, A. A. and Marcon Filho, J. L. (2009). Raleio de cachos em vinhedos de altitude e qualidade do vinho da cultivar Syrah. Pesquisa Agropecuária Brasileira, 44, 148-154. http://dx.doi.org/10.1590/S0100-204X2009000200006.

Yamamoto, L. Y., Assis, A. M., Morais, H., Souza, F. S., Miotto, L. C. V., Sato, A. J., Souza, R. T. and Roberto, S. R. (2011). Evolução da maturação da uva 'BRS Clara' sob cultivo protegido durante a safra fora de época. Bragantia, 70, 825-831. http://dx.doi.org/10.1590/S0006-87052011000400014.

Wu, H., Svoboda, M. D., Hayes, M. J., Wilhite, D. A. and Wen, F. (2007). Appropriate application of the Standardized Precipitation Index in arid locations and dry seasons. International Journal of Climatology, 27, 65-79. http://dx.doi.org/10.1002/joc.1371.