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The influences of rootstock and pruning seasons on productive and physicochemical traits of 'Niagara Rosada' grape

Marco Antonio Tecchio[1], Marlon Jocimar Rodrigues da Silva[1], Camilo André Pereira Contreras Sánchez[1 *], Charles Yukihiro Watanabe[1], Mara Fernandes Moura[2], Sarita Leonel[1], Adilson Pimentel Junior[1]

[1]Sao Paulo State University (Unesp), School of Agriculture, Botucatu, Universitaria Avenue, Post Code 18610-307, Botucatu, state of Sao Paulo, Brazil
[2]Agronomic Institute of Campinas (IAC), APTA Fruit centre. 1500 Luiz Pereira do Santos Avenue, Post Code 13.214-820, Jundiaí, state of Sao Paulo, Brazil

***Corresponding author: camiloapcsanchez@outlook.com**

Abstract

The current study aimed to evaluate the effect of different rootstocks ('IAC 766', 'IAC 572', 'IAC 313', 'IAC 571-6' and '106-8 Mgt') on the physicochemical quality of 'Niagara Rosada' grape under Brazilian subtropical climate. In this study, a vineyard trellising system supported three years old vines at a density of 6536 plants ha^{-1}. Therefore, evaluations consisted of three pruning seasons: two winter pruning (August 2011 and September 2012) and a summer pruning (January 2012). A complete randomized block design was conducted, subdivided into plots, with five replicates, the plots represented by 5 rootstocks and subplots by pruning seasons. We evaluated bunch number per plant; bunch, berry and rachis fresh mass; berries number per bunch; soluble solid, pH and titratable acidity content in the grape must. Results showed that 'Niagara Rosada' grafted onto 'IAC 572', presented the highest bunch mass (227g), rachis fresh mass (7.5g) and berries number per bunch (66); while 'IAC 313' rootstock performed the lowest values. Moreover, 'IAC 766' and '106-8 Mgt' rootstocks presented the highest soluble solid and titratable acidity content, due to these rootstock's precocity. Furthermore, the highest ratio between soluble solid and titratable acidity was found in 'Niagara Rosada' grafted onto 'IAC 313' and 'IAC 571-6' rootstock.

Keywords: *Vitis*, yield, physicochemical analysis, production cycle**,** pruning management.

Introduction

Brazil is the nineteenth-largest grape producer in the world, with approximately 1,505,000 tons in 79,000 ha. The states of Rio Grande do Sul, Pernambuco, Sao Paulo, Parana, Santa Catarina and Bahia are the main producers (Agrianual, 2016). The state of Sao Paulo is the third-largest producer in Brazil; and is the second-largest producer of table grape. The region of Jundiai is in the east of Sao Paulo state, producing about 67% of 'Niagara Rosada'.

In Jundiai, winter pruning is mainly performed from July to September, whereas harvesting happens from December to February. Also, summer pruning has been practiced in this region, being performed right after the traditional harvest, which increases production, as there will be more than one harvest in a year. Despite that, summer pruning allows harvesting during a low rainfall period, which decreases the number of rotten bunches and improves grape quality.

By evaluating the influence of pruning season on the cv. Niagara Branca, Souza and Fochesato (2007) reported that pruning in early November, enabled a second harvest in March or April. For these authors summer pruning is an alternative to increase the supply of grapes, without affecting their quantity and quality from first harvest. Anzanello et al. (2010) evaluated the effects of winter and green pruning on the Niagara Rosada, Niagara Branca and Concord varieties, they concluded that dry pruning associated with green pruning, yielded two harvests per season, but it was more efficient when dry pruning took place in August, while green pruning in November.

Regarding to the grapevine performance grafted onto different rootstocks, literature has plenty of studies on vegetative growth, yield, the quality of bunches and berries (Pauletto et al., 2001a,b; Terra et al., 2003; Vanden Heuvel et al., 2004; Mota et al., 2009; Tecchio et al., 2011; Rizk-Alla et al., 2011; Jogaiah et al., 2013). However, there is a paucity of evidence-based literature regarding either the area of Jundiai or 'Niagara Rosada' grafted onto different rootstocks on yield, vigor and bunch quality after winter and summer pruning.

In Taubaté, state of Sao Paulo, Pauletto et al. (2001a) found similar outcomes for yield, bunch number per plant and bunch mass in cv. Niagara Rosada grafted onto 'IAC 313', 'IAC 766' and '106-8 Mgt' rootstocks. For the quality of bunches, Pauletto et al. (2001b) found similar values for fresh mass of bunches and berries, number of berries per bunch and soluble solid content in the grape must of

'Niagara Rosada' grafted onto 'IAC 313', 'IAC 766' and '106-8Mgt' rootstocks.

In Monte Alegre do Sul, state of Sao Paulo, Terra et al. (2003) found similar values for bunch number (13.8 to 14.0) and bunch mean weight (229.5 to 236.9 g) in 'Niagara Rosada' grafted onto 'IAC 313', '106-8 Mgt', 'IAC 766' and 'IAC 572'. Mota et al. (2009) evaluated 'Niagara Rosada' production with different rootstock in Caldas, state of Minas Gerais, reported that 'IAC 572' had a higher production than 'IAC 766'; while the highest berry fresh mass was found in 'IAC 313'; but the highest soluble solid, pH and titratable acidity were found in the grape must of 'Niagara Rosada' grafted onto 'IAC 766' and '106-8 Mgt' rootstocks.

The current study aimed to evaluate the effect of different rootstocks ('IAC 766', 'IAC 572', 'IAC 313', 'IAC 571-6' and '106-8 Mgt') and pruning seasons on the physicochemical quality of 'Niagara Rosada' grape in Louveira, state of São Paulo, Brazil.

Results and Discussion

Productive components

Results indicated significant effects of rootstocks and pruning seasons on fresh mass of the bunches and rachis, as well as number of berries per bunch, besides there was no interaction between factors (Table 1).

With regards to 'Niagara Rosada' grapevine grafted onto 'IAC 572' rootstock, results showed higher values for bunch fresh mass (227g) and number of berries per bunch (66), which was significantly different from 'IAC 313' and '106-8 Mgt' rootstock (Table 1). Moreover, 'IAC 766' and 'IAC 571-6' rootstocks also presented similar outcomes of bunch mass and number of berries per bunch. By evaluating 'IAC 313', 'IAC 766' and '106-8 Mgt', Pauletto et al. (2001b) did not find any significant variations in either fresh mass of bunches and berries or number of berries per bunch.

Despite the type of rootstock used, there was no significant variations in the number of berries per plant and berry fresh mass, whereas the lowest value for rachis fresh mass was found in cv. Niagara Rosada grafted onto 'IAC 313' (Table 1).

By comparing the three pruning seasons, results showed high yield; fresh mass of bunches, berries and rachis and number of berries per bunch in the first and third pruning seasons, i.e. winter pruning. On the other hand, the lowest values were found in summer pruning. During winter pruning, the cycle length was longer, as well as higher carbohydrate accumulation in branches after winter dormancy; consequently, the highest averages for yield, bunch and berry fresh mass.

Physicochemical characteristics of the grapes

The means of pH in grape must during all pruning seasons was similar for all rootstocks (Table 2). Although pruning season had some influence, since the lowest values were observed in the first season. Sato et al. (2008) did not find any pH variations in the grape must for Isabel and BRS Rúbea varieties grafted onto 'IAC 766' and 'IAC 572'.

However, there were variations in soluble solid content of cv. Niagara Rosada, according to the rootstock, as results showed higher values in 'IAC 766' and '106-8 Mgt', due to these rootstocks' capacity to induce cropping precocity and decrease vigor in the scion, since there was low dry mass accumulation in branches that were removed by pruning (Table 2). Mota et al. (2009) also found higher soluble solid content and titratable acidity in the grape must of cv. Niagara Rosada grafted onto 'IAC 766' and '106-8 Mgt'. Such titratable acidity and soluble solid variations in grape must, according to rootstock, were also reported by Venegas and Martínez-Peniche (2001) and Rizk-Alla et al. (2011).

Regarding to the pruning seasons, high soluble solids content was found in the second season (summer pruning), because low rainfall (Figure 1) and wide thermal range (Figure 2) prior to harvesting (May and June 2012). While, the harvests of first and third pruning season happened from 7 to 14 January 2012 and 18 January to 15 February 2013, respectively. It is known that strong rainfall during harvesting reduces soluble solid content in grapes. Besides that, low yield was reported in the second pruning season, which contributed to higher soluble solids content in the grape must. For the quality of fruits, Anzanello et al. (2008) did not find any differences between harvest periods in Rio Grande do Sul. These authors found no significant differences in soluble solids and titratable acidity in fruits subjected to summer pruning, when compared with winter pruning. According to them, both harvests had plenty of sunlight throughout the ripening stage.

The highest titratable acidity was observed in grape must of cv. 'Niagara Rosada' grafted onto 'IAC 572', which only differed from 'IAC 313' and 'IAC 571-6'. In a study with 'Cabernet Sauvignon', Nuzzo and Matthews (2006) also observed the highest titratable acidity in grape must by using the most vigorous rootstock. On average, high titratable acidity in grape must was found in second season, which might be related to the wide thermal range during ripening (June 2012), when compared with periods prior to harvesting from first and third pruning season. Among factors responsible for higher acidity, hot days and cold nights stand out (Fregoni, 1998). The 'IAC 313' and 'IAC 571-6' provided high soluble solids/titratable acidity ratio, with the highest values observed in winter pruning (Table 2), due to the higher titratable acidity of the grapes.

Materials and Methods

***Experimental location and* growing conditions**

The experimental area was in Louveira (23º04'S, 46º55'W), state of Sao Paulo, Brazil. Louveira is at an altitude of 766 m, with 1,400 mm annual precipitation, 19.5ºC and 70.6% relative humidity. A vineyard trellising system supported three years old vines, with a plot spacing of 1.7 x 0.9 m, i.e. at a density of 6536 plants ha^{-1}.

Treatments and experimental design

The treatments consisted of cv. Niagara Rosada grafted on five rootstocks and three pruning seasons. The rootstocks were 'IAC 766', 'IAC 572', 'IAC 313', 'IAC 571-6' and '106-8 Mgt'. The pruning seasons evaluated consisted of two winter pruning (31/08/2011 [first] and 22/09/2012 [third] and a summer pruning (27/01/2012 [second]). In winter, one bud was left per vine. In summer pruning, it was left from 4 to 5 buds. In all seasons, 5% hydrogen cyanamide was used to break dormancy in grapevine floral buds.

This study used a complete randomized block design, subdivided into plots, with five replicates, the plots represe-

Table 1. Averages of bunch number per plant; bunch, berry and rachis fresh mass; berry number per bunch in the cv. 'Niagara Rosada' grapevine grafted onto different rootstocks over three production cycles.

Rootstocks	Bunch number per plant	Bunch fresh mass (g per bunch)	Berry fresh mass (g per berry)	Rachis fresh mass (g per rachis)	Berry number per bunch
'IAC 313'	10.9 a	191 c	4.3 a	5.3 b	54 c
'IAC 572'	12.3 a	227 a	4.2 a	7.5 a	66 a
'IAC 571-6'	11.8 a	223 ab	4.1 a	6.7 a	62 ab
'IAC 766'	11.0 a	211 abc	4.3 a	6.9 a	59 bc
'106-8 Mgt'	11.3 a	204 bc	4.2 a	6.7 a	58 bc
Pruning season					
First	10.3 b	226 b	4.8 a	7.5 b	57 b
Second	10.4 b	122 c	3.3 c	3.6 c	52 c
Third	13.7 a	286 a	4.6 b	8.9 a	71 a

Means followed by letter differ among themselves by Tukey test at 5% probability.

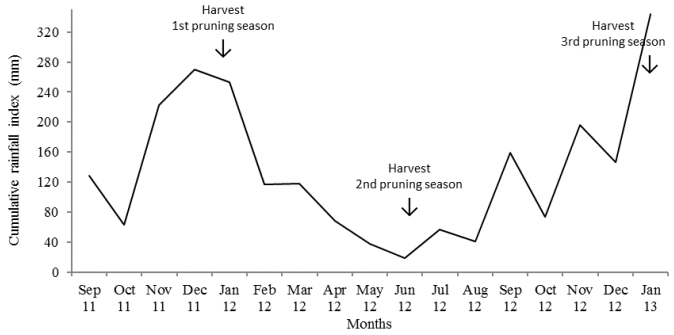

Fig 1. Cumulative rainfall index from September 2011 to January 2013. Louveira, state of Sao Paulo, Brazil, 2011/2012/2013.

Table 2. Averages of pH, soluble solid, titratable acidity and soluble solid/titratable acidity ratio in the grape must of cv. 'Niagara Rosada' grafted onto different rootstocks over three production cycles.

Rootstocks	pH	Soluble solid (°Brix)	Titratable acidity (g tartaric acid 100 g^{-1})	soluble solid/titratable acidity ratio
'IAC 313'	3.29 a	14.4 c	0.489 b	34.6 a
'IAC 572'	3.31 a	14.7 b	0.560 a	29.7 b
'IAC 571-6'	3.31 a	14.4 c	0.490 b	32.0 ab
'IAC 766'	3.33 a	15.2 a	0.524 ab	31.4 b
'106-8Mgt'	3.33 a	14.9 ab	0.520 ab	30.6 b
Pruning season				
First	3.12 b	14.1 c	0.41 b	36.0 a
Second	3.41 a	15.4 a	0.75 a	21.0 b
Third	3.41 a	14.6 b	0.39 b	37.9 a

Means followed by letter differ among themselves by Tukey test at 5% probability.

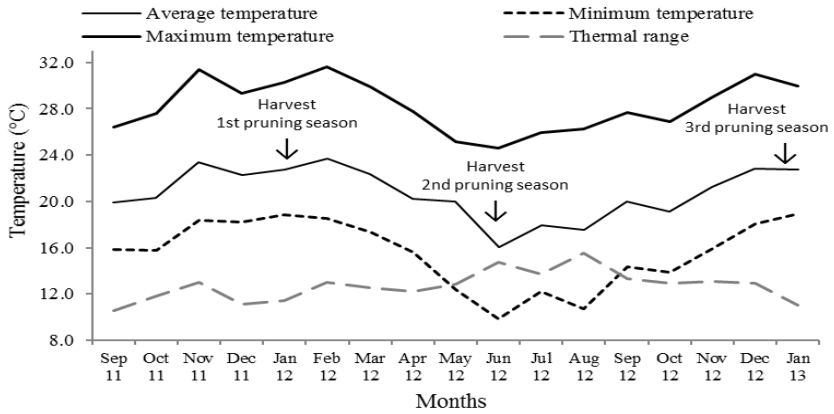

Fig 2. Minimum, average, maximum monthly temperatures, and thermal range from September 2011 to January 2013. Louveira, state of Sao Paulo, Brazil, 2011/2012/2013.

nted by 5 rootstocks and subplots by pruning seasons. Each plot contained five plants.

Harvest and measurements

The first, second and third pruning season were harvested in January and June 2012 and February 2013, respectively.

The number of bunches per plant was determined at harvest. The bunch mass was determined as function of yield per plant and bunch number per plant. After that, 10 bunches per plot were sampled for physicochemical traits. Then, berry and rachis fresh mass and berry number per bunch were evaluated. For rachis fresh mass, a semi-analytical scale 0.1 g was used. The number of berries was assessed by counting all berries in the bunches; berry fresh mass was calculated by subtracting rachis mass from bunch mass, then dividing by the total number of berries in the bunch.

From each bunch sample taken for physical analysis, 8 berries were taken for chemical analysis. The grape must was pressed from berries and evaluated for soluble solid content, pH, titratable acidity and maturation index (soluble solid/titratable acidity ratio). The content of soluble solids (SS) was determined in grape must by using Abbe manual refractometer (ATAGO®), expressed in ºBrix. The pH was determined in the grape must, with a Micronal pH meter (model B-274) at a ratio of 1:9, according to the Instituto Adolfo Lutz (1985). Titratable acidity (TA) was estimated with a laboratory ph meter (DM-22/Digimed®), being titrated with 0.1 NaOH to an endpoint of pH 8.1. The amount of titratable acid was expressed as g tartaric acid 100 g^{-1} of sample.

Statistical analysis

Data were subjected to analysis of variance (ANOVA), and when the analysis indicated statistically significance, data were compared by the Tukey's test at 5% probability**.**

Conclusions

The 'IAC 572', 'IAC 571-6' and 'IAC 766' rootstocks provided greater bunch mass and number of berries per bunch in 'Niagara Rosada' grape. Besides 'IAC 766' and '106-8 Mgt' provided the highest soluble solids content in the grape must.

The best quality of bunches was of winter pruning, compared with summer pruning. However, summer pruning provided the best quality in grape must, since presented high soluble solid and titratable acidity content.

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