ISSN 0100-2945 http://dx.doi.org/10.1590/0100-29452017828

EFFECT OF SHOOT AND BUNCH DENSITY ON YIELD AND QUALITY OF 'SUGRAONE' AND 'THOMPSON SEEDLESS' TABLE GRAPES[1]

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ABSTRACT- This study aimed to evaluate the effect of shoot and bunch density through thinning practices on yield components and quality of 'Thompson Seedless' and 'Sugraone' grapevines in the São Francisco River valley. The experiments were carried out during two growing seasons (2010 and 2012) in commercial vineyards of Lagoa Grande, state of Pernambuco, Brazil. Treatments were a split plot represented by three shoot densities and three bunch densities in a random block design. The yield of 'Thompson Seedless' grapevine was up to 25.9% higher in plants kept with 6 bunches.m^{-2}, reaching 20.7 and 27.0 kg.plant^{-1}, in the 2010 and 2012 crop years, respectively. Although effects on yield were not observed in 'Sugraone' cultivar, bunch and berry mass was higher in treatments with 5 bunches.m^{-2} and 7 shoots.m^{-2}, respectively, in the last production cycles. 'Thompson Seedless' grapes with greater berry firmness were harvested in 2012 in plants submitted to densities of 7 or 8 shoots.m^{-2}, while the contents of soluble solids and total soluble sugars were higher in grapes harvested from plants with lower shoot and bunch densities. However no effects of treatments on the contents of soluble solids were observed in 'Sugraoen' grapes. The use of 7 shoots.m^{-2} associated to 6 bunches.m^{-2} is recommended for 'Thompson Seedless' grapevines because it increased yield with no harm to fruit quality, while for 'Sugraone', densities of 7 shoots.m^{-2} and 5 bunches.m^{-2} can be used to increase the mass of bunches and berries.
Index terms: Seedless grapes. *Vitis vinifera* L.. Shoot removal. Thinning.

DENSIDADE DE RAMOS E DE CACHOS NA PRODUÇÃO E QUALIDADE DE UVAS DE MESA 'SUGRAONE' E 'THOMPSON SEEDLESS'

RESUMO - Este trabalho teve como objetivo avaliar a influência de diferentes densidades de brotos e de cachos, por meio das práticas de desbrota e desbaste, sobre os componentes de produção e de qualidade dos cachos de uvas 'Sugraone' e 'Thompson Seedless' no Vale do São Francisco. Os experimentos foram realizados durante dois ciclos de produção (2010 e 2012), em vinhedos comerciais, no município de Lagoa Grande-PE. Os tratamentos estavam distribuídos em parcelas subdivididas, representadas por três densidades de brotos e três densidades de cachos, em delineamento experimental, em blocos ao acaso. A produção em 'Thompson Seedless' foi 25,9% maior em plantas mantidas com 6 cachos.m^{-2}, alcançando 20,7 e 27,0 kg.planta^{-1}, nas colheitas de 2010 e 2012, respectivamente. Na cultivar Sugraone, não houve efeitos sobre a produção por planta, embora a massa do cacho e da baga tenham sido maiores, em, pelo menos, um ciclo de produção, respectivamente, nos tratamentos com densidade de 5 cachos.m^{-2} e 7 brotos.m^{-2}. Em 'Thompson Seedless', uvas mais firmes foram colhidas em 2012, de plantas com 7 ou 8 brotos.m^{-2}, enquanto os teores de sólidos solúveis e de açúcares solúveis totais foram maiores nas uvas colhidas de plantas com menores densidades de brotos e cachos. Entretanto, na 'Sugraone', não se observou efeito dos tratamentos sobre o teor de sólidos solúveis totais. Recomenda-se, para a cultivar Thompson Seedless, densidade de 7 brotos.m^{-2} associado a 6 cachos.m^{-2}, por favorecer a produtividade sem prejuízo da qualidade dos frutos, enquanto para a cv. Sugraone, densidades de 7 brotos.m^{-2} e 5 cachos.m^{-2} podem ser utilizadas para incrementar a massa de cachos e bagas.
Termos para indexação: Uvas sem sementes. *Vitis vinifera* L.. Desbrota. Desbaste de cachos.

[1](Paper 023-16). Received January 26, 2016. Accepted August 10, 2016.
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INTRODUCTION

The São Francisco River Valley stands out as the main region producing table grapes in Brazil, presenting a harvested area of 8,835ha in 2014 (AGRIANUAL, 2015). The main cultivars of seedless grapes are 'Sugraone' and 'Thompson Seedless' (LION et al., 2009). However, the area occupied with these cultivars has suffered a considerable reduction in the last years due to substitutions by other cultivars whose management ensures two productive harvests in the crop year and that are less susceptible to cracking of berries when harvest coincides with rainy periods.

The successful production of 'Sugraone' and 'Thompson Seedless' grapes in the São Francisco River valley depends, among other factors, on the adoption of canopy management adapted to the particularities of each cultivar. Canopy management consists of a set of techniques performed on the vine shoots, resulting in changes in the position or amount of leaves, shoots and fruits in order to obtain a desirable arrangement in the space and to reduce excessive shading (DRY, 2000). Among these techniques, shoot and bunch thinning has a great impact on the source-sink relationship and the distribution of photo assimilates between leaves and fruits (MOTA et al., 2010).

The sprouting practice also has influence on the productive potential, being able to increase the number of bunches per shoot and the final mass of these bunches (REYNOLDS et al., 1994). However, severe sprouting with the elimination of 85% of shoots near flowering increased the vigor of remnants and the incidence of necrosis in primary buds, reducing their fertility in different grapevines (DRY; COOMBE, 1994).

In general, shoot and bunch thinning is performed to improve the chemical composition of grapes by controlling the relationship between leaf area and fruit mass, a measure of source-sink balance (DAYER et al., 2013). Excessive number of bunches on the vine may reduce berry diameter and the content of soluble solids (SS) (SOMKUWAR; RAMTEKE, 2010), while lower densities per plant may, despite reducing yield, increase berry mass, SS/TA ratio (EZZAHOUANI; WILLIAMS, 2003), phenolic composition (GIL et al 2013) and vegetative vigor (KAVOOSI et al., 2009). In the 'Sangiovese' grapevine, bunch thinning increased the source: sink ratio, which increased from 0.6 to 1.2 m^2 of leaf area/kg of grape, SS and anthocyanin contents in harvest (PASTORE et al. 2011). In the set of quality-associated effects, bunch and berry thinning allows achieving more uniformly maturity indicators for grape harvest (GIL et al., 2013).

Thus, although the control of the leaves: fruits ratio through practices of shoot and bunch removal is well established and with research results in subtropical and temperate regions, there is not enough information about the responses of vines grown in tropical regions. The aim of the present work was to evaluate the effect of different shoot and bunch densities by means of sprouting and thinning practices on production components and quality of the 'Sugraone' and 'Thompson Seedless' grapes harvested in the São Francisco River valley.

MATERIAL AND METHODS

Two experiments were carried out in commercial vineyards of 'Sugraone' and 'Thompson Seedless' grapevines in the municipality of Lagoa Grande, PE (08º59'49 "S, 40º16'19" W, 345m a.s.l.) during two crop years in 2010 and 2012. The climate of the region is classified, according to Köepen, as Bswh type, which corresponds to a very hot semiarid region.

Maximum, minimum and average temperature values and global solar radiation during the experimental period were collected from the meteorological station of the Experimental Field of Bebedouro, Petrolina, PE, and are presented in Figure 1.

The vines of both grapevines were five years old and were grafted onto 'IAC 766' rootstock. A trellis-type conduction system was used, with lateral cord pruning, with 3.5m spacing between rows and 3.0m between plants and localized drip irrigation. Pruning with spurs of up to 4 buds was carried out in the first semester cycle and pruning with 10 to 12 buds was carried out in the second semester cycle. Therefore, experiments were carried out during this production cycle. The other cultural treatments were carried out according to the company's guidelines and followed recommendations for grapevine cultivation in the São Francisco River valley (LEÃO and RODRIGUES, 2009).

For 'Sugraone' grapevine, production pruning and harvest dates were, respectively, 05/30/2010 and 09/09/2010, for the 1st cycle, and 06/18/2012 and 10/08/2012, for the 2nd cycle. For 'Thompson Seedless' grapevine, pruning and harvesting were carried out, respectively, on 04/06/2010 and 08/03/2010 and on 06/18/2012 and 10/11/2012. Data were not collected in 2011 due to the abnormally reduced productivity in vineyards of grapevines under study, which were not representative of the regional production at the time.

The experimental design was randomized blocks, with four replicates and two useful plants per plot. Treatments were represented by the combination of shoot and bunch density in subdivided plots. The main plot was composed of treatments of shoot density and secondary plots of bunch density. Sprouting was performed after buds were completely budded, about 20 days after pruning, while the selection of bunches was performed when berries had around 8 to 10 mm in diameter before the thinning operation. In the 'Sugraone' grapevine, shoot densities evaluated were six shoots.m^{-2} (63 shoots.plant^{-1}); seven shoots.m^{-2} (74 shoots.plant^{-1}) and eight shoots.m^{-2} (84 shoots.plant^{-1}), while bunch densities corresponded to five bunches.m^{-2} (52 bunches.plant^{-1}), six bunches.m^{-2} (64 bunches. plant^{-1}) and seven bunches.m^{-2} (74 bunches.plant^{-1}). In the 'Thompson Seedless' grapevine, treatments for shoots were the same as those adopted for 'Sugraone', but bunch densities were adjusted to four bunches.m^{-2} (42 bunches.plant^{-1}), five bunches.m^{-2} (52 bunches.plant^{-1}) and six bunches.m^{-2} (64 bunches. plant^{-1}).

Harvesting was performed when the SS content reached 15º Brix. During harvest, the following variables were evaluated: production per plant (kg); number of bunches per plant, obtained by the average count performed in two useful plants per plot; bunch mass (g), obtained by the production / number of bunches per plant ratio.

Samples of five bunches per plot were analyzed at the Laboratory of Post-Harvest Physiology -Embrapa Semiárido, for the determination of the following fruit quality variables: berry mass (g), by weighing in semi-analytical scale; pulp firmness (N), obtained in electronic texturometer with a 2 mm diameter tip; SS content (°Brix), obtained in Abbe bench-type digital refractometer (AOAC, 1992); soluble sugar content (g.100 g^{-1}), quantified from the anthrone reactive, according to Yemn and Willis (1954); TA (% tartaric acid), determined by titration in 0.1 M NaOH solution (AOAC, 1992); and total extractable polyphenols (mg.100 g^{-1}), extracted and quantified using the Folin-Ciocalteau reagent, as recommended by Larrauri et al. (1997).

Data were submitted to analysis of variance and the comparison of means was performed by the Tukey test at 5% probability level.

RESULTS AND DISCUSSION

There was no significant interaction between treatments of shoot and bunch density for variables of production components (production per plant, number of bunches per plant, bunch and berry mass) for both cultivars and in both production cycles evaluated (Table 1).

Sprouting and thinning practices resulted in specific responses between 'Sugraone' and 'Thompson Seedless' (Table 1). For 'Sugraone' grapevine, sprouting did not affect production per plant, number of clusters and bunch mass in 2010, but in 2012, higher shoot densities favored an increase in the number of bunches per plant. In 'Thompson seedless' grapevine, no significant effects of shoot density on any of the production components were observed in both cycles evaluated. In the case of bunch density, changes resulting from the thinning practice did not result in significant responses on production per plant in 'Sugraone', although larger bunch mass was observed when only 5 bunches.m^{-2} were maintained in the production cycle of 2012. On the contrary, in the 'Thompson Seedless', with the increase in density from 4 to 6 bunches.m^{-2}, there were increases in the production per plant of the order of 18.9% and 25.9%, respectively, in 2010 and 2012, with estimated increases in yield from 16 ton.ha^{-1} to 20 ton.ha^{-1} in 2010, and from 19 ton.ha^{-1} to 26 ton.ha^{-1} in 2012. In turn, the increase in bunch density did not influence the bunch and berry mass, which shows that, in 'Thompson Seedless' grapevine, densities of 6 bunches.m^{-2} should be used to promote greater yield.

Ezzahouani and Williams (2003) did not observe influence of bunch removal associated to other practices on the production of 'Ruby Seedless' grapevine. Berkey et al. (2011) evaluated the sprouting and thinning of bunches in grapevines for the production of 'Seyval Blanc' wine and emphasized that the impact of these treatments differed between years probably due to the influence of the management of a previous cycle on the subsequent ones. Therefore, results obtained in one harvest may be due to previous management. Plant characteristics such as vigor and shoot diameter; management aspects such as length of the resting phase between cycles and climatic conditions such as solar radiation and temperatures during the differentiation of buds in the formation cycle, can determine such variations between cycles.

Considering the effect of cultural practices, studies with different grapevines pointed to increases in bunch mass when smaller bunch densities per plant are adopted (KAVOOSI et al., 2009; SOMKUWAR; RAMTEKE, 2010; GIL et al., 2013). The response is a consequence of the greater availability of photoassimilates directed to clusters in plants showing lower density. However, high bunch thinning intensity may reduce yield (FANZONE et al., 2011; AVIZCURI-INAC et al., 2013). It should be emphasized that these responses are influenced by different components of the production system.

Sase and Tambe (2015) also associated the largest bunch mass of 'Thompson Seedless' grapes with the lowest density of shoots per plant. Finally, it is considered that the total number of bunches per plant is due to a significant and additive interaction in the vineyard, including bunch sprouting and thinning (BERKEY et al., 2011).

The berry mass differed only in 'Sugraone' grapes, in 2010, being higher when smaller shoot densities per plant were adopted (Table 1). This practice can increase the efficiency of translocation of photoassimilates from leaves to berries, which would be fewer in number since there are fewer bunches in the plant. On the other hand, the lack of response reproducibility in the second cycle evaluated can be explained by differences in the number of berries per bunch and under the climatic conditions in each year, represented by higher air temperatures and global solar radiation in 2012 (Figure 1).

Regarding variables related to quality, there was no influence of shoot and bunch density on the pulp firmness of 'Sugraone' grape in both cycles studied (Table 2). For 'Thompson Seedless', pulp firmness was higher in the production cycle of 2012 (Table 3), in which firmer grapes were harvested from plants in which 7 or 8 shootes.m^{-2} were maintained.

However, other studies have associated greater pulp firmness with lower bunch density per plant. Perez et al. (1998) reported this response on 'Red Globe' grapevine. These studies considered that, with a more favorable source: sink ratio, plants with lower bunch density showed greater availability of carbohydrates and other molecules that, when incorporated to the cell walls of berries, gave them greater rigidity. Likewise, important mineral nutrients such as calcium, can be more efficiently distributed among bunches, accumulating in the cell wall. According to Kazemi et al. (2011), calcium favors the formation of links among pectic polymers, increasing the cohesion and resistance of the cell wall. However, these links brake with the ripening advancement (KELLER, 2010) at rates influenced by the environment, and shading, which decreases the temperature below leaves, can reduce them.

There was no influence of shoot and bunch density on the contents of SS and total soluble sugars in 'Sugraone' grapes in production cycle of 2010 and 2012 (Table 2). In 'Thompson Seedless' grapevine, the influence of treatments on the contents of SS and total soluble sugars varied between production cycles (Tables 3 and 4), suggesting greater interference of climatic variables such as temperatures and global solar radiation on quality components of their berries. Thus, while in the crop year of 2010, there were no significant effects of shoot and bunch density (Table 3), in 2012, the highest SS contents were observed in grapes harvested from plants with lower shoot and bunch density (Table 4). In the same year, higher levels of total soluble sugars were also related to the lower shoot density in 'Thompson Seedless' (Table 3). For both grapevines, regardless of treatment and year, SS contents, such as bunch and berry mass and TA, were consistent with export standards.

As observed in 'Sugraone', Miele and Rizzon (2013) evaluated the effect of dry pruning intensity and bunch thinning on 'Cabernet Sauvignon' grapevine and concluded that both cultural practices did not have an expressive effect on grape quality variables such as SS, pH and TA. Avizcuri-Inac et al. (2013) considered that the intensity of these responses is affected by other factors that influence growth and production. These authors exemplified that deficiencies in fruiting as a consequence of restrictive climatic conditions may limit the expected benefits to the quality of the grapes and / or their derivatives when bunch thinning is adopted.

Results similar to those observed for 'Thompson Seedless' grapevine were reported in different cultivars, highlighting an inverse relationship between number of bunches per plant and SS (EZZAHOUANI; WILLIAMS, 2003; KUNIHISA *et al*., 2003; KAVOOSI *et al*, 2009; SOMKUWAR ; RAMTEKE, 2010; BERKEY *et al*., 2011; PASTORE *et al*., 2011; MIELE; RIZZON, 2013). Dayer et al. (2013) suggested, from a study with the 'Malbec' grapevine, that bunch thinning has a greater impact on the ratio between simple and reserve sugars (starch) than the total content available in the plant. In turn, translocation maintains the pattern of being directed at growing young organs, such as berries, which accumulate more SS, particularly sugars (KUNIHISA et al., 2003). However, in plants maintained with high shoot density, high vigor leads to excessive lateral growth, competing with fruits for carbohydrates (KELLER, 2010).

Other studies have emphasized different responses between years. Greven et al. (2014)

attributed production variations in 'Sauvignon Blanc' grapevine between successive production cycles to changes in the number of bunches kept in the plant and in the mass of these bunches. The differences between production cycles can also be explained by the close relationship between SS content in the berry and climate, and under mild conditions, the levels tend to be lower. Therefore, high temperatures associated with low water availability allow the harvesting of grapes with higher SS content (VOOL et al., 2015). In this study, the production cycle of 2012, according to Figure 1, was characterized by higher temperatures and high global solar radiation, factors that must have increased the synthesis and translocation of photo assimilates to the berries of 'Thompson Seedless' grapes.

The TA of 'Sugraone' grapes harvested in the production cycle of 2010 was higher when plants were submitted to density of 8 shoots.m^{-2}, which represents lower sprouting intensity (Table 2). For the 'Thompson Seedless' grapes, TA did not differ between treatments of shoot and bunch densities in the production cycle of 2010 (Table 4), similar to results of Ezzahouani and Williams (2003), in 'Ruby Seedless' grapevine. However, in the production cycle of 2012, the significant interaction between shoot and bunch densities revealed that a greater number of shoots per m^2 results in higher TA of 'Thompson Seedless' grapes, provided that the number of bunches per m^2 is 4 or 6 (Table 4).

Under higher shoot densities, bunches may be more shaded than those with lower densities, where exposure to sunlight is greater. This condition may have reduced the temperature of 'Sugraone' and 'Thompson Seedless' grape berries in certain cycles. As the berry temperature affects metabolic processes that convert sugars into acids and secondary substrates important for fruit quality and determines the degradation rate of these acids (KELLER, 2010), it is expected that, under higher shoot densities, TA of fruits is greater. However, for this study, it was observed that differences of 0.05 or 0.06% in TA between treatments with 6 and 7 shoots.m^{-2} in 'Sugraone' grapes are not enough to change the taste of fruits. Similarly, the higher acidity of 'Thompson Seedless' grapes from treatment 6 shootes.m^{-2} and 5 bunches.m^{-2} would not have an impact on taste, unless the SS content was below that recommended for harvesting, which did not occur in this study.

According to Pastore et al. (2011), the variation in acidity would be associated with the impact of bunch thinning on ripening, particularly on SS content. The authors concluded that this practice may reduce acidity; however, as observed in 'Sangiovese' grapevine, only when the SS content is strongly and positively affected. In this situation, the lower TA of berries was explained by the malate degradation, resulting from the induction of degrading enzymes and from the synthesis of dicarboxylates / tricarboxylates membrane transporters.

Significant interaction between bunch and shoot density treatments was found in both cultivars evaluated and in both production cycles, 2010 and 2012, for the content of total extractable polyphenols (Table 5). For both cultivars, the contents of total extractable polyphenols were higher in 2012, possibly due to the climatic conditions from June to November 2012, characterized by higher temperatures and global solar radiation compared to 2010 (Figure 1). These conditions can stimulate the synthesis routes of these compounds (KELLER, 2010). However, the implication of these higher levels on grape acceptance needs to be evaluated through sensory analysis.

In 'Sugraone', higher levels were obtained in grapes harvested from plants with lower shoot density combined with lower bunch density (Table 5). It should be noted, however, that the contents of total extractable polyphenols were reduced when density of 7 shootes.m^{-2} was adopted as the bunch density increased. For the 'Thompson seedless' grapes, the higher bunch density associated with lower shoot density contributed to increase the concentration of these compounds in the production cycle of 2012 (Table 5). In 2010, high contents of total extractable polyphenols were observed associated with intermediate shoot density, but without significant differences between the extreme bunch density treatments.

Fanzone et al. (2011) pointed out that thinning promotes the biosynthesis of some phenolic compounds, such as anthocyanins, in bark, and flavonols, in seeds. However, the differences between crop years may result in greater biosynthesis of non-anthocyanin flavonoids (flavones and flavonols) in the bark and flavonols in the seeds in a given year. In addition, the total content may be higher in one year compared to the previous or next year.

Based on the information that plants of low vigor have higher contents of polyphenols, especially anthocyanins and tannins (MARTINEZ-CASASNOVAS et al., 2012), it could be considered that lower shoot densities explain the higher levels of polyphenols in 'Sugraone' grape. However, this did not occur in 'Thompson Seedless' grape.

The phenylpropanoid pathway is fed by more phenolic precursors in berry of plants that have undergone bunch thinning. Thus, the synthesis of stilbenes, isoflavones, phenolic acids and flavonoids are induced by the regulation of specific genes, which are activated after bunch thinning, inducing transcriptomic changes in berries, especially at the end of the stage that delimits changes in color and softening of grapes (PASTORE et al., 2011).

Avizcuri-Inac et al. (2013) pointed out that different grapevines respond differently to bunch thinning. The authors reported higher anthocyanin and tannin phenolic contents in grapes harvested from plants submitted to bunch thinning. According to Pastore et al. (2011), bunch thinning increases the ripening of grapes. The claim is supported by the relatively large (2019) number of highly modulated genes identified in berry of plants that have undergone bunch thinning. However, the amount of genes involved makes it clear that many other metabolic and cellular processes, in addition to maturation, are affected by this cultural practice.

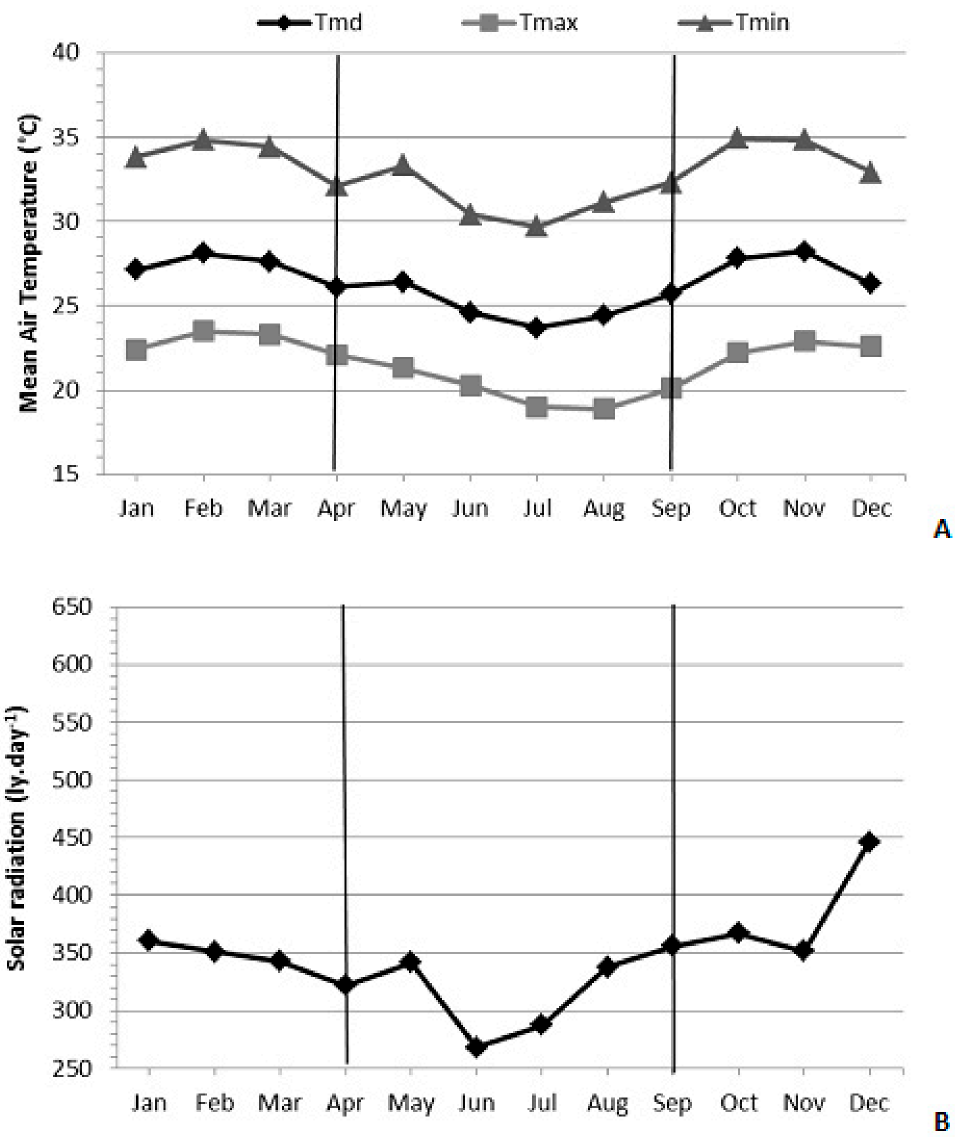

FIGURE 1- Mean, maximum and minimum temperatures in the years 2010 (A) and 2012 (C) and global solar radiation in the years 2010 (B) and 2012 (D), in Petrolina, PE. The period of the experiments is delimited between vertical lines.

TABLE 1- Production, number of bunches per plant, bunch mass and berries mass of 'Sugraone' and 'Thompson Seedless' grapevines, submitted to treatments of shoot and bunch densities, Lagoa Grande, PE, 2010 and 2012*.

Treatments	Production (Kg.plant^{-1})		Nº of Bunches		Bunch Mass (g)		Berry Mass (g)	
	2010	**2012**	**2010**	**2012**	**2010**	**2012**	**2010**	**2012**
				Sugraone				
6 shoots.m^{-2}	44.11^{ns}	34.79^{ns}	63^{ns}	63 b	633.00^{ns}	558.07^{ns}	6.06 ab	7.78^{ns}
7 shoots.m^{-2}	44.78	35.14	65	65 ab	600.33	537.20	6.56 a	7.55
8 shoots.m^{-2}	43.62	38.32	70	66 a	572.75	598.38	5.75 b	7.97
5 bunches.m^{-2}	43.57^{ns}	33.51^{ns}	62 b	53 c	602.17^{ns}	629.69 a	6.02^{ns}	7.43^{ns}
6 bunches.m^{-2}	43.32	36.27	65 ab	64 b	621.33	563.75 ab	6.41	8.06
7 bunches.m^{-2}	45.62	38.04	70 a	74 a	582.58	512.74 b	5.94	7.79
Mean	**44.17**	**36.07**	**66**	**64**	**602.03**	**565.18**	**6.12**	**7.76**
CV (%)	**18.13**	**20.72**	**10.55**	**3.33**	**15.19**	**17.99**	**9.64**	**8.96**
				Thompson Seedless				
6 shoots.m^{-2}	18.21^{ns}	22.14^{ns}	57^{ns}	54^{ns}	372.33^{ns}	413.77^{ns}	4.31^{ns}	5.7^{ns}
7 shoots.m^{-2}	19.37	23.47	55	53	378.00	446.72	4.34	5.68
8 shoots.m^{-2}	18.84	24.39	54	54	367.92	451.39	4.38	5.53
4 bunches.m^{-2}	16.82 b	20.03 b	49 c	44 c	382.58^{ns}	455.11^{ns}	4.44^{ns}	5.86^{ns}
5 bunches.m^{-2}	18.97 ab	22.79 ab	56 b	54 b	365.67	422.53	4.48	5.55
6 bunches.m^{-2}	20.75 a	27.02 a	62 a	62 a	369.27	437.69	4.12	5.53
Mean	**18.79**	**23.37**	**56**	**53**	**372.60**	**437.96**	**4.34**	**5.65**
CV (%)	**19.72**	**17.55**	**8.59**	**10.71**	**12.62**	**11.99**	**8.96**	**6.18**

*Means in column followed by the same letter do not differ by Tukey's test ($p \leq 0.05$). Ns = not significant by the F test of the analysis of variance.

TABLE 2- Firmness of the pulp, soluble solids content, total soluble sugars and titratable acidity of 'Sugraone' grapes, Lagoa Grande, PE, 2010 and 2012*.

Treatments	Firmness of the pulp (N)		Soluble solids (ºBrix)		Total soluble sugars (g.100g^{-1})		Titratable acidity (% tartaric acid)	
	2010	**2012**	**2010**	**2012**	**2010**	**2012**	**2010**	**2012**
6 shoots.m^{-2}	8.15^{ns}	9.36^{ns}	16.2^{ns}	15.3^{ns}	15.78^{ns}	14.14^{ns}	0.49 b	0.35^{ns}
7 shoots.m^{-2}	8.13	11.36	16.0	14.4	15.48	13.63	0.48 b	0.36
8 shoots.m^{-2}	7.48	9.37	15.7	14.9	15.23	13.93	0.54 a	0.34
5 bunches.m^{-2}	6.02^{ns}	9.24^{ns}	15.8^{ns}	15.2^{ns}	15.40^{ns}	14.22^{ns}	0.50^{ns}	0.34^{ns}
6 bunches.m^{-2}	5.94	9.17	16.2	14.9	15.64	14.02	0.50	0.35
7 bunches.m^{-2}	6.41	11.89	16.0	14.4	15.45	13.42	0.51	0.36
Mean	**7.92**	**10.05**	**16.0**	**14.9**	**15.50**	**14.22 a**	**0.50**	**0.35**
CV (%)	**10.75**	**5.49**	**9.52**	**5.58**	**9.44**	**14.02 a**	**8.84**	**6.49**

*Means in column followed by the same letter do not differ by Tukey's test ($p \leq 0.05$). Ns = not significant by the F test of the analysis of variance.

TABLE 3- Firmness of the pulp. soluble solids content, total soluble sugars and titratable acidity of 'Thompson Seedless' grapes, Lagoa Grande, PE, 2010 and 2012*.

Treatments	Firmness of the pulp (N)		Soluble solids (ºBrix)		Total soluble sugars (g.100g^{-1})	Titratable acidity (% tartaric acid)
	2010	**2012**	**2010**	**2012**	**2010**	**2010**
6 shoots.m^{-2}	4.00^{ns}	6.29 b	18.78^{ns}	16.21 ab	19.2^{ns}	0.64^{ns}
7 shoots.m^{-2}	4.37	7.08 a	18.77	16.95 a	19.2	0.67
8 shoots.m^{-2}	4.53	7.18 a	18.37	15.67 b	18.8	0.68
5 bunches.m^{-2}	4.30^{ns}	6.76^{ns}	18.69^{ns}	16.58^{ns}	19.1^{ns}	0.65^{ns}
6 bunches.m^{-2}	4.35	6.86	19.05	16.34	19.4	0.66
7 bunches.m^{-2}	4.25	6.92	18.18	15.91	18.6	0.68
Mean	**4.30**	**6.85**	**18.64**	**16.28**	**19.1**	**0.66**
CV (%)	**12.25**	**7.03**	**5.28**	**6.60**	**5.24**	**4.43**

*Means in column followed by the same letter do not differ by Tukey's test ($p \leq 0.05$). Ns = not significant by the F test of the analysis of variance.

TABLE 4 - Soluble solids content and titratable acidity of 'Thompson Seedless' grapes submitted to treatments with different shoots and bunches densities. Lagoa Grande. PE. 2012*.

Density of shoots	Density of Bunches		
	4 bunches.m^{-2}	**5 bunches.m^{-2}**	**6 bunches.m^{-2}**
		Soluble Solids (ºBrix)	
6 shoots.m^{-2}	19.5 aA	17.6 abA	16.4 bA
7 shoots.m^{-2}	17.4 aB	18.3 aA	18.2 aA
8 shoots.m^{-2}	16.9 aB	16.9 aA	16.7 aA
Means		**17.6**	
CV (%)		**6.29**	
		Titratable acidity (% tartaric acid)	
6 shoots.m^{-2}	0.45 bA	0.54 aA	0.44 bA
7 shoots.m^{-2}	0.47 aA	0.44 aB	0.48 aA
8 shoots.m^{-2}	0.48 aA	0.48 aAB	0.47 aA
Means		**0.47**	
CV (%)		**7.21**	

*Means followed by the same lowercase letter in the line and uppercase letter in column do not differ by Tukey's test ($p \leq 0.05$).

TABLE 5- Total extractable polyphenol contents of 'Sugraone' and 'Thompson Seedless' grapes submitted to treatments with different shoots and bunches densities, Lagoa Grande, PE, 2010 and 2012*.

Density of shoots	Density of Bunches					
	4 bunches.m^{-2}		**5 bunches.m^{-2}**		**6 bunches.m^{-2}**	
	2010	**2012**	**2010**	**2012**	**2010**	**2012**
			Sugraone			
6 shoots.m^{-2}	252.41 aA	327.20 aA	248.60 aA	351.72 aA	230.62 aA	351.85 aA
7 shoots.m^{-2}	264.46 aA	322.17 aA	194.38 bB	301.77 aB	211.07 bAB	267.00 bC
8 shoots.m^{-2}	165.02 aB	251.32 bB	178.36 aB	328.54 aAB	172.63 aB	311.50 aB
Means	**213.06**	**312.59**				
CV (%)	**7.87**	**5.57**				
			Thompson Seedless			
6 shoots.m^{-2}	**4 bunches.m^{-2}**		**5 bunches.m^{-2}**		**6 bunches.m^{-2}**	
7 shoots.m^{-2}	106.98 aB	240.54 cB	96.45 aA	280.16 bA	100.07 aB	349.46 aA
8 shoots.m^{-2}	151.78 aA	204.43 bC	109.54 bA	222.74 bB	132.02 abA	257.04 aC
6 shoots.m^{-2}	116.96 aA	278.09 bA	117.76 aA	206.40 cB	117.38 aAB	320.38 aB
7 shoots.m^{-2}	**116.55**	**262.14**				
8 shoots.m^{-2}	**11.13**	**4.17**				

*Means followed by the same lowercase letter in the line and uppercase letter in column do not differ by Tukey's test ($p \leq 0.05$).

CONCLUSIONS

The influence of shoot and bunch density on the production and quality of the grapes varied according to the grapevine cultivar and production cycle.

In 'Sugraone' grapevine, although the sprouting and bunch thinning practices did not affect production and quality, it is recommended the adoption of lower shoot and bunch densities because they have increased the bunch and berry mass and the content of total extractable polyphenols.

The sprouting and bunch thinning practices affected the production and quality attributes of Thompson Seedless grapes, and densities of 7 shoots.m^2 associated with 6 bunches.m^{-2} are recommended to obtain high yields without harm to fruit quality.

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