Canopy Management of Table Grapes Cultivar in Tropical Conditions

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Abstract: The production of some seedless table grapes under tropical conditions presents low bud fertility on the main canes and low yield, which leads to the need of pruning in the lateral shoots. The objective of this study was to evaluate the influence of the canopy management for the formation of lateral shoots associated with density of canes on the yield and quality of grapes “Sugraone” in the São Francisco Valley. The experiment was carried out over two growing seasons (2011-2012) in a commercial vineyard of Sugraone in Petrolina, Pernambuco state, Brazil. The treatments consisted of two canopy managements (shoot topping associated to elimination of lateral shoots and shoot topping and formation of lateral shoots) combined with two to three densities of canes after pruning (1.8, 2.8 and 3.8 canes/m²). The formation of “lateral shoots” increased yield and number of clusters per plant during two consecutive growing seasons, besides using 2.8 varas/m² resulted in highest yields only in 2011 growing season. The variables mass bunch, mass berry, soluble solids (SS), soluble sugar, titratable acidity (TA) and pulp firmness were not affected by treatments, while the attributes related to color, as like brightness and hue angle of the skin, and total extractable polyphenols content were influenced by canopy management, especially in the 2012 growing season. Shoot topping to induce formation of laterals shoots associated with density of 2.8 canes/m² increased the yield of seedless grapes cultivar Sugraone grown in the São Francisco Valley, not significantly affecting the quality of the grape.

Key words: Vitis vinifera L., seedless grapes, tropical viticulture.

1. Introduction

The São Francisco River Valley, in the northeastern region of Brazil, is the main producing and exporting region of table grapes in Brazil, reaching 9,703 ha harvested and a production of 315,338 tons in 2015 [1]. However, under tropical conditions, traditional seedless grapes cultivars such as “Sugraone” and “Thompson Seedless” are difficult to reach economically viable productivities, related to their low bud fertility, production instability and susceptibility to cracking of berries and diseases. In the São Francisco Valley, lateral shoots have shown greater fertility in basal buds than main canes, which led grape growers to adopt this canopy management [2]. However, many variations have been observed among the seedless grapes cultivars with a tendency of reduction in the use of these practices during the formation growing season, in order to reduce the costs of production.

Similar to the observed for other practices usually adopted for table grape growers, such as thinning, the influence of several factors on the result must be taken into account, such as the season in which the operation is carried out, the intensity of the operation, climatic conditions during the vegetative cycle of the vine, soil structure and texture, cultivar evaluated and the set of cultural practices used in the vineyard [3].

Bud load or the density of canes retained in the production pruning also affects canopy management and its definition depends on the behavior of the cultivar and the production system used. Ninety and six buds per vine were the number that provided the highest percentage of budding and yield in the cultivars Thompson Seedless and King Ruby [4]. The authors observed that, although with higher bud load, there were reductions in shoot length, leaf formation.
and leaf area. Greater masses of clusters and berries in Thompson Seedless were obtained in plants with 30 canes after pruning. However, higher yields, uniformity of berries color, higher soluble solids (SS), lower titratable acidity (TA) and higher SS/TA ratio were obtained in the treatments with 35 canes/vine [5].

Spur-pruning with two buds was evaluated in the cultivars Flame Seedless and Ruby Seedless and the treatments with greater number of spurs per plant resulted in lower budding percentages [6]. Nevertheless, the bud fertility index, as well as mass of clusters, SS and TA content was not affected by the treatments.

Despite the importance of the study to define the pruning system to be used by the grape growers, there is no information in the literature about the response of the cultivar Sugraone, especially in tropical conditions. This study evaluated the influence of canopy management on the formation of lateral shoots associated with the density of canes on the yield performance and the quality of Sugraone grapes in the São Francisco River Valley.

2. Materials and Methods

The experiment was carried out in a commercial vineyard of the cultivar Sugraone, four years old, in Lagoa Grande, state of Pernambuco (08°59'49" S; 40°16'19" W, 345 m altitude). Plants were cordon trained in an overhead trellis, spaced 3.5 m between rows and 3.0 m between plants, using drip irrigation, with vines grafted onto the rootstock “IAC 766”. The cultural practices were performed according to the grape industry’s guidelines and followed the recommendations for grapevine growing in the São Francisco Valley [7].

The work was carried out during two cycles, whose production pruning and harvest occurred, respectively, on 05/30/2011 and 09/19/2011, for the first cycle, and 06/18/2012 and 10/08/2012, for the second. Harvest dates were defined by the grower as a function of SS content and SS/TA ratio.

The treatments corresponded to management of the canopy in the formation cycle: topping and removal of lateral shoots (T1) and topping and formation of lateral shoots (T2); and density of canes after production pruning: 1.8 canes/m² (20 canes/vine) and 2.8 canes/m² (30 canes/vine). In the 2nd production cycle, an additional treatment with 3.8 canes/m² (40 canes/vine) was included.

The experiment was a split plot randomized blocks design, with four replicates and two useful plants for each replicate. The main plots were represented by the canopy managements in the formation cycle and the subplots, by the densities of canes defined in the production cycle.

The topping with the purpose of stimulating sprouting of axillary buds and the formation of lateral shoots was carried out when the shoots had about 10 leaves formed and expanded. A second topping, common to all treatments, was performed when the branches exceeded the row spacing limit, in order to open the canopy, to improve aeration and luminosity inside the vineyard.

The following variables were evaluated: production (kg/plant), number of clusters per plant and average mass of the cluster (g), obtained by the ratio production/number of clusters per plant. Samples of five clusters per plot were analyzed at Post-Harvest Physiology Laboratory of Embrapa Semiárido to determine the following fruit quality variables: (a) berry mass (g); (b) color of berries, by means of the attributes lightness, chroma and color angle of the peel, obtained in a portable digital colorimeter; (c) pulp firmness, obtained in an electronic texturometer; (d) SS content, obtained with an Abbe digital refractometer [8]; (e) total soluble sugars (g/100 g), quantified using the anthrone reagent [9]; (f) TA, determined by titration with 0.1 M NaOH solution (g/100 mL) [8]; (g) extractable polyphenols (mg/100 g) extracted and quantified using Folin-Ciocalteau reagent [10].

Data were subjected to analysis of variance and to
comparison of means by the Tukey’s test, at the level of 5% of probability.

3. Results and Discussion

There was no significant effect of the interaction between canopy management treatments during the formation cycle and densities of canes on the variables related to production, mass of clusters and berries and grape quality during the two consecutive production cycles in the cultivar Sugraone (Tables 1 and 2).

Positive responses were detected in the production of the plants that were subjected to the topping and maintenance of the lateral shoots, compared to those in which there was removal of lateral shoots, with 27% increments in the second production cycle (Table 2).

Table 1  Mean of yield components and quality of “Sugraone” grapes submitted to different canopy management treatments, Lagoa Grande, Pernambuco, Brazil, 2011 [1, 2].

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Y</th>
<th>NC</th>
<th>CM</th>
<th>BeM</th>
<th>SS</th>
<th>TSS</th>
<th>TA</th>
<th>TEP</th>
<th>F</th>
<th>L</th>
<th>C</th>
<th>°H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral shoot removal</td>
<td>33.98</td>
<td>62b</td>
<td>550.83</td>
<td>7.82</td>
<td>15.7</td>
<td>15.7</td>
<td>0.38</td>
<td>213.22</td>
<td>8.31</td>
<td>27.04</td>
<td>8.60</td>
<td>129.68</td>
</tr>
<tr>
<td>No lateral shoots removal</td>
<td>39.40</td>
<td>72a</td>
<td>547.60</td>
<td>7.72</td>
<td>15.3</td>
<td>15.3</td>
<td>0.39</td>
<td>217.12</td>
<td>8.01</td>
<td>26.74</td>
<td>8.55</td>
<td>131.90</td>
</tr>
<tr>
<td>Mean</td>
<td>36.7</td>
<td>67</td>
<td>549.21</td>
<td>7.76</td>
<td>15.5</td>
<td>15.5</td>
<td>0.39</td>
<td>215.17</td>
<td>8.16</td>
<td>26.89</td>
<td>8.58</td>
<td>127.17</td>
</tr>
<tr>
<td>CV (%)</td>
<td>19.62</td>
<td>12.50</td>
<td>9.50</td>
<td>5.05</td>
<td>5.19</td>
<td>5.19</td>
<td>0.81</td>
<td>7.02</td>
<td>9.85</td>
<td>2.39</td>
<td>12.02</td>
<td>4.40</td>
</tr>
<tr>
<td>1.8 canes/m²</td>
<td>31.91</td>
<td>46b</td>
<td>543.46</td>
<td>7.72</td>
<td>15.6</td>
<td>15.6</td>
<td>0.38</td>
<td>206.55</td>
<td>8.27</td>
<td>26.82</td>
<td>2.68</td>
<td>130.20</td>
</tr>
<tr>
<td>2.8 canes/m²</td>
<td>41.46</td>
<td>75a</td>
<td>554.97</td>
<td>7.79</td>
<td>15.3</td>
<td>15.3</td>
<td>0.40</td>
<td>223.79</td>
<td>8.04</td>
<td>26.97</td>
<td>8.47</td>
<td>131.38</td>
</tr>
</tbody>
</table>

ns: not significant by the F test (p > 0.05); means followed by the same letter do not differ by Tukey test (p ≤ 0.05).

Y: yield (kg/plant); NC: number of clusters per plant; CM: cluster mass (g); BeM: mass of the berry (g); SS: total SS (“Brix); TSS: total soluble sugars (g/100 g); TA: titratable acidity (% tartaric acid); TEP: total extractable polyphenols (mg/100 g); F: firmness of the pulp (N); L: brightness; C: chroma; °H: color peeling angle.

Table 2  Mean of yield components and quality of “Sugraone” grapes submitted to different canopy management treatments, Lagoa Grande, Pernambuco, Brazil, 2012 [1, 2].

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Y</th>
<th>NC</th>
<th>CM</th>
<th>BeM</th>
<th>SS</th>
<th>TSS</th>
<th>TA</th>
<th>TEP</th>
<th>F</th>
<th>L</th>
<th>C</th>
<th>°H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral shoot removal</td>
<td>24.51</td>
<td>46b</td>
<td>537.81</td>
<td>6.88</td>
<td>17.0</td>
<td>16.05</td>
<td>0.34</td>
<td>10.84</td>
<td>26.19</td>
<td>5.01</td>
<td>131.59</td>
<td></td>
</tr>
<tr>
<td>No lateral shoots removal</td>
<td>33.59</td>
<td>62a</td>
<td>545.66</td>
<td>6.97</td>
<td>16.5</td>
<td>15.60</td>
<td>0.34</td>
<td>10.34</td>
<td>26.23</td>
<td>5.38</td>
<td>122.36</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>29.05</td>
<td>54</td>
<td>541.73</td>
<td>6.92</td>
<td>16.8</td>
<td>15.83</td>
<td>0.34</td>
<td>10.60</td>
<td>26.21</td>
<td>5.18</td>
<td>127.17</td>
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</tr>
<tr>
<td>CV (%)</td>
<td>26.42</td>
<td>22.48</td>
<td>11.80</td>
<td>10.76</td>
<td>6.00</td>
<td>6.38</td>
<td>9.01</td>
<td>6.52</td>
<td>2.30</td>
<td>17.32</td>
<td>4.40</td>
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<tr>
<td>1.8 canes/m²</td>
<td>29.51</td>
<td>53a</td>
<td>555.63</td>
<td>7.28</td>
<td>16.6</td>
<td>15.75</td>
<td>0.33</td>
<td>10.81</td>
<td>26.78</td>
<td>4.66</td>
<td>122.76</td>
<td></td>
</tr>
<tr>
<td>2.8 canes/m²</td>
<td>28.75</td>
<td>53</td>
<td>563.69</td>
<td>6.72</td>
<td>17.2</td>
<td>16.24</td>
<td>0.34</td>
<td>10.38</td>
<td>26.19</td>
<td>5.05</td>
<td>128.60</td>
<td></td>
</tr>
<tr>
<td>3.8 canes/m²</td>
<td>28.88</td>
<td>56</td>
<td>505.89</td>
<td>6.75</td>
<td>16.3</td>
<td>15.47</td>
<td>0.34</td>
<td>10.61</td>
<td>25.57</td>
<td>5.93</td>
<td>130.58</td>
<td></td>
</tr>
</tbody>
</table>

ns: not significant by the F test (p > 0.05); means followed by the same letter do not differ by Tukey test (p ≤ 0.05).

Y: yield (kg/plant); NC: number of clusters per plant; CM: cluster mass (g); BeM: mass of the berry (g); SS: total SS (“Brix); TSS: total soluble sugars (g/100 g); TA: titratable acidity (% tartaric acid); F: firmness of the pulp (N); L: brightness; C: chroma; °H: color peeling angle.
increases of 23% and 21%, respectively, for the cited variables, in the treatment with 2.8 canes/m² (30 canes/vine) compared to 1.8 canes/m² or 20 canes/vine (Table 1). In Crimson Seedless, an increase in the bud load for 10 canes and 14 buds per cane also resulted in higher fertility of buds and production per plant [14]. However, these results were not observed in the subsequent cycle, when small differences in production and number of clusters were verified between the three treatments of cane densities (Table 2).

The average yields were estimated at 35 t/ha and 27 t/ha for the 2011 and 2012 cycles, respectively, which is above the average recorded in the São Francisco Valley for the cultivar Sugraone, which is approximately 25 t/ha [2]. The differences between each year for yield may be related to different practices of management and climatic conditions, mainly air temperatures and solar radiation that influence the differentiation of the fertile buds. In the second production cycle, the estimated average yield was higher than 32 t/ha in the treatment corresponding to the management with topping and removal of lateral shoots, and 38 t/ha, when made topping and lateral shoots were maintained, which shows the importance of this practice during the formation cycle to increase the yield of the cultivar Sugraone in the São Francisco Valley. Importantly, when the emergence is associated with the defoliation at the beginning of flowering and the thinning, it can reduce the vigor and productivity of the vine, as observed in “Merlot” [3].

There was no effect of the treatments on the cluster and berry masses in the two production cycles studied (Tables 1 and 2), but the observed values met the acceptable standard for clusters destined to export or to more demanding markets and are in agreement with the average values obtained for the cultivar Sugraone in the São Francisco Valley [2]. Also, no significant effects of shoot management or cane density on grape quality variables were observed in the production cycle of 2011, differing from the results reported in Crimson Seedless [14]. In their studies, the authors observed an increase in berry size, SS/TA ratio and anthocyanin content when using lower bud density (96 buds per vine). It is possible to increase the sugar content in the berries and the content of anthocyanins by means of a moderate pruning, which preserves a leaf area of approximately 3.0 m²/kg grapes [15]. In turn, it was observed a decrease in SS content in “Cardinal” grapes subjected to a higher density of buds per vine [16].

In the cycle of 2012, only the color of the peel differed significantly between lateral shoots management treatments (Table 2). With the formation of lateral shoots, the values of this color component were reduced, so that the grapes harvested from this treatment presented a slightly lighter green coloration. The density of canes in this cycle also significantly influenced the components lightness and color angle (Table 2). The highest density of canes, 3.8 canes/m² (40 canes/vine), resulted in berries with lower brightness (lower values of lightness of the peel) and darker green color (higher value of H), compared to treatment with 1.8 canes/m² (20 canes/vine). The response can be attributed to the greater exposure to the sun of the clusters in the plants with lower density of canes, which should promote greater degradation of pigments during the ripening of the berries. However, the observed differences were small, with little influence on the consumer purchasing decision.

The total extractable polyphenols content was not different between treatments on grapes harvested in 2011 (Table 1). Nonetheless, in 2012, the results revealed significant interaction between the treatments (Table 3). The presence of lateral shoots contributed to reducing the total extractable polyphenols content in the grape only when associated with the density of 1.8 canes/m² and 2.8 canes/m². When the highest density of canes was adopted, the content of these compounds was increased.

Some management practices promote a stronger positive effect on the content of phenolic compounds of the grape peel, compared to the seeds [17]. Under
Table 3  Total extractable polyphenols content (g/100 g) of cv. Sugraone submitted to different canopy management treatments, Lagoa Grande, Pernambuco, Brazil, 2012 [1].

<table>
<thead>
<tr>
<th>Lateral shoot treatments</th>
<th>Density of canes</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.8 canes/m²</td>
<td>2.8 canes/m²</td>
<td>3.8 canes/m²</td>
</tr>
<tr>
<td>Lateral shoot removal</td>
<td>311.11 aB</td>
<td>335.43 aA</td>
<td>216.62 bC</td>
</tr>
<tr>
<td>No lateral shoot removal</td>
<td>287.52 bA</td>
<td>263.25 bC</td>
<td>273.96 aB</td>
</tr>
<tr>
<td>Mean</td>
<td>284.13</td>
<td>CV (%) 3.92</td>
<td></td>
</tr>
</tbody>
</table>

ns: not significant by the F test ($p \leq 0.05$); means followed by the same capital letter in the line and lower case letter in the column do not differ by Tukey test ($p \leq 0.05$).

semi-arid climate conditions in Northern Greece, defoliation after flowering improves the chemical composition of the berry of some cultivars. Thus, it is possible to obtain increases in the contents of some phenolic groups, in which the main example is the anthocyanins in the peel of the red varieties, and the lower contribution of seeds to the reserve of other types, such as the tannins in the berries. In a study developed by the aforementioned authors, the observed gains did not represent a reduction in TA or increase in alcoholic levels, contributing to a better quality product.

Although the responses discussed have been observed in grape cultivars intended for the production of wines, corresponding results can be expected for those fresh consumption also. However, for the data of this study, an assessment of the conditions of exposure of the canopy to light would be necessary to relate increases in the total extractable polyphenols contents with a certain type of management of the canopy. In advance, it is recognized that conditions that generate some degree of stress in the plant, whether by light, water, oxygen, microorganisms or another factor, can encourage the synthesis of these compounds, which are also associated with defense mechanisms.

4. Conclusions

Canopy management compounds by topping with lateral shoots retained associated with the density of 2.8 canes/m² or 30 canes/vine are recommended for increasing the yield of the cultivar Sugraone in the tropical conditions of São Francisco Valley, northeastern region of Brazil. Minor effects of the treatments were observed on the attributes of grape quality.

References


