

Cane girdling and gibberellic acid effects on yield and fruit quality of (*Vitis vinifera* L.) cv. Victoria and Italia

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Abstract The effect on yield and berries quality of cane girdling and gibberellins (GA₃) application on *Vitis vinifera* L. cv. Victoria and Italia table grapes were investigated during 2015-2016 growing season in Silagiu vineyards. Gibberellins were applied during fruit set. Bunches were sprayed with GA₃ solution (6, 9 and 12 mg/l in Victoria variety and 8, 12, 15 mg l⁻¹ on Italia variety), at the end of bloom stage in each variety. Girdling was done near cane base after gibberellins application (the end of fruit set) to increase berries and accelerate ripening. Bunches were harvested in August (Victoria variety) and the second decade of September (Italia variety), when berries were well ripened. In both varieties gibberellic acid treatments and girdling influenced by climate in the growing season and ripening stage, increased the average cluster weight and berry dimensions and quality. Statistical analysis showed that berry length, diameter and weight were significantly affected in both varieties by girdling treatments in both years. It was also observed 3 -5 days earlier ripening in Victoria variety and 8-10 days earliness in Italia variety compared to the control vines.

Key words

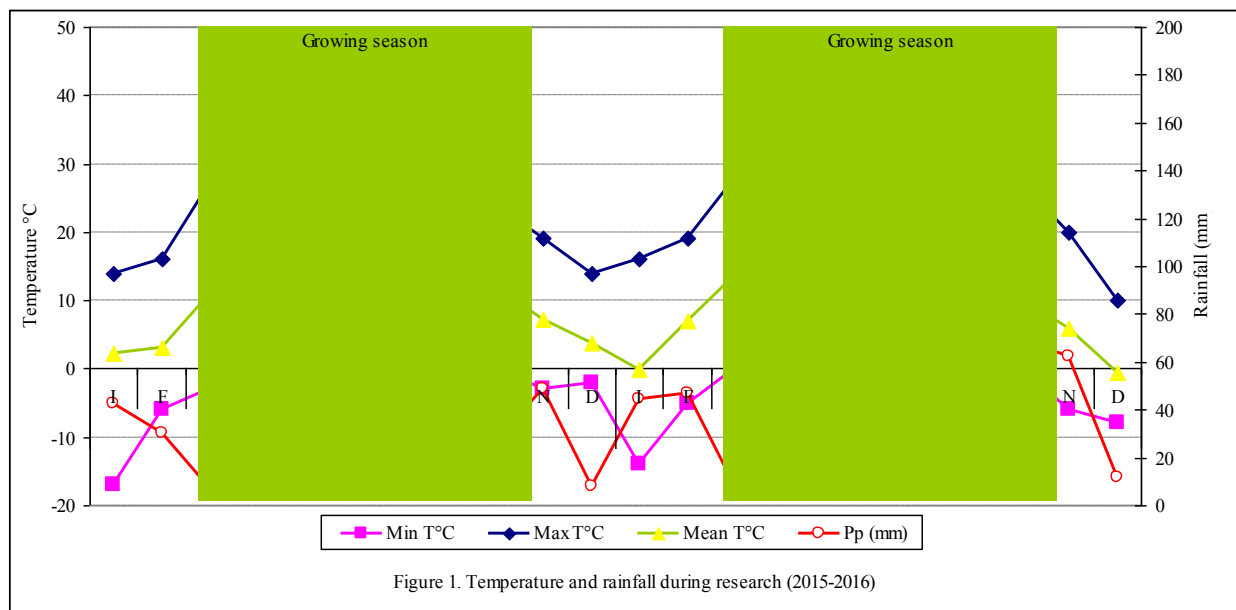
girdling, gibberellins, berry, table grapes, quality, Victoria, Italia

The diversity of our country geographic landscape offers favourable conditions for growing table grape varieties, known as more demanding of heat, hydric and sunshine hours. Recent research in Romania has shown that climate change last decades has favoured the spread of the table grape varieties from the southern area of the country, where it was located three to four decades ago, in the north-east of the country [5]. Table grapes are in the highly demanded food group, showing a trend of increasing consumption over a longer period of time [10]. Nowadays, the requirements of the consumers for table grapes are quite high, with large and intact berries, well formed, crisp, delicious taste, and uniform color, evenly spaced along the stalk [11]. Achieving constant and qualitatively superior yields of table grapes is closely linked to the application of complex agro-technical measures different from each varieties, soil, and climate conditions from the area [7]. An important and distinctive link in the technology of growing table grapes is the application of growth regulators or girdling [4]. The girdling is an operation with particularly spectacular effects on grape quality but also with negative effects on the whole plant, requiring a large amount of work (79 hours/hectare), which limits its use only in exceptional cases [11]. Girdling can be made both on the shoots or canes base with the help of special ring scissors; the blades cut the phloem and cambium bark (sometimes goes to xylem), after which the ring detaches and is removed with a knife. The ring-bark should be done moderately, since

the practice of a large number of incisions stops assimilates migration to the root system, which affects the vines vigour and endangers their life [1]. For this reason, it is not recommended to ring all the shoots or canes on a vine but only a third of them and no more often than three years [18]. Girdling canes should not be used the following year for pruning and new shoots growth [16]. Most of table grape varieties have excessive compactness, imperfection which is taken into account in the selection process. In viticulture, only gibberellins (GA₃) allow obtaining the expected effect of increasing the berry size and loose bunch and berry thinning [2]. The purpose of the investigations was to determine the influence of gibberellic acid applied in fruit setting and growing stages and accelerated ripening by girdling on the quantity and quality of production in Victoria (early ripening) and Italia (late ripening) table grape varieties, in the west of Romania during two years with variable climate.

Material and Method

Research was carried out in Silagiu vineyards on Victoria and Italia table grape variety of 8 years old, during 2015- 2016 growing seasons. Climate in this area is Mediterranean continental-temperate climate with hot and dry summers and warm winters (Figure 1).



Year 2015 was drier than 2016 with highest temperature of 38°C in August. June 2015 was medium rainfall while in 2016 June was the wettest month of the growing season. Vines from research plots were not irrigated, and rainfall influenced the cluster and berry development.

Vine training-trellis system was Guyot. Planting distance was 2.5 m between vine rows and 1.5 m between vines/row. The experiment was organized in three repetitions, with 10 vines in each plot, and the consecutive variants on the same vine row. There were three treatments and girdling in each variant plus control. Bunches were sprayed with GA₃ solution (6, 9 and 12 mg/l in Victoria variety and 8, 12, 15 mg l⁻¹ on Italia variety), during fruit set, at the end of bloom stage in each variety. Girdling was done near cane base after gibberellins application (the end of fruit set) to increase berries and accelerate ripening. Bunches were harvested in August (Victoria variety) and the second decade of September (Italia variety), when berries were well ripened. From each variant were collected four bunches and put in paper bags and in shortest time brought to the laboratory for analysis. For each experimental factor were taken 50 berries and measurements for berry weight (g), diameter (mm), bunch weight (g), total soluble solids (TSS –measured by refractometer) and total titratable acidity (TTA – mg l⁻¹ tartaric acid, by standard method). Berry length

was measured with measuring tape and the diameter was measured with a digital calliper.

Resulted data were analyzed by Graph-Pad Prism 5.01 for one way analysis of variance (ANOVA) and Microsoft XLstat 2014.5.03.

Results and Discussions

Last decades, table grape varieties, besides high-quality properties, must be resistant to diseases and pests, and in the same time is a tendency of consumers from all over the world for seedless and muscadine flavour varieties. To get a quality production, in table grape varieties should be applied various viticultural practices, such as adjusting crop load (including bunch thinning), shoots tipping, and application of growth regulators (GA₃) or girdling from time to time. The influence of gibberellic acid (GA₃) and girdling on growth and development are specific to each variety, which have different budbreak and ripening time.

The average bunch weight is a relatively steady parameter of the variety, but it may vary depending on climatic factors and cultivation technology. Analyzing the data, it was observed that the application of gibberellins led to an increase in the average weight of the grape cluster by 13.33 to 49.8% compared to the control an important indicator in the vines productivity increase (Table 1).

Table 1

Effect of gibberellins (GA₃) and girdling on grape yield and quality in cv. Victoria (2015)

GA ₃ /Girdling treatment	Yield (kg/vine)	Cluster weight (g)	Berry weight (g)	Berry length (mm)	Berry diameter (mm)	TSS (°Brix)	Titratable acidity (g/100 ml)
GA ₃ - 6 mg l ⁻¹	21.9	510	9.7	27.0	19.8	16.6	3.9
GA ₃ - 9 mg l ⁻¹	22.7	547	10.0	27.8	21.0	17.4	3.8
GA ₃ - 12 mg l ⁻¹	23.1	674	11.1	29.3	22.3	18.2	3.7
Girdling	24.2	621	10.6	28.1	21.5	18.8	3.6
Control	18.6	450	7.4	25.6	19.3	15.7	4.1

The average weight of berries is one of the main table grape quality standards. The increase in the average weight of the berries under the gibberellins effect is directly proportional to the concentration of gibberellins up to the GA₃ - 12 mg l⁻¹ variant. The best results for average weight of the berries resulted by

applying the dose of GA₃ of 9 mg l⁻¹ and 12 mg l⁻¹, which showed an increase of up to 1.43 times compared to the control in 2015 and 1.48 fold in 2016. When girdling was applied in Victoria variety during 2015 and 2016, the clusters weight more 38% than control, and 23.2% respectively (Table 1-2).

Table 2

Effect of gibberellins (GA₃) and girdling on grape yield and quality in cv. Victoria (2016)

GA ₃ /Girdling treatment	Yield (kg/vine)	Cluster weight (g)	Berry weight (g)	Berry length (mm)	Berry diameter (mm)	TSS (°Brix)	Titratable acidity (g/100 ml)
GA ₃ - 6 mg l ⁻¹	22.7	520	12.5	28.1	22.5	15.3	4.0
GA ₃ - 9 mg l ⁻¹	23.4	573	14.1	28.5	23.1	15.6	3.9
GA ₃ - 12 mg l ⁻¹	24.2	611	17.2	30.7	24.6	16.5	3.8
Girdling	24.8	599	15.8	29.0	23.4	16.9	3.7
Control	18.9	486	10.7	27.9	21.1	15.0	4.3

The data in Table 1-2 show that gibberellins directly influence berries uniformity. Due to the high content of sugars, vitamins and other useful organic matters and minerals, berries are very valuable fruits for fresh consumption. The application of gibberellins (GA₃) at 12 mg l⁻¹ led to an increase in the sugars concentration and decreased in titratable acidity, by 1.14 in 2015 and 1.16 in 2016 compared to the control and accelerated the maturation. Applying gibberellins influenced more the berries length compared to their diameter. It can be noticed that with the increasing concentrations of gibberellins (GA₃) also the concentration of sugars increased compared to the control, but not with high amplitude (1.1 °Brix in both years). Total soluble solids were highly influenced by girdling in both 2015 and 2016 in Victoria variety. Similar results were found in Sovereign Coronation variety by Reynolds and de Savigny (2004) [14]; throughout the trial, yield was not affected by GA₃ or girdling compared to the control,

but girdling increased cluster and berry weights, and decreased °Brix and TA.

Variety "Italy" is considered one of the most valuable table grape varieties. It is resistant, fertile, with large, yellow in colour, rich and flavoured berry flesh, with late ripening, in the second decade of September.

Applying gibberellins significantly increased the weight of bunches and the yield on the vine. Bunches treated with GB₃ and girdling had higher bunches weight compared to control. Girdling increase the size and bunch weight of grapes in Italy variety (Tables 3-4). Similar results were reported for this variety by Ferrara et al. (2014) [8] in Italy.

Titratable acidity was lower when girdling was applied compared to controls. In a study conducted in California on Crimson Seedless girdling, resulted in a reduction in total soluble solids [6]. In our two-year study, girdling applied after the fruit set, this effect on sugars was not found.

Table 3

Effect of gibberellins (GA₃) and girdling on grape yield and quality in cv. Italia (2015)

GA ₃ /Girdling treatment	Yield (kg/vine)	Cluster weight (g)	Berry weight (g)	Berry length (mm)	Berry diameter (mm)	TSS (°Brix)	Titratable acidity (g/100 ml)
GA ₃ - 8 mg l ⁻¹	23.9	699	10.7	28.6	24.2	17.1	4.1
GA ₃ - 12 mg l ⁻¹	24.5	711	11.0	29.9	24.6	17.4	4.0
GA ₃ - 15 mg l ⁻¹	26.1	740	11.3	30.8	24.9	17.9	3.8
Girdling	23.6	768	11.9	32.6	25.1	17.5	3.6
Control	21.4	625	9.8	27.2	23.7	16.6	4.4

Yeganeh et al. (2014) [17], in Bidaneh Sefid grape variety cultivated in Iran, found that experimental doses of GA₃ and girdling did not have significant influence on bunch weight and titratable acidity but have significant effects on berries weight and diameter, but after investigations concerning the gibberellins effects applied before blooming for thinning clusters and to increase the yield and berries quality, recommended the treatment in the future. Less significant result were found in Italia variety grown in Thailand by Nilnond and Sukumalanandana (1988)

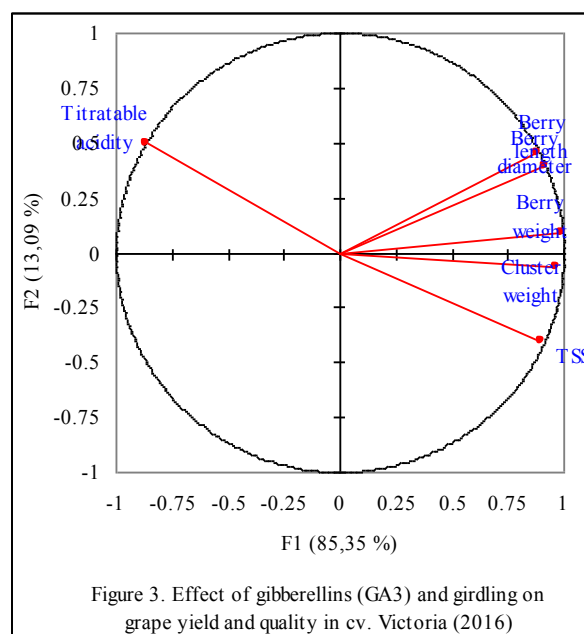
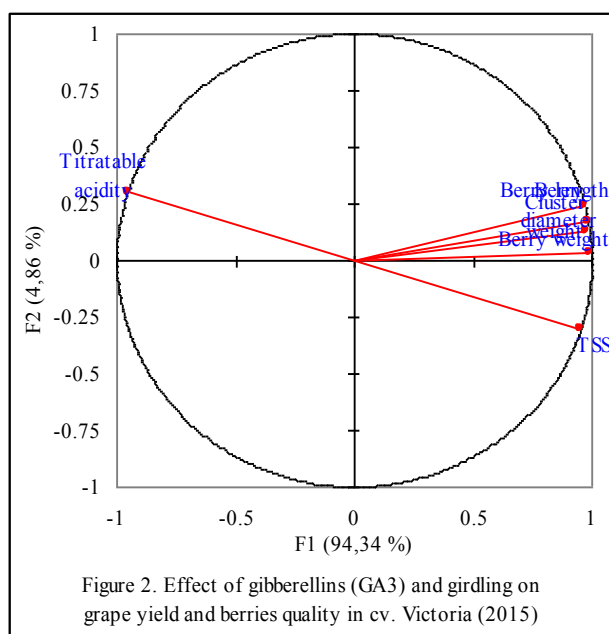
[13], after GA₃ applications (25-75 ppm), excepting some significantly effect on cluster weigh. The highest cluster weight was found for GA₃ 25 ppm (268.0 g respectively). TSS and TA were not significantly influenced by post-bloom GA₃ application and tend to be lower compared to control. Cane girdling was investigated with similar results by Soltekin and al. (2016) [15] in cv. Flame Seedless in Turkey, and found that the treatment increase berries dimensions and weight along two growing seasons.

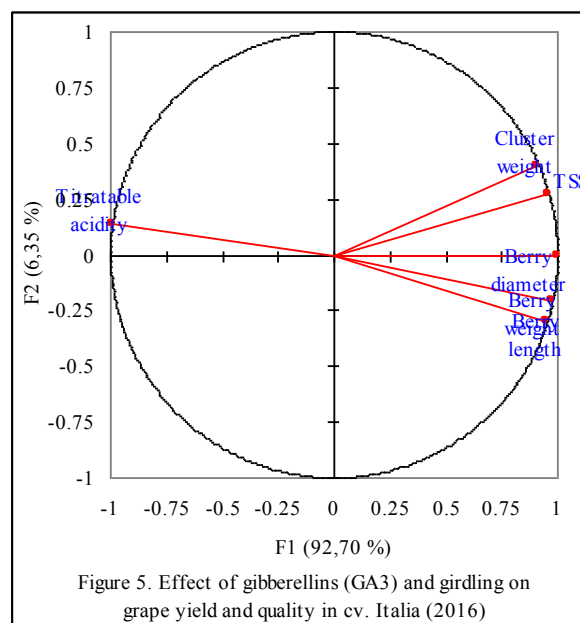
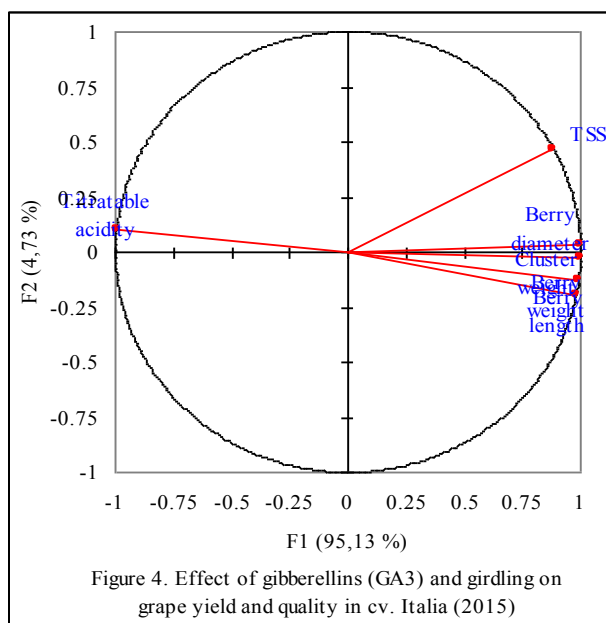
Table 4

Effect of gibberellins (GA₃) and girdling on grape yield and quality in cv. Italia (2016)							
GA ₃ /Girdling treatment	Yield (kg/vine)	Cluster weight (g)	Berry weight (g)	Berry length (mm)	Berry diameter (mm)	TSS (°Brix)	Titratable acidity (g/100 ml)
GA ₃ - 8 mg l ⁻¹	24.1	698	8.9	31.1	26.2	16.5	4.8
GA ₃ - 12 mg l ⁻¹	24.9	701	9.8	31.9	27.6	17.2	4.6
GA ₃ - 15 mg l ⁻¹	26.8	752	10.1	32.6	28.9	18.1	4.5
Girdling	24.5	849	11.2	33.2	29.1	18.7	4.3
Control	21.7	674	6.9	25.2	23.7	16.0	5.2

Studding associate treatments of girdling and gibberellins on table grapes, Coelho de Souza et al. (2005) [3], evaluate the effect of gibberellins (in five doses, from 10 to 50 mg l⁻¹) and girdling, on cv. Thompson Seedless and found out that the combination treatment of girdling and gibberellins had the best results on cluster weight, berries size and grape yield.

In figures 2-5 are shown the PCA analysis among the yield and berry quality parameters for cv. Victoria and Italia in both years of research (2015-2016). For both varieties, cluster weight, berry sizes (weight, length and diameter) and TSS are very significantly correlated. Obviously, cluster weight is positively influenced by berries weight and berry sizes.





Total soluble solids are very significantly negatively correlated with titratable acidity. Results show that if total soluble solids increases titratable acidity decrease as grape berries development progress up to the ripening stage. The same results and opinion was presented after research in commercial table grapes varieties by Muñoz-Robredo et al. (2011)[12].

Conclusions

Growing season 2015, poorer in rainfall has positively influenced the quality of grape of Victoria variety that is earlier ripening, while in 2016 the high amount of rainfall has led to the berries growth and yield in Italia variety which is late ripening. Both gibberellins (GA₃) and girdling has accelerated ripening depending on the climate of the research year. Research was carried on in only two growing seasons with climate variability, therefore is recommended to repeat the trial at least one more season to verify the results already obtained and if the treatments can be developed over time in significant differences for early ripening, and higher yields and berries quality.

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