

Evaluation of vegetative growth on several table grape cultivars under semiarid tropic conditions in Venezuela

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Abstract

The vegetative growth of twelve table grape cultivars, "Italia, Regina, Napoleón, Sultanina, Alphonse Lavallée, Red Globe, Datal, Perlón, Matilde, Michelli Palieri, Moscatel de Alejandría and Queen; grafted on "K" rootstock was studied during the three first productive cycles after planting, in El Tocuyo, Lara state, Venezuela (9° 48' N; 69° 47' W; to 630 msnm). Some horticultural characteristics were assessed taking into account different variables such as, number of nodes, trunk perimeter, pruning waste weight. The vineyard was established on vertical trellis, trained in bilateral cordon and furrow irrigated. The shoot growth of all cultivars showed an approximately sigmoidal curve in time. The greater shoot lengths were presented for cultivars Sultanina and Alphonse Lavallée; while "Moscatel of Alejandría" and "Queen" showed the less shoot length. In general, the cumulative shoot length showed a slow increase between cycles, while the total node number at the end of each cycle varied among cultivars, mostly due to their endogenous conditions. The higher trunk perimeters were observed in cultivar "Michelle Palieri" followed by "Sultanina and Napoleón", while cv "Queen" showed the minor perimeter value. The higher pruning waste weight was observed in the cvs. "Sultanina and Napoleón". The cultivar with larger values of trunk thickening and pruning weights, as "Sultanina", "Napoleón" y "Michelle Palieri" might be considered like vigorous vegetative growth cultivars.

Key words: *Vitis vinifera*, growth, cultivars

Introduction

Growth is definite, just like an irreversible increase in size of the plant, through higher levels in number and size of cells (21), which can be appreciated making mass, length, height, size, superficial area or volume measurements (30). In the case of the grape, growth can be expressed in length, number of leaves, weight, foliar area, etc. and represented by a sigmoidal curve, just like the one observed in most of vegetables (37); this curve keeps the sigmoidal tendency even when pruning treatments are applied (10). Growth analysis may contribute to evaluation of cultivars under new microclimate conditions, to establish with greater precision the most important horticultural characteristics, according to observed results.

Some authors relate length of vine shoots, thickness and length of nodes with fertility of buds (16, 19, 24), which is related to the vigor of the plant, common characteristic used to describe the capacity of growth and production of grape (14, 22, 31). Vigorous plants have vine shoots with a determined vegetative expression, over which influence external (temperature, water, mineral

elements, photoperiod) and internal conditions (hormonal and nutritional balance). Vigor also depends on genetic characteristics of the cultivar and the cleft graft. In the case of patterns, Williams and Smith (36), working with "5C Teleki, Aramon rupestri Ganzin and St. George", found out that the cultivar "Cabernet Sauvignon" showed a great vegetative growth expressed in high values of biomass and contents of N and P, in grafted plants on "Aramon rupestri Ganzin", whereas grafted plants on "St. George" obtained smaller values.

The enlargement of the trunks and the foliage formation has a noticeable influence over the increase and components of values, since trunks accumulate and form the carbohydrate used by the plant (17). The pruning weight is used as a measure for the growth of the previous cycle (29), and its value is directly related to the number of buds held by the plant (18). The objective of this research was to determine the characteristics of vegetative growth of different table grape cultivars, expressed in perimeter of the trunk, length and number of nodes per vine shoot and pruning waste weight.

Materials and methods

Location

The research was carried out in the vineyard of the Experimental Station El Tocuyo (Estación Experimental El Tocuyo) Institute of Grape,

Western University Lisandro Alvarado (Instituto de la Uva, Universidad Centroccidental Lisandro Alvarado) Lara State, Venezuela (9° 48' N y 69° 47' W, to 630 msnm). The

zone has an annual precipitation average of 600 mm, annual temperature average of 31.5°C (the highest) and 20.5°C (the lowest), respectively, with an average of 6.5 h daily of sunstroke and 17MJ/m². The experimental area have loamy soils, with a electric conductivity of 0.94 ds/m, pH of 7.8 (Slightly alkaline), with salts of carbonated calcium and magnesium, a good capacity to retain humidity and nutrients and favorable conditions of development and proliferation of roots, at ventilation and permeability (9, 26).

Vegetal material and agronomic management

For this study, table grape cultivars were used, "Italia, Regina, Napoleón, Sultanina, Alphonse Lavallée, Red Globe, Datal, Perlón, Matilde, Michelle Palieri, Moscatel de Alejandría and Queen", all of them grafted on "Criolla Negra". The cultivars come from chosen clones and propagated biotechnologically by cv. «Rausedo and Italia. But cv. "Datal" which comes from the Viticultural Center of Zulia State (Centro Vitícola del estado Zulia).

The distance of the vineyard was of 3 m between rows and 1 m between plants, generating a density of 3333 plants/ha using vertical trellis with four wires and a system of conduction trained in bilateral cordon (25). The irrigation was made along furrows and the rest of the cultural shores as fertilization, weed control, aspersions, etc. were carried out following the normal procedures of the vineyard managements.

Establishment and Formation of plants

The pattern was propagated through sticks in bags of polyethylene.

The graft of cultivars was made through the special procedure of lateral wedge and double pointer (2).

The graft was carried out when the internodes of the cleft graft, located 50 cm from the soil, reached a diameter of 1.5 and 2 cm. For conduction and formation of plants, the methodology described by Vargas and Bautista (34) was used, which is a sequence of successive prunings to conform at the end, a plant with a trunk (pattern-graft), arms and thumbs. Plants were ready to be pruned when their trunks, arms and, at least, the third part of vine shoots completed the process of lignification after its insertion, which in this case happened approx. 80 days after graft.

Statistical design

Twelve cultivars were evaluated, as treatments, under block design at random with 6 replications per treatment, using 10 plants per experimental unit for a total of 60 plants each cultivar. The information was obtained during three consecutive cycles, which began in August 2000 and finished May 2001. Duncan's multiple range test was applied using the SAS program.

Studied variables

Trunk perimeter. It was measured 4 cm over the union of the graft using a plastic metric tape measure. Measurements in centimeters were made at the end of every cycle in every plant, determining the average value for each cultivar.

Length and number of nodes, length of internodes. At the beginning of each cycle, 2 shoots were chosen in three plants of each

treatment and by repetition, for a total of 36 shoots per treatment. Measurements were carried out twice a week since born until harvest, from the base of the plant until the last formed leaf and nodes were counted acropetally until the apical internode completely differentiated; nodes were counted immediately after measuring the length of shoots. Shoots in apical position were selected. With these values was determined the average length of internodes of the evaluated cycles. Figures were represented with average data obtained by cultivars; to

make easier the comprehension, the variable was taken as the earliest, the intermediate and the latest.

Pruning waste. This indicator consisted in weighting all the wood vegetal material and the dry foliage after the pruning, for every plant of the test. The pruning waste corresponds to the vegetal material accumulated on the plant during the previous cycle, which has to be eliminated and weighted to balance the growth and development of the following cycle.

Results and discussion

Shoot Length

Every cycle began with shoots, which was practically uniform due to the irrigation after the pruning and the growth lasted from 11 to 14 days, depending on the cultivar (25). The longitudinal growth showed a tendency to a sigmoidal curve with regard to time (figure 1). The growth curve was characterized by a first slow phase after shoots appeared, then followed by a second fast phase initiated before the anthesis and lasted before the maturation of grapes; subsequently, growth was diminished during maturation period and paralyzed for the vintage. The growth curve keeps fast from before the anthesis, 30 to 39 days, it becomes slower at 60 or 70 days, from there, growth was virtually paralyzed in cv. "Regina"; in "Michelle Palieri" the average of growth keeps fast at 60 days, it becomes slower at 60 and 88 days, being virtually paralyzed; whereas, cv.

"Napoleon" shows a fast growth until day 71, then it slows down and paralyzed at day 105 (figure 1).

The growth of shoots length was higher in cultivar "Sutanina and Alphonse Lavallée" than in the rest of cultivars (table 1) during three cycles, while "Moscatel of Alejandria and Queen" showed the lowest growth in length, having significant differences between cultivars. The length of vine shoots depends on the number and length of internodes and varies with the specie and the cultivar (4, 6).

It is important to highlight that cultivar "Sutanina" showed the biggest growth in length of branches and at the same time the lowest production by plant, while, on the other side, it has been reported that high levels of harvest tend to diminish significantly the length of vine shoots (27). Vine shoots length, size of leaf and length of the floral bouquet of each vine shoot,

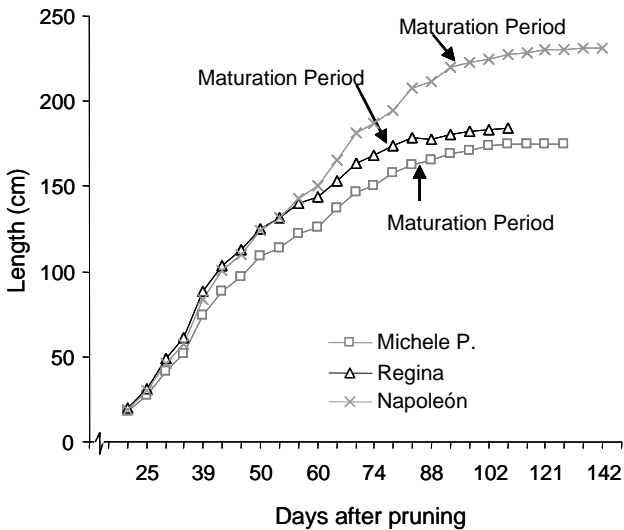


Figure 1. Longitudinal growth of branch (cm) of three table grape cultivars, represented by the earliest, the intermediate and the latest. Average of three cycles.

are directly related; therefore, small vine shoots produce less inflorescences that show less flowers and originate small bouquets (20).

Growth of vine shoots was similar to the one reported by Harpe and Visser (10) and Winkler *et al.* (37), showing at the beginning a slow phase of growth, then it accelerates until it stands during a period of time, after this, it begins to diminish progressively, until it paralyzes completely (3). This stop seems to be a response of the plant to the modifications in the hormonal balance (6). To Williams *et al.* (35) competition for photosynthates between the reproductive and vegetative part, play an important role; growth of the flower bouquet always has the priority for photosynthates, however, this

competition, by itself, cannot explain the growth of the plant.

Number of nodes

Vine shoots growth in function to the number of nodes in regard to time, also followed a simple sigmoidal model (figure 2), similar to the one observed by Harpe and Visser (10). Cultivar "Napoleon", in spite of having the highest growth in length (figure 2) it showed the lowest number of nodes (table 1) which indicates that internodal length is the biggest between the three indicated cultivars (table 2).

Statistical analysis revealed significant differences in regard to the number of nodes per vine shoot between the cultivars. The highest number of nodes was showed by cv. "Sultanina" (table 1) during three cycles, followed by Cultivar "Datal";

Table 1. Length and number of nodes per branch, in twelve table grape cultivars, during three cycles.

Cultivars	Length (cm)			Cycles			Total of nodes
	I	II	III	I	II	III	
Perlón	172.17 ^{bed}	283 ^b	246.5 ^{ab}	33.17 ^{bed}	42.33 ^{bc}	45.33 ^{ab}	
Sultanina	318.33 ^a	314 ^a	286.83 ^a	56.5 ^a	51 ^a	51.5 ^a	
Matilde	157.67 ^{ed}	165.17 ^{de}	224 ^{abc}	33.33 ^{de}	31 ^d	43.33 ^{abcd}	
Italia	179 ^{bed}	194 ^{bed}	214.5 ^{abc}	37.18 ^{bede}	35.5 ^{cd}	39 ^{bed}	
Alphonse Lavallée	213.83 ^b	215.33 ^{bed}	228.83 ^{abc}	40.83 ^{bc}	38.5 ^{bed}	42 ^{abcd}	
Datal	165.17 ^{bed}	206.67 ^{bed}	194.17 ^{bed}	40.68 ^{bc}	44 ^b	42 ^{abcd}	
Michelle Palieri	165.83 ^{bed}	175.5 ^{de}	188.33 ^{bed}	41.83 ^b	38 ^{bed}	43.33 ^{abcd}	
Red Globe	128.17 ^d	163.67 ^{de}	162.5 ^{bed}	30.33 ^e	34 ^d	33.67 ^{cd}	
Regina	152.50 ^{cd}	184.83 ^{cd}	154 ^{cd}	34 ^{cde}	35.17 ^{cd}	33.17 ^{cd}	
Napoleón	191.67 ^{bc}	230.67 ^{bc}	208 ^{abc}	39.68 ^{bed}	37.83 ^{bed}	37.17 ^{bed}	
Moscatel Alejandría	-	130.5 ^e	114.5 ^d	-	35 ^{cd}	31.17 ^d	
Queen	-	129.17 ^e	186.5 ^{bed}	-	32.33 ^d	43.33 ^{abc}	
Significance	*	*	*	*	*	*	

Measures with the same font do not differ significantly according to Duncan's test to 5%.

whereas the lowest number of nodes was presented by cv. "Moscatel de Alejandria". Bugnon and Bessis (4), Champagnol (6) and Mullins *et al.* (21) point out a direct relation between the number of formed nodes and growth of branches, product of the division and elongation of the apical meristems of shoots.

Perimeter of trunk

Vigor analysis was made in function of the perimeter of the trunk and the pruning waste weight. Table 3 shows results of the perimeter of trunk, which represents the enlargement of the trunk of the plant in each cultivar corresponding to the first, second and third cycle of production. Significant differences were detected between cultivars during the three cycles and according to them cv. "Michelle Palieri" produced the biggest perimeter of trunk during

the three evaluated cycles, followed by cv. "Sultanina" while the lowest value was showed by cultivar "Queen", followed by cultivar "Moscatel de Alejandria and Red Globe", with no significant differences between them, the rest of cultivars are positioned between cvs. "Sultanina and Datal". In this regard it can be pointed out that in general, cultivars constitute two groups: the ones with the biggest diameter such as, "Michelle Palieri, Sultanina, Matilde, Datal, Italia, Napoleón, Alphonse Lavallée, Regina and Perlón" with a perimeter, during the three cycles, over than 9.35 cm, whereas cultivars "Moscatel de Alejandria, Queen and Red Globe" showed perimeters under 8.63 cm. As cultivars get older, perimeter of trunks grow (table 3) increasing their capacity of storage (17), also their number of vascular bundles (6, 21).

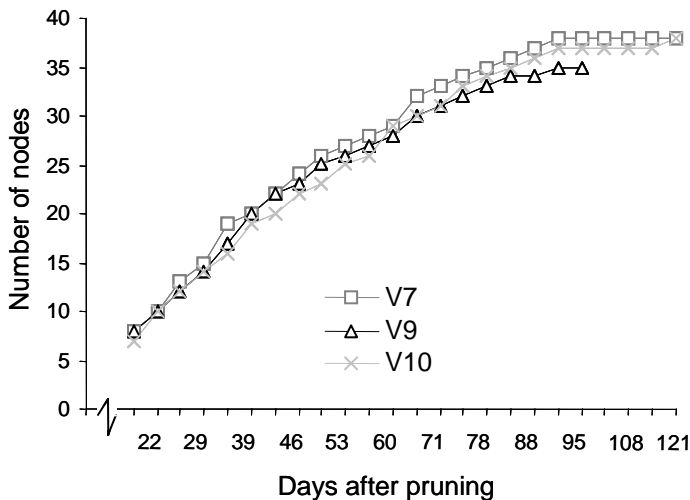


Figure 2. Growth of branch represented in number of nodes of three table grape cultivars, represented by the earliest, the intermediate and the latest. Average of three cycles.

Table 2. Internodal length per branch (cm), in twelve table grape cultivars, during three cycles.

Cultivars	Cycles		
	I	II	III
Perlón	4.71 ^{bcd}	5.65 ^{ab}	5.43 ^a
Sultanina	5.62 ^a	6.16 ^a	5.46 ^a
Matilde	4.67 ^{bcd}	5.28 ^{bc}	5.46 ^a
Italia	4.74 ^{bcd}	5.44 ^b	5.47 ^a
Alphonse Lavallée	5.22 ^{ab}	5.59 ^{ab}	5.32 ^a
Datal	4.03 ^e	4.60 ^d	4.62 ^{ab}
Michelle Palieri	3.93 ^e	4.59 ^d	4.63 ^{ab}
Red Globe	4.17 ^{de}	4.73 ^{cd}	4.51 ^{ab}
Regina	4.46 ^{cde}	5.22 ^{bed}	4.63 ^{ab}
Napoleón	4.83 ^{bc}	6.11 ^a	5.56 ^a
Moscatel Alejandría	-	3.72 ^e	3.68 ^b
Queen	-	3.83 ^e	4.19 ^b
Significancia	*	*	*

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Pruning waste weight

The term vigor is used to describe the accumulation of vegetative biomass (8), hence, the best way to express it is relating it to the pruning waste weight (1, 11). Table 4 presents the variation of the pruning waste weight in different cultivars, detecting significant differences in the different evaluated cycles. Cultivar "Sultanina" showed the highest pruning weight followed by cultivar "Napoleon", respectively. The lowest pruning weight was for cv. "Moscatel de Alejandria" with an average of 0.62 kg per vine. In similar conditions were evaluated 4 vine cultivars for wine, being the highest values the ones obtained at the end of the first cycle in every cultivar (33), having the same behavior all the evaluated cultivars and diminishing progressively.

However, "Perlón, Matilde, Michelle Palieri and Red Globe, did not have the same behavior and had their biggest growth during the second evaluated cycle, which could have been due to the vigorous growth determined in each one of these cultivars or to the vigor of growth of every plant.

Differences observed in regard to the pruning waste weight during the study, revealed that there are differences of growth between one cultivar and another. The vigor is a varietal character and the production of wood is carried out following transformation coefficients denominated varietal coefficients, which are relatively constant for each cultivar (12, 13).

In general, those cultivars that showed high values for trunk

Table 3. Trunk perimeter (cm) in twelve table grape cultivars, during three cycles.

Cultivars	Cycles		
	I	II	III
Perlón	8.41 ^e	9.86 ^{bc}	9.86 ^{def}
Sultanina	10.93 ^{ab}	12.6 ^a	13.22 ^{ab}
Matilde	10.13 ^{bc}	11.09 ^b	12.95 ^{ab}
Italia	9.82 ^{bcd}	10.78 ^b	11.21 ^{bcd}
Alphonse Lavallée	9.66 ^{cde}	9.87 ^{bc}	10.70 ^{cde}
Datal	9.42 ^{cde}	10.92 ^b	12.62 ^{abc}
Michelle Palieri	11.57 ^a	12.84 ^a	13.88 ^a
Red Globe	6.88 ^f	8.51 ^d	8.21 ^f
Regina	8.54 ^e	9.29 ^{cd}	10.22 ^{def}
Napoleón	8.84 ^{de}	10.17 ^{bc}	11.31 ^{bcd}
Moscatel Alejandría	-	8.18 ^d	9.07 ^f
Queen	-	7.99 ^d	8.51 ^f
Significancia	*	*	*

Measures with the same font do not differ significantly according to Duncan's test to 5%.

perimeters and for pruning waste weight, such as "Sultanina, Napoleón and Michelle Palieri" are also characterized by their growth in the

vegetative growth, condition that some authors (27, 28, 35) consider proportionally negative for productiveness.

Conclusions

Longitudinal growth of plants, like formation of nodes during the cycle, generated sigmoidal curves in regard to time, in every cultivar.

The biggest longitudinal growth was showed by shoots from cultivars "Sultanina and Alphonse Lavallée" and the smallest was presented by

cvs. "Moscatel de Alejandria and Queen".

The highest perimeter of trunks were showed by cultivars "Michelle Palieri and Sultanina".

The highest values for the pruning waste weight were shown by cultivars "Sultanina and Napoleon".

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Table 4. Pruning waste weight (kg) in twelve table grape cultivars, during three cycles.

Cultivars	Cycles		
	I	II	III
Perlón	1.25 ^{cde}	1.76 ^{ab}	1.55 ^{bc}
Sultanina	2.53 ^a	2.34 ^a	2.29 ^a
Matilde	1.36 ^{bcd}	1.39 ^{bcd}	1.23 ^{cd}
Italia	1.75 ^{bc}	1.42 ^{bcd}	1.18 ^{cd}
Alphonse Lavallée	2.03 ^{ab}	1.64 ^{bc}	1.59 ^{bc}
Datal	1.54 ^{bcd}	1.33 ^{bcd}	1.29 ^{cd}
Michelle Palieri	1.62 ^{bc}	1.74 ^{ab}	1.44 ^c
Red Globe	0.80 ^e	1.06 ^{cde}	0.76 ^{ef}
Regina	0.99 ^{ed}	0.88 ^{de}	1.01 ^{cde}
Napoleón	2.49 ^a	2.38 ^a	2.12 ^{ab}
Moscatel Alejandría	-	0.70 ^e	0.53 ^f
Queen	-	1.19 ^{bcd}	0.84 ^{def}
Significancia	*	*	*

Measures with the same font do not differ significantly according to Duncan's test to 5%.

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