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COMPARATIVE STUDY OF JUVENILITY RESULTING FROM *IN VITRO* PROPAGATED *VITIS VINIFERA L.*, CV. ALBARIÑO VINES WHEN SUBJECTED TO DIFFERENT PRUNING SYSTEMS

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Abstract : *Plants of* Vitis vinifera *L., cv. Albariño propagated* in vitro *were planted on their own roots and subjected to three different pruning systems, one at high level (Crosstree cordon system), one at middle level (Sylvoz system) and one at low level (Royat cordon system). Ampelographic and ampelometric characters were studied in different organs of these vines at several periods of the vegetative cycle during the 4th and 5th year.*

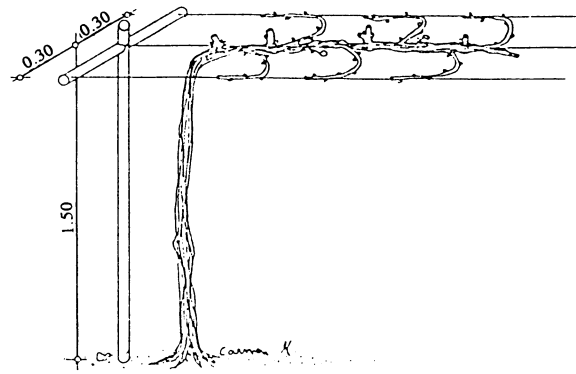
In the 4th year, although the vines from the Crosstree cordon system were slightly different, all of them showed very similar characteristics, such as: leaves with deep lateral sinuses, anthocyanin pigmentation of buds, and of the dorsal face of the nodes and internodes, presence of erect hairs on the young and adult leaves and, above all, on the margin of the dentation. These features were less noticeable in leaves on the Crosstree cordon system. Flowering during the 4th year was limited resulting in the production of a low number of small grape clusters. In the high cordon system, the level of flowering was slightly better.

During the 5th year, a very marked difference was observed between the vines subjected to the Crosstree high cordon pruning system and those subjected to the other two systems. In the first case, the leaves show an almost total absence of erect hairs and lateral sinuses, and the number and the size of grape clusters increase significantly. The vines from Sylvoz and cordon Royat continued practically to appear the same as the previous year and flowering continued to be almost absent.

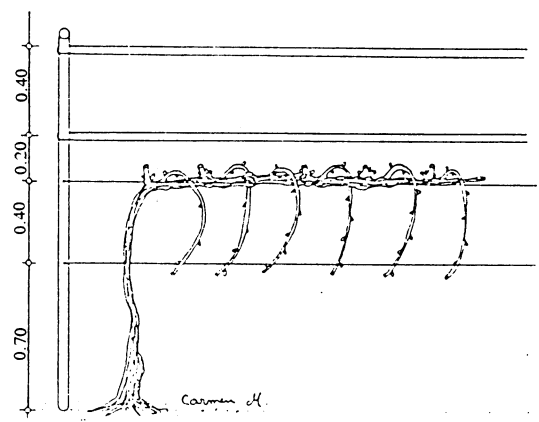
INTRODUCTION

In previous studies (MARTINEZ and MANTILLA, 1993a,b), we observed that Albariño plants from *in vitro* propagation that were planted on their own-roots, in the field or in pots, showed juvenile characters during the first years (typical of plants grown from seed) that never appeared in plants propagated from dormant cuttings from mature Albariño vines. These juvenile characteristics were : strong anthocyanin pigmentation of the shoots, and of the ramifications of the veins in the leaves ; deep sinuses of leaves ; high density of erect hairs and low density of horizontal hairs ; either the absence or reduced size of clusters. At the shoot apex, however, characters which are typical of adult Albariño vines were seen, such as the

CROSSTREE CORDON



SYLVOZ



ROYAT CORDON

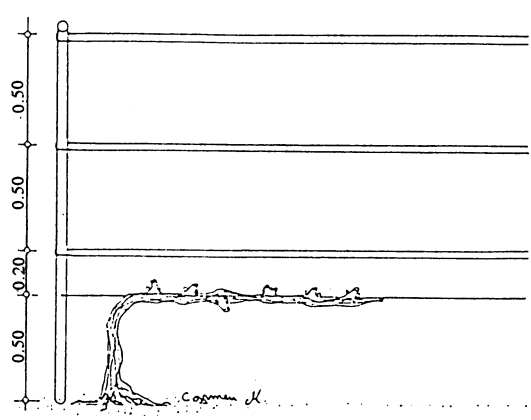


Fig. 1 — Pruning systems

pale green color of the shoot ; the green color or green with red stripes of the nodes and internodes ; presence of leaves without sinuses ; absence of erect hairs ; presence of horizontal hairs ; and the appearance of clusters. It is for this reason that it appeared to be of interest to study the behaviour of these vines when subjected to different pruning systems, high, middle, and low level.

MATERIAL AND METHOD

I — PLANT MATERIAL

The *Vitis vinifera* L., cv. Albariño grapevines studied in this work, were propagated *in vitro* from 0.2 - 0.3 mm apical meristems, using the method developed by FERRO (1989) for this variety. They were then planted on their own-roots, in the field and subjected to pruning as described later. We waited until the 4th and 5th year to realise this study, when the vine was well formed.

The study was carried out on a plot situated in the Instituto de Investigaciones Agrobiológicas de Galicia (C.S.I.C.), Santiago de Compostela. Three rows, each with 5 vines, were plan ted in the plot and subjected to the following pruning systems (figure 1)

a) 1th row : Crosstree cordon system (high level pruning) (CAC).
b) 2th row : Sylvoz system (midle level pruning) (SV).
c) 3th row : Royat cordon system (low level pruning) (CR).

II — PARAMETERS MEASURED AND INSTRUMENTS USED

Two samples of each organ studied were taken from each of the 15 vines (10 repetitions for each pruning system).

The qualitative parameters corresponding to pubescence were observed with the help of a binocular microscope.

The quantitative parameters of adult leaves were measured from pressed leaves using a Digital Image Procesing System MIP 1.4 (MICROM) and a Hitachi CCTV Camera MICROM video camera with natural light.

The seeds were weighed with an electronic precision scale (Sartorius, Analytic 1612-MP8) and the clusters with an electronic scale (Mettler PE 2000).

The following qualitative and quantitative parameters were measured and studied (table 1) :

1) When the length of the green shoot is between 10 and 30 cm :

Qualitative.

- O.I.V. codes: 001, 002, 003, 004, 005.

TABLE I

Parameters measured

Organs studied	Qualitative parameters	Quantitative parameters
Length of the green shoot between 10 and 30 cm : Young shoots	* O.I.V. Codes : 001, 002, 003, 004, 005	
Before flowering : **Young leaves**	* O.I.V. Codes : 051, 052, 053 054, 055, 056 * Density of the erect hairs on the margin of the dentation. * Anthocyanin coloration on the back of the principal nerves.	
During flowering : **Shoots**	* O.I.V. Codes : 006, 007, 008 009, 010, 011, 012, 013, 014, 015	
Tendrils	* O.I.V. Codes : 016, 017	
Inflorescences	* O.I.V. Codes : 151, 152	
From berry set to veraison : **Adults leaves**	* O.I.V. Codes : 067, 068, 069, 070 071, 075, 076, 079, 080, 081, 082 083, 084, 085, 086, 087, 088, 089 090, 091. * Minimal List (9) Code 083-1. * Density of erect hairs on the edge of the dentation.	* Lengths: Nc, S1d, N1d, S2d, N2d, N3d, ON3d, N4d, N5d, ASP, N5i, N4i, ON3i, N3i, N2i, S2i, N1i, S1i, a, AD1d, LD1d, Ld, AD3d, LD3d, AD3i, LD3i, Li, AD1i, LD1i, LP, ADt, LDt, ai, ad (Fig 2) * Angles: A, B, G, D, D`, G`, B`, A` (Fig. 3) * Relationships: Ld1d/Ad1d, LD3d/AD3d, LD3i/AD3i, LD1i/AD1i, N1d/Nc, N2d/Nc, N3d/Nc, ON3d/Nc, N1i/Nc, N2i/Nc, N3i/Nc, ON3iNc, S1d/N1d, S1i/N1i, S2d/N2d, S2i/N2i, N5d/N2d, N5i/N2i, (S1d+S2d)/(Nc+N1d), (S1i+S2i)/(Nc+N1i), (S1d+S2d)/(N1d+N2d), (S1i+S2i)/(N1i+N2i), Nc/a, ΣS1/ΣN1, ΣS2/ΣN2, Nc/ΣN1, a/ΣN1, A+B, A+B+G, A`+B`, A`+B`+G`, (A+B)/(S1d+S2d), (A`+B`)/(S1i+S2i), ASP/(D+D`), LP/Nc, LDt/ADt. * Others: Area, Perimeter, Convex Perimeter, Circular shape factor Elongation factor, Rugosity factor
During ripening : **Clusters**	* O.I.V. Codes : 204, 205, 206. * Shape of the cluster * Number of clusters per green shoot	* Length of the cluster (cm) * Width of the cluster (cm) * Length of the peduncle (cm) * Weight of the cluster (gr)
Grapes	* O.I.V. Codes : 222, 223, 224, 225, 226, 227, 229, 230, 231 232, 234, 236, 237, 239, 240. * Number of seeds per berry	* Width of the berry (cm) * Length of the pedicel (cm) * Length of the berry (cm)
Seeds		* Length of the seeds (cm) * Weight of the seeds (gr)

TABLE II

Average values and Standard Deviation of the quantitative parameters with significant differences between Albariño vines *in vitro* (4 years old) subjected to three different pruning systems, Crosstree cordon system (CAC), Sylvoz system (SV), and Royat cordon system (CR)

Parameters	Pruning systems						Significant differences
	CAC		SV		CR		
	Av.val.	S. D.	Av. val.	S. D.	Av. val.	S. D.	
Nc	9.00	1.52	8.87	0.57	10.01	0.95	SV - CR *
ON3i	3.65	0.76	3.87	0.28	4.26	0.42	CAC - CR *
N1i	7.74	1.34	7.79	0.39	8.96	0.81	SV - CR **
LP	8.62	2.30	9.68	0.93	11.24	1.67	CAC - CR *
B'	39.03	5.45	46.38	5.44	42.26	6.69	CAC - SV *
LP/Nc	0.92	0.18	1.06	0.09	1.12	0.10	CAC - CR *
$\frac{S1i+S2i}{Nc+N1i}$	0.62	0.07	0.64	0.07	0.52	0.07	SV - CR ** CAC - CR *
ΣS1/ΣN1	0.68	0.12	0.72	0.13	0.57	0.09	SV - CR *
Perimeter	56.44	10.38	52.35	6.63	62.73	7.78	SV - CR *
Cluster : kg of grape per vine	0.51	0.29	0.00	0.00	0.04	0.08	CAC - SV *** CAC - CR ***

*95 % ; **99 % ; ***99.9 %
Av. Val. = Average value ; SD. = Standard Deviation

2) Before flowering, in young leaves:

Qualitative.

- O.I.V. codes: 051, 052, 053, 054, 055, 056.

To these parameters at this stage of the growing cycle, we have added the following:

- Density of the erect hairs on the margin of the dentation: None or very sparse "1"; Sparse "3"; Medium "5"; Dense "7"; Very dense "9".

- Anthocyanin coloration on the back of the principal veins: Absent or very weak "1"; Weak "3"; Medium "5"; Strong "7"; Very strong "9".

3) During flowering, in shoots, tendrils and inflorescences :

Qualitative

TABLE III

Average values, Standard Deviation, Maximum and Minimum of the qualitative parameters with significant differences between Albariño vines *in vitro* (4 years old), subjected to three different pruning systems, Crosstree cordon system (CAC), Sylvoz system (SV), and Royat cordon system (CR)

Parameters	Pruning systems												Significant differences
	CAC				SV				CR				
	Av. Val	S. D.	M.	m.	Av. Val.	S. D.	M.	m.	Av. Val.	S. D.	M.	m.	
O.I.V.: 005	4.30	0.94	5	3	4.30	0.82	5	3	5.50	0.52	6	5	CAC - CR ** SV - CR **
O.I.V.: 051	1.00	0.00	1	1	2.00	0.00	2	2	1.90	0.31	2	1	CAC - SV *** SV - CR ***
O.I.V.: 053	6.00	0.00	6	6	5.00	0.00	5	5	5.90	0.31	6	5	CAC - CR ** CAC - SV **
O.I.V.: 054	3.20	0.63	5	3	5.00	0.00	5	5	3.60	0.69	5	3	CAC - SV ** CR - SV **
O.I.V.: 056	3.00	0.00	3	3	5.20	0.42	6	5	4.90	0.87	6	3	CAC - SV *** CAC - CR ***
I	2.70	0.67	3	1	4.10	1.19	6	3	4.10	1.19	6	3	CAC - SV ** CAC - CR**
O.I.V.: 007-009	1.80	0.42	2	1	3.00	0.00	3	3	3.00	0.00	3	3	CAC - SV *** CAC - CR ***
O.I.V.: 013-014	2.80	0.42	3	2	3.70	0.48	4	3	3.00	0.00	3	3	CAC - SV *** CR - SV ***
O.I.V.: 015	1.00	0.00	1	1	3.00	0.00	3	3	4.80	0.63	5	3	CAC - SV *** CAC - CR *** SV - CR **

TABLE III (suite)

Average values, Standard Deviation, Maximum and Minimum of the qualitative parameters with significant differences between Albariño vines *in vitro* (4 years old), subjected to three different pruning systems, Crosstree cordon system (CAC), Sylvoz system (SV), and Royat cordon system (CR)

Parameters	Pruning systems												Significant differences
	CAC				SV				CR				
	Av. Val	S. D.	M.	m.	Av. Val.	S. D.	M.	m.	Av. Val.	S. D.	M.	m.	
O.I.V.: 071	2.20	0.78	4	1	2.10	0.31	3	2	3.80	1.54	5	2	CAC - CR * CAC - SV *
O.I.V.: 080	1.70	0.48	2	1	1.80	0.42	2	1	1.20	0.42	2	1	CAC - CR * CAC - SV *
O.I.V.: 085	2.10	0.31	3	2	3.40	1.83	6	1	4.00	0.94	5	3	CAC - CR **
O.I.V.: 088	2.00	0.00	2	2	2.50	1.08	4	1	2.70	0.48	3	2	CAC - CR SV - CR *
O.I.V.: 091	1.50	0.52	2	1	2.20	0.78	4	1	2.60	0.51	3	2	CAC - SV ** CAC - CR **
II	2.30	1.05	5	1	2.00	2.16	7	1	4.30	1.33	5	1	CAC - SV * CAC - CR ** SV - CR *
III	1.13	1.00	3	0	0.03	0.19	1	0	0.19	0.44	2	0	CAC - CR ** CAC - SV ** SV - CR *

* 95 % ; ** 99 % ; *** 99.9 %
I = Young leaf : density of the erect hairs on the margin of the dentation. ; II = Adult leaf : density of the erect hairs on the margin of the dentation. ;
III = Cluster : number of clusters in one shoot

TABLE IV

Average values and Standard Deviation of the quantitative parameters with significant differences between Albariño vines in vitro (5 years old) subjected to three different pruning systems, Crosstree cordon system (CAC), Sylvoz system (SV), and Royat cordon system (CR)

Parameters	Pruning systems						Significant differences
	CAC		SV		CR		
	Av. Val.	S.D.	Av. Val.	S.D.	Av. Val.	S.D.	
S1d	8.65	0.78	6.66	1.56	6.75	1.64	CAC - SV * CAC - CR *
S1i	8.22	1.29	6.38	1.44	6.52	1.78	CAC - SV *
LD1d/AD1d	0.61	0.06	0.78	0.18	0.70	0.14	CAC - SV *
S1d/N1d	0.86	0.07	0.68	0.13	0.72	0.16	CAC - SV * CAC - CR *
S2i/N2i	0.94	0.01	0.90	0.04	0.90	0.01	CAC - CR *** CAC - SV *
S1d+S2d Nc +N1d	0.69	0.05	0.60	0.08	0.60	0.06	CAC - SV * CAC - CR *
S1d+S2d N1d+N2d	0.89	0.05	0.76	0.10	0.78	0.10	CAC - SV * CAC - CR *
S1i+S2i N1i+N2i	0.88	0.07	0.77	0.10	0.77	0.06	CAC - CR **
N5d/N2d	0.13	0.03	0.14	0.02	0.16	0.03	CAC - CR *
ΣS1/ΣN1	0.85	0.08	0.68	0.14	0.70	0.11	CAC - SV * CAC - CR *
ΣS2/ΣN2	0.94	0.02	0.89	0.03	0.89	0.03	CAC - SV * CAC - CR *

TABLE IV (suite)

Average values and Standard Deviation of the quantitative parameters with significant differences between Albariño vines in vitro (5 years old) subjected to three different pruning systems, Crosstree cordon system (CAC), Sylvoz system (SV), and Royat cordon system (CR)

Parameters	Pruning systems						Significant differences
	CAC		SV		CR		
	Av. Val.	S.D.	Av. Val.	S.D.	Av. Val.	S.D.	
A+B S1d+S2d	5.71	0.87	7.04	1.13	7.48	1.53	CAC - CR **
Circular shape factor	0.47	0.05	0.39	0.07	0.41	0.05	CAC - SV *
Cluster : length of the cluster	7.63	1.66	5.02	1.96	3.86	1.44	CAC - SV *** CAC - CR *** SV - CR **
Cluster : length of the peduncle	3.73	1.53	5.91	2.67	4.03	2.08	CAC - SV *** SV - CR ***
Cluster : weigth of the cluster	67.80	27.16	37.97	27.12	22.74	14.63	CAC - SV *** CAC - CR *** SV - CR **
Cluster : weigth of the first cluster of the shoot	77.92	26.13	30.74	16.86	13.34	7.24	CAC - SV *** CAC - CR *** SV - CR *
Cluster: weigth of the second cluster of the shoot	64.71	21.28	35.81	22.34	16.80	9.40	CAC - CR *** CAC - SV *
Cluster: kg of grape per vine	2.32	0.80	0.47	0.34	0.17	0.19	CAC - SV *** CAC - CR ***
Berry : length of the berry	1.22	0.08	1.14	0.09	1.15	0.09	CAC - SV *** CAC - CR ***
Berry: width of the berry	1.25	0.09	1.17	0.10	1.22	0.09	CAC - SV ***

*95 % ; **99 % ; ***99.9 %
Av. val. = Average value ; D. = Standard deviation

TABLE V

Average values, Standard Deviation, Maximum and Minimum of the qualitative parameters with significant differences between Albariño vines *in vitro* (5 years old), subjected to three different pruning systems, Crosstree cordon system (CAC), Sylvoz system (SV), and Royat cordon system (CR).

Parameters	Pruning systems												Significant differences
	CAC				SV.				CR				
	Av. Val.	S. D.	M.	m.	Av. Val.	S. D.	M.	m.	Av. Val.	S. D.	M.	m.	
O.I.V.: 004	5.70	0.82	7	5	6.60	0.51	7	6	7.00	0.00	7	7	CAC - CR ** CAC - SV *
O.I.V.: 005	1.00	0.00	1	1	3.70	1.25	5	1	4.90	1.19	6	2	CAC - CR ** CAC - SV *
O.I.V.: 054	3.60	1.43	5	1	5.10	0.31	6	5	3.70	1.16	5	1	CAC - SV ** SV - CR **
I	1.10	0.31	2	1	2.20	1.22	5	1	3.10	1.59	5	1	CAC - SV ** CAC - CR **
O.I.V.: 007-009	2.20	0.63	3	1	2.90	0.31	3	2	2.90	0.31	3	2	CAC - SV ** CAC - CR **
O.I.V. 067	2.50	0.52	3	2	2.90	0.31	3	2	3.00	0.00	3	3	CAC - CR *
O.I.V.: 068	2.00	0.00	2	2	2.90	0.99	4	2	2.40	0.69	4	2	CAC - CR *
O.I.V.: 070	1.10	0.31	2	1	1.40	0.51	2	1	1.00	0.00	1	1	SV - CR *

TABLE V (suite)

Average values, Standard Deviation, Maximum and Minimum of the qualitative parameters with significant differences between Albariño vines *in vitro* (5 years old), subjected to three different pruning systems, Crosstree cordon system (CAC), Sylvoz system (SV), and Royat cordon system (CR).

Parameters	Pruning systems												Significant differences
	CAC				SV.				CR				
	Av. Val.	S. D.	M.	m.	Av. Val.	S. D.	M.	m.	Av. Val.	S. D.	M.	m.	
O.I.V.: 089	1.00	0.00	1	1	2.00	1.15	4	1	1.50	0.85	3	1	CAC - SV *
III	2.34	0.82	4	1	0.86	1.17	4	0	0.54	0.88	3	0	CAC - SV *** CAC - CR ***
O.I.V.: 204	4.78	0.73	6	3	4.27	0.63	5	3	3.23	1.25	5	1	CAC - SV *** CAC - CR *** SV - CR ***
O.I.V: 205	2.36	1.42	7	1	1.28	0.57	4	1	1.06	0.24	2	1	CAC - SV *** CAC - CR *** SV - CR *
O.I.V.: 223	2.68	0.47	3	2	2.62	0.49	3	2	2.38	0.49	3	2	CAC - CR ** SV - CR *

*95 % ; **99 % ; ***99.9 %
I = Young leaf : density of the erect hairs on the margin of the dentation
III = Cluster : number of clusters in one shoot
Av. Val. = Average value ; S.D. = Standard deviation ; M. = Maximum ; m. = Minimum

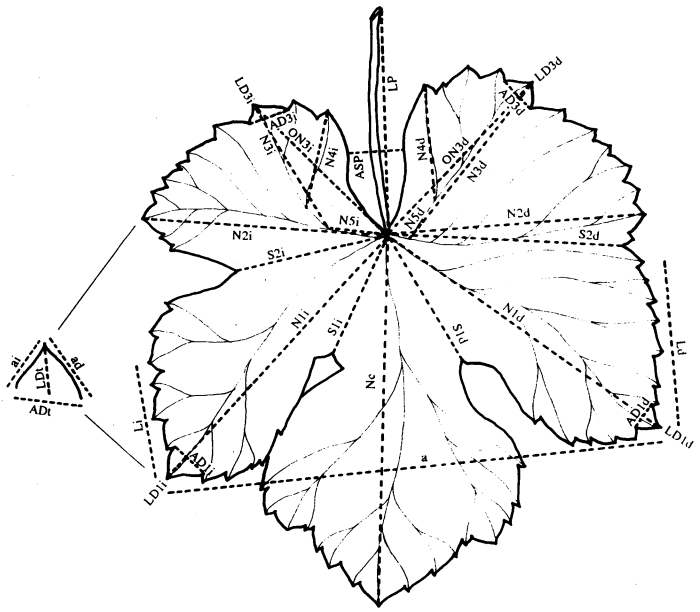


Fig. 2 — Lengths measured in the adults leaves

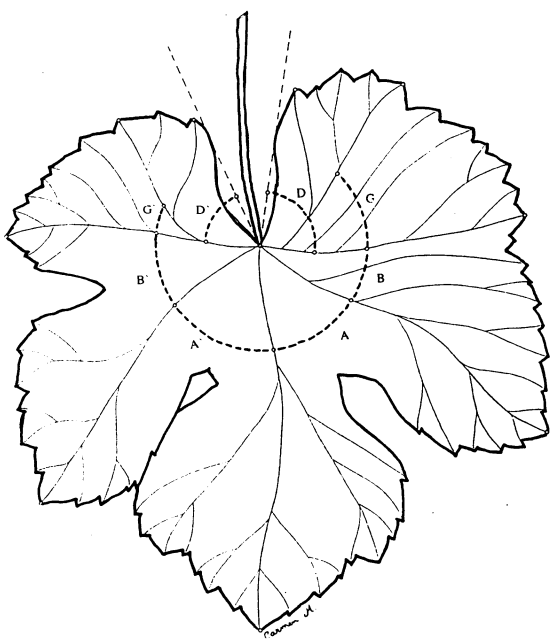


Fig. 3 — Angles measured in the adult leaves

- shoots, O.I.V. codes: 006, 007, 008, 009, 010, 011, 012, 013, 014, 015 ;
- tendrils, O.I.V. codes : 016, 017 ;
- inflorescence, O.I.V. codes: 151, 152.

4) From berry set to veraison, in adult leaves

Qualitative

- O.I.V. codes: 067, 068, 069, 070, 071, 075, 076, 079, 080, 081, 082, 083, 084, 085, 086, 087, 088, 089, 090, 091.
- Minimal List (DETTWEILER, 1991) code 083-1.

To these parameters proposed by the O.I.V., (1983) and DETTWEILER, (1991) in the "Minimal List", we have added the following parameter:

- Density of erect hairs on the margin of the dentation: None or very sparse "1"; Sparse "3"; Medium "5"; Dense "7"; Very dense "9".

Quantitative

These parameters were selected based on studies by various authors (BOURSIQUOT et *al.*, 1987, 1989 ; CARBONNEAU, 1976 ; DETTWEILER, 1987, 1991 ; GALET, 1985; GRENAN, 1982a,b ; O.I.V., 1983). Their nomenclature has been modified, for personal accomodations and ease of manipulation and interpretation.

The following parameters were measured :

- Lengths (figure 2, table I):

Here we have also proposed some new parameters which are: ON3d, ON3i, ADt, ai, and ad.

- Angles (figure 3, table I).

- Relationships (table I).

We have proposed the following as new parameters: N5d/N2d, N5i/N2i, ON3d/Nc, ON3i/Nc and ASP/(D+D`).

- Others

We also included a series of parameters which were obtained automatically using a Digital Image Processing System MIP 1.4 (MICROM).

These measurements only take into account the leaf blade, excluding the petiole, and are the following:

- Area (cm).

- Perimeter (cm).

- Convex perimeter (cm): This is the length of the figure formed by drawing a line joining the most prominent points of the leaf.

- Circular shape factor: This parameter was proposed by KEEFE AND DRAPER (1986, 1988) for the study of the shape of the leaves and the seeds of several species by means of image analysis.

Other authors such as WEST AND NOBLE (1984) used it for measuring leaves and seeds and called it "Shape Factor". It takes values oscillating between 0 for elongated shapes and 1 for circular shapes.

- Elongation factor: This is the ratio between the minimum and maximum diameter of the leaf.

- Rugosity factor: This parameter measures the ratio between the convex perimeter and the perimeter.

5) During ripening, in clusters, berries and seeds:

Qualitative

- Clusters, O.I.V. codes: 204, 205, 206.

We added two more parameters to these, which are the following:

- Shape of the cluster: Cylindrical "1"; Conical "2"; Conical with one wing "3"; Conical with two wings "4"; Conical with a tendril "5"; Branched "6"; Double branched "7".

- Number of clusters per green shoot: 1 "1"; 2 "2"; 3 "3"; 4 "4".

- Berries, O.I.V. codes: 222, 223, 224, 225, 226, 227, 229, 230, 231, 232, 234, 236, 237, 239, 240.

We have added the following parameter to the berry measurements:

- Number of seeds per berry: 1 "1"; 2 "2"; 3 "3"; 4 "4"; 5 "5"; 6 "6".

Quantitative

- length of the cluster (cm),
- width of the cluster (cm),
- length of the peduncle (cm),
- weight of the cluster (gr),
- width of the berry (cm),
- length of the berry (cm),
- length of the pedicel (cm),
- length of the seeds (cm),
- weight of the seeds (gr),

III — STATISTICAL ANALYSES CARRIED OUT

Analysis of Variance: Applied to quantitative data, it was carried out using the BMDP statistical programme (BMDP7D - "One way Analysis of Variance", 1988 version).

Kruskal-Wallis non parametric analysis: As applied to the qualitative data. This test indicates whether or not there are significant differences between the sets of groups. Afterwards, it is applied to pairs and in this case indicates which are the specific groups responsible for these differences. A BMDP statistical programme (BMDP3S - "Nonparametric Statistics, Kruskal-Wallis one way", 1988 version), was used

RESULTS AND DISCUSSION

As can be seen in the following, according to the type of pruning, the Albariño *in vitro* plants showed differences in both their ampelographic level and fertility.

I — IN THE 4TH YEAR

In table II the quantitative parameters can be found which, when subjected to a statistical analysis of variance (ANOVA), showed significant differences between the three types of plants.

In table III can be found the qualitative parameters that, when subjected to the Kruskal-Wallis statistical analysis, showed significant differences between plants subjected to different pruning systems.

The most notable difference was found between the Albariño vines grown *in vitro* which were pruned in Crosstree high cordon and those pruned using the Sylvoz or Royat cordon system, especially with reference to the qualitative parameters.

Those pruned using the Royat cordon system and the Sylvoz system showed a high density of erect hairs, on the young leaves (O.I.V. code: 056). These were especially noticeable on the margin of the dentation, both on the young and adult leaves (news parameters that we have proposed, I, II) (Table III).

There were oscillations in the density of horizontal hairs between the different types of pruning, but these differences were less noticeable (code O.I.V.. 053) (Table III).

The Sylvoz pruned vines had green young leaves with bronze areas (O.I.V. code: 051) (Table III). Both the Royat cordon and Sylvoz pruned vines had nodes, internodes and buds which were red (O.I.V. codes: 007, 009, 015) (Table III), and almost non-existent flowering (this was the first year that clusters of grapes were produced). In the Crosstree high cordon system, flowering, although low, was slightly better (kg of grape per vine, Table II), (parameter III, Table III).

However, leaves with very deep lateral sinuses were present in all three types of pruning, especially in the Cordon Royat system (S1i+S2i/Nc+N1i ; ∑S1/∑N1) (Table II).

I — IN THE 5TH YEAR

In table IV are the quantitative parameters which, when subjected to a statistical analysis of variance (ANOVA), showed significant differences between the various types of pruning.

In table V can be found the qualitative parameters which, when subjected to the Kruskal-Wallis statistical analysis, showed significant differences between plants subjected to different pruning systems.

A marked differences was observed in the vines subjected to the Crosstree high cordon system, as evidenced by :

- Absence or smaller density of erect hairs on the tip of the young shoot (O.I.V. code: 005) (Table V), on the margin of the dentation on the young leaf (parameter I, table V).

- Green color with red stripes on nodes and internodes (O.I.V codes: 007, 009) (Table V).

- The lateral sinuses on the adult leaves were either missing or shallow. Observe (table IV) the values of the relationships S2i/N2i; S1d+S2d/Nc+N1d; S1d+S2d/N1d+N2d; S1i+S2i/N1i+N2i; ∑S1/∑N1; ∑S2/∑N2.

- A higher level of fertility, indicated by the larger number (parameter III, table V) and increased size of the clusters (length of the clusters, table IV). The clusters were also more compact (O.I.V. code: 204) (table V), shorter peduncles (table IV), and were larger than those produced by the other two pruning systems (weigth of the clusters, table IV).

Features on the Sylvoz and Royat cordon systems were similar to the previous year, with many juvenile characteristics such as :

- Presence of erect hairs on the tip of the young shoot (O.I.V. code: 005) (table V) and, above all, on the margin of the dentation of young leaves (parameter I, table V).

- Red color of the dorsal face of the nodes and internodes (O.I.V. codes: 007, 009) (table V).

- Presence of fairly deep lateral sinuses on the adult leaves. Observe the values of the relationships S2i/N2i; S1d+S2d/Nc+N1d; S1d+S2d/N1d+N2d; S1i+S2i/N1i+N2i; ∑S1/∑N1; ∑S2/∑N2 (table IV).

- The fertility, although slightly increased, was still very low; there were many shoots which had no clusters (parameter III, table V) and even completely infertile vines (kg of grapes per vine, table IV).

- The appearance of the Sylvoz and Royat cordon clusters were different to the Crosstree high cordon clusters. In the first two cases, the clusters were much smaller, especially in

the first cluster of the shoot (table IV). The peduncle was longer (table IV) and the cluster less compact (O.I.V. code: 204) (table V). The Sylvoz clusters had 50 or less berries in each cluster (O.I.V. code: 205) (table V) and the Royat cordon less than 50. The berries of both these types of pruning systems were generally smaller (length and width of the berry, table IV).

These findings on the presence of erect hairs, leaves with sinuses and fertility, coincide with those observed by other authors in different species (MARGARA, 1982 ; NOZERAN, 1978a,b, 1985 ; NOZERAN and BANCILHON, 1977 ; WATELET-GONOD AND FAVRE, 1981) as well as with grapevines grown from seed (WAGNER and BRONNER, 1974) and *in vitro* (CANCELLIER and COSSIO, 1988 ; GRENAN, 1982a,b ; NOZERAN et *al.*, 1982; NOZERAN et *al.*, 1983).

The alarming reduction in the fertility in the Sylvoz and Royat cordon systems also coincides with observation by GRENAN (1982a,b). He found that when "Muscat à petits grains B", was subjected to low level pruning, it did not produce any clusters or if it did produce clusters, they were very small.

A questions arise, as a result of the findings from this study, What is the cause of all these differences ?

This answer cannot be found in studies of this area (CANCELLIER and COSSIO, 1988; GRENAN, 1982a,b). Although, several differing hypothesis have been presented to explain these juvenility observations.

A very high Standard Deviation has been observed in many of the parameters measured, which implies a high degree of variability. This had been observed when comparing Albariño plants propagated from dormant cuttings cultivated *in vitro* and seed (MARTINEZ and MANTILLA, 1993). This variability indicates that plants cultivated *in vitro* are characterized by their being in a type of evolution towards the adult state, while their morphological characters, pubescence and fertility show a certain margin of instability. This does not signify that the parameters used are not valid as, despite this, the differences observed are clear. However, it is a factor that we should take into account when interpreting results and we should look for the differences found.

A possible cause could reside in the distance between the apical meristem and the roots. For this reason NOZERAN et *al.* (1982, 1983) and NOZERAN and BANCILHON (1977) call attention to the juvenile behaviour of the shoots from one year wood and blame this on their situation close to the root system, where the meristems may suffer a protracted diapause. In this sense, SCHWABE and ALDOORI (1973), FRYDMAN and WAREING (1973) and MULLINS et *al.* (1979) believed that the distance between the roots and the apical meristem is a factor which controls the expression of the juvenile and adult characters, so that when free growth is permitted in plants grown *in vitro*, the adult morphology reappears. This could explain the fact that in the high level pruning systems (> distance between the roots and the apical meristem) the characters were those of adult plants, whereas in the low and middle level pruning systems (< distance between the roots and the apical meristem) they were of a more juvenile nature.

CONCLUSIONS

The vines of *Vitis vinifera* L., cv. Albariño, propagated *in vitro*, planted ungrafted in the field, and when subjected to low level (cordon Royat), middle level (Sylvoz) and high level pruning (Crosstree high cordon), show some differences in the 4th year due to fertility (very weak in Sylvoz and cordon Royat, and higher in Crosstree high cordon) and pubescence even though they show some common characters such as the presence of leaves with deep lateral sinuses.

During the 5th year, the vines pruned on the Crosstree high cordon system begin to differentiate themselves very clearly from those subjected to the other pruning systems.

This noticeably different behaviour is translated into the maintenance in the Sylvoz and cordon Royat of a higher density of erect hairs on the tip of the shoot and leaves (above all on the margin of the dentation), a higher level of anthocyanin pigmentation in nodes, internodes and buds, and the conservation of leaves with deep lateral sinuses. Fertility in the Sylvoz and cordon Royat was very weak, demonstrated as much by the number of clusters as by their size and weigth.

The vines subjected to pruning at a high level (Crosstree high cordon) showed an important reduction in the number of erect hairs, leaves without sinuses or with very small ones, and a marked increase in fertility indicated both by the increased number and by the larger size of the clusters and weigth.

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