Study of phenotypic variation by analysing data gathered together by O.I.V. on new varieties of table grapes

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Summary: If we consider progenies of seedless, muscat or early cultivar (SME cv.), they may be prone to show some differences in their distribution for phenologic or cultural characteristics, when compared to more common varieties (control cv.). Data gathered together by O.I.V. on 190 new table grape cultivars originating from 37 different breeding stations was used to test this hypothesis. Only the most objective characteristics (for instance: berry weight) were chosen, so as to reduce observer's influence on cv. descriptions. Differences between SME and control cvs could be shown in mean, variance and/or distribution analysis for some characteristics. In comparison, no significant change appeared for the same features between black versus white cvs. These provisional results have to be confirmed by experimental studies, but the tendencies shown may still be of interest in breeding work.

Key words: table grape, variety of vine, variation, ecology, phenotype, seedlessness, muscat flavour, early maturity, biometry, analysis, breeding.

Introduction

Breeding is only possible if some variation exists in the biological material to be improved. To maintain variability, every breeder is concerned about genetic resources.

If we are interested in seedless, muscat or early cvs, the question is: is the variability potential of progenies of these cvs equal to that of progenies from more common cvs? The problem is particularly important with seedlessness. Since most of these cvs are related to Sultanina, these progenies may be more inbred than other, non-seedless progenies. This situation may also be found, but to a lesser degree, with characters such as muscat or earliness. It is well known that inbreeding implies a risk of loss of variability, but also the possibility of reduced fitness.

The study published by the Office International de la Vigne et du Vin on new varieties of table grapes (WAGNER and TRUEL 1988) gave us the opportunity to see if differences can be detected, at least for some characters, among these groups of cvs.

Materials and methods

Plant material

Data used in this study were collected from all known grape breeders. O.I.V. asked them to fill out two types of forms:

- one for each new variety registered: information on cultural characters,
- one for the location where these varieties had been bred: information on climatic and training system variables.

Characters selected for the study

Only the most objective characteristics described were chosen to reduce observer bias on cvs descriptions.

Experimental design

37 stations belonging to 19 countries, situated in very different climatic areas (ranging from Canada and USSR to Israel) gave information on 190 cvs. As every station often contributed to

Table 1: Regression between cultural variables (x1-x6) and climatic variables: average temperature and water-supply for the 72 to 139 cvs observed. t values for null hypothesis and significance

independant variables / dependant variables	temperature	water supply
x1 = time of bud bursting (OIV d.n.)	2.23 *	0.49 NS
x2 = time of fruit maturity (OIV d.n.)	3.42 ***	0.67 NS
x3 = cluster weight (OIV d.n.)	5.71 ***	0.32 NS
x4 = berry weight (OIV d.n.)	5.26 ***	0.27 NS
x5 = number of seeds per berry	1.64 NS	1.45 NS
x6 = weight of 100 seeds (g)	0.59 NS	2.36 *

*,**,***,NS : significant at the 5%, 1%, or 0.1% levels, respectively.

OIV d.n. = OIV descriptor numbers for the different variables.

every group of cvs, differences due to soil, climate or training systems may be minimal when making comparisons between groups of cvs. This hypothesis can be only valid if enough stations are considered. As climatic variables were available for most stations, a control of the validity of this hypothesis was possible: if the assumption made is true, then temperature and water availability averages from relevant groups of cvs are expected not to be significant. If they are, then differences among groups may originate both from cvs differences and unbalanced location distribution of these cvs. In the latter case it is not easy to determine which factor is the most important.

Soil differences could not be controlled. Also considered was whether growth regulators and ringing were used; all places (and cvs) submitted to such cultural practices were discarded from the study. For this reason, seedless cvs could not generally be analysed, or when they were, this condition could not be applied, so that the results must be considered with this restriction.

Table 2: Comparison between seedless and seeded cvs, muscat and neutral cvs, early and non-early cvs, black and white cvs. The only characters listed in the table are those which are significantly different for their means, their variances or their distributions

statistics	comparision between :			
	SDL/SDD cvs	MUSCAT/ NEUTRAL cvs	EARLY/NON- EARLY cvs	BLACK/ WHITE cv
mean	-	cluster wght	-	-
	berry wght	berry wght	berry wght	-
variance	-	cluster wght	-	-
	-	berry wght	-	-
	-	-	nb s./b.	-
distri-	-	cluster wght	-	-
bution	berry wght	berry wght	berry wght	-

cluster wght = cluster weight (x3)

berry wght = berry weight (x4)

nb s./b. = number of seeds per berry (x5)

As black versus white cvs showed no differences with either climatic variables or with cultural characters, only random differences were used to evaluate differences which were found among other groups of cvs with a completely nested design (random effect model).

Results

1. Test of the hypothesis: no differences in climate variables between groups of cvs

Temperature and water supply showed no differences between:

- black and white cvs,
- early versus non early cvs.

Between muscat and neutral cvs, no differences were found for water supply, but a highly significant difference appeared for temperature:

- the average temperature for locations where muscat cvs were bred and observed was 12.04 °C,
- to compare to: 13.48 °C for neutral cvs.

The same result was found for

- seedless, 14.97 °C and
- seeded cvs, 12.95 °C,

which was not unexpected, as seedless cvs are mostly grown and bred in hot countries.

Table 3: Means of different variables for black and white cultivars. Only seeded cvs have been considered

variables	WHITE cvs	BLACK cvs	F value
x1 = time of bud bursting (OIV d.n.)	4.84	4.63	0.58 NS
x2 = time of fruit maturity (OIV d.n.)	4.52	3.84	3.10 NS
x3 = cluster weight (OIV d.n.)	4.62	4.39	0.91 NS
x4 = berry weight (OIV d.n.)	5.44	5.31	0.30 NS
x5 = number of seeds per berry	2.14	2.17	0.07 NS
x6 = weight of 100 seeds (g)	4.60	4.31	1.34 NS

Significance levels, see table 1.

OIV d.n. = OIV descriptor numbers for the different variables.

2. Regression between cultural and climatic variable (Table 1)

In general, only regression with temperature gave significant positive coefficients, with the exception of x5 and x6. All cultural variables were independant of water supply, only x6 (weight of 100 seeds) was positively correlated with water supply.

3. Comparisons made for cultural variables between

- seedless (SDL) and seeded (SDD) cvs,
- muscat and neutral cvs (among only SDD cvs),
- early and non-early maturing cvs (among only SDD cvs),
- black and white cvs (among only SDD).

In general, only cluster weight and/or berry weight are found significantly different for their means (or variances, or distributions) between the groups of cvs compared (Table 2).

Black and white cvs have similar means (Table 3), variances and distributions for all the six characters considered.

Table 4: Means of different variables for early and non-early cvs. Only seeded cvs have been considered

variables	EARLY cvs	NON-EARLY cvs	F value
x3 = cluster weight (OIV d.n.)	4.29	4.57	1.03 NS
x4 = berry weight (OIV d.n.)	4.70	5.63	14.66 **
x5 = number of seeds per berry	2.10	2.18	0.47 NS
x6 = weight of 100 seeds (g)	4.58	4.36	0.66 NS

Significance levels, see table 1.

OIV d.n. = OIV descriptor numbers for the different variables.

Early cvs have smaller berries than more later ones (Table 4) and their seed number per berry seems to be less variable:

$s5 = 3.15$, standard deviation for early cvs,

to compare with

$s5 = 5.57$ for non-early cvs.

Between muscat and neutral cvs two characters are different: cluster weight and berry weight. In both comparisons neutral cvs show greater means (Table 5) and variances.

Only mean and distribution in berry weight are different between SDD/SDL cvs. Mean berry weight found for SDL cvs is

$\overline{x4} = 3.94$

to compare with

$\overline{x4} = 5.37$, for SDD cv.
(F value = 22.76 ***).

4. Correlations between cultural variables

Table 6 gives simultaneously three different correlation matrices; each of the first three lines corresponds to the first line of a correlation matrix, respectively for:

- muscat cvs
- black-and-neutral cvs
- white-and-neutral cvs.

As before, only SDD cvs were considered. These three groups of cvs gave significant correlation coefficients between x1 and x2, x1 and x4, x3 and x4.

Table 5: Means of different variables for muscat and neutral cultivars. Only seeded cvs have been considered

variables	MUSCAT cvs	NEUTRAL cvs	F value
x1 = time of bud bursting (OIV d.n.)	4.47	4.89	2.35 NS
x2 = time of fruit maturity (OIV d.n.)	4.04	4.18	0.14 NS
x3 = cluster weight (OIV d.n.)	4.14	4.72	6.05 **
x4 = berry weight (OIV d.n.)	5.05	5.58	5.09 *
x5 = number of seeds per berry	2.03	2.22	2.92 NS
x6 = weight of 100 seeds (g)	4.49	4.39	0.14 NS

Significance levels, see table 1.

OIV d.n. = OIV descriptor numbers for the different variables.

- Correlation between x1 and x2: This relation holds also within seedless (SDL) cvs. The value of the correlation coefficient is high:
  $r = +0.62$ ($P > 0.001$),
  when calculated on all seeded (SDD) cvs.
- Correlation between x1 and x4: Early bud burst is correlated with small berry weight. The value of the correlation coefficient is lower than the former:
  $r = +0.48$ ($P > 0.001$),
  when calculated for all SDD cvs.
- Correlation between x3 and x4: Cluster weight and berry weight are highly correlated:
  $r = +0.64$ ($P > 0.001$),
  when calculated on all SDD cvs.
- As the other correlation coefficients of these matrices are generally just at the edge of significance ($P = 0.05$), it seems safer, provisionnally, to doubt their reality.

Table 6: Correlation matrices for six characteristics (x1-x6) and three groups of seeded varieties: muscat cvs (MUS.cvs), black-and-neutral cvs (BL.cvs), white-and-neutral cvs (WH.cvs). The names of cvs groups are put at the place where significant correlation coefficients should figure . — = non-significant correlation coefficients

variables	x1	x2	x3	x4	x5	x6
variables						
x1 = time of	1.00	MUS.cvs	-	MUS.cvs	-	-
bud bursting	1.00	BL.cvs	-	BL.cvs	-	-
(OIV d.n.)	1.00	WH.cvs	WH.cvs	WH.cvs	-	WH.cvs
x2 = time of		1.00	-	-	-	MUS.vcs
fruit maturity		1.00	-	-	-	-
(OIV d.n.)		1.00	WH.cvs	WH.cvs	-	-
x3 = cluster-			1.00	MUS.cvs	-	-
weight			1.00	BL.cvs	-	-
(OIV d.n.)			1.00	WH.cvs	-	-
x4 = berry-				1.00	-	-
weight				1.00	-	BL.cvs
(OIV d.n.)				1.00	-	-
x5 = number of					1.00	-
seeds per berry					1.00	-
					1.00	-
x6 = weight						1.00
of 100 seeds						1.00
(g)						1.00

OIV d.n. = OIV descriptor numbers for the different variables.

Discussion and conclusion

There are not many studies on grape phenotypic variability. Generally, data considered is taken either from ampelographic collections (Huglin 1958; Benin *et al.* 1985) or from seedling collections during the process of grape breeding (Fanizza 1979; Lefort and Bronner 1981; Calo *et al.* 1987). In both cases, the plant material considered is situated at the same place. In this study, data were collected from all over the table grape growing area. These results may obviously appear as more general. In fact, they must be considered only as heuristic results. They may give some interesting indications, if the hypothesis of good balance of climatic variables can be accepted. This must be kept in mind in the following discussion.

1. Regression between cultural and climatologic variables

x1, x2, x3 and x4 (earliness of bud burst and berry maturity, cluster weight and berry weight) are positively correlated with average air temperatures. This means that hot areas are prone to breed later cvs, with bigger bunches and larger berries. But it is unexpected that cluster and berry weight are not related with water supply, as x6 (weight of 100 seeds) is.

2. Seeded versus seedless cvs

The big difference found for berry weight (x4 = 3.94 and x4 = 5.37) was expected. It includes not only varietal factors, but also climatic (SDL cvs are bred in hotter climates) and cultural factors (ringing, gibberellic acid treatments not applied on SDD cvs). It must be emphasized that x4 is the only character which gave a significant difference between SDL and SDD cvs, as the other cultural characters (earliness, cluster weight) showed similar means, in spite of climatic and cultural factors capable of causing divergences.

3. Muscat versus neutral cvs

Differences were found for cluster weight (x3) and berry weight (x4). In fact, these results can also be explained by the highly significant positive regressions between x3, x4 and average temperature of the place of breeding: it seems that new muscat cvs are more frequently registered in cooler areas than neutral cvs. In consequence they have, on average, smaller clusters and smaller berries.

4. Early versus non-early cvs

Neither climatic nor cultural factors differ between these two groups, so differences found (for berry weight) may really be attributed to earliness divergence.

5. Correlation between cultural variables

The preceding result is confirmed in these correlations: x4 (berrx weight) is correlated with x1 (time of bud burst), and also with time of fruit maturity (only in white-and-neutral cvs).

The other remarkable fact is the strong correlation between:

- x1 and x2 (earliness of bud burst and of fruit maturity),
- x3 and x4 (cluster weight and berry weight).

In conclusion, it appears that few characters show differences for mean, variance and/or distribution between the groups of cvs considered. Of the six variables considered, only cluster weight and berry weight gave significant results for SDL/SDD, muscat/neutral and early/non-early cvs, but not for black versus white cvs. Differences not related with climatic or cultural factors were only observed between early and non-early cvs for berry weight.

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