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Studies on table grape germplasm grown in Northern Greece. II. Seedlessness, berry and must characteristics

by

A. MATTHEOU, N. STAVROPOULOS and S. SAMARAS

N.AG.RE.F., Agricultural Research Center of Makedonia and Thraki, Greek Gene Bank, Thessaloniki, Greece

S u m m a r y : From 1991 to 1993 nine quantitative and qualitative characteristics of the grape berry and its must were evaluated using local and introduced table grape cultivars of the grapevine collection of the Greek Gene Bank. The data indicate a distinct variation in the grape germplasm in all characters and demonstrate the usefulness of the genetic material as a donor of important genes for grapevine improvement. Principal Component Analysis (PCA) produced 2 factors representing 68.1% of the total variation. PC_1, explaining 43.6% of the total variance, is highly correlated with berry size parameters and characteristics of the berry structure. By Cluster Analysis the assessed cultivars were separated into distinct groups; while seedlessness, was associated with small berry detachment force from the pedicel, late maturity was combined with high acid and low sugar content and a large number of seeds per berry was accompanied by low sugar content.

K e y w o r d s : table grapes, germplasm, seedlessness, berry, must, Greece.

Introduction

It is widely recognized that the modern objectives in table grape breeding are large berry size, high berry attachment to the pedicel, attractive colour, firm flesh, good taste, good transport characteristics, good storage quality and very early or very late ripening.

The climate of Greece constitutes a very favorable environment for the production of high quality table grapes. Except for Razaki (Dattier de Beyrouth) that shows good adaptability and having high quality standards, most other cultivars show various defects in certain regions of Greece resulting in a reduced commercial value. However certain new cultivars were released in the last decade, bred by the Vine Institute of Athens, which have very promissing qualitative characteristics (MICHOS 1992).

Berry weight is a crucial qualitative character, in conjunction with resistance to crushing and to pedicel detachment. The estimated heritability coefficient ranges from h^2=0.62 to 0.72 (GOLODRIGA and TROSHIN 1978) or even h^2=0.86 (AVRAMOV *et al.* 1978).

Seedlessness is an attractive characteristic for the modern table grape breeders due to an increased demand. It is believed that seedlessness is controlled by some recessive genes (SPIEGEL-ROY *et al.* 1986) and its heritability is significantly influenced by the maternal genotype (LOUMIS and WEINBERGER 1979; RAMMING *et al.* 1990; SPIEGEL-ROY *et al.* 1990). On the other hand, seedlessness is linked to certain negative characters, such as small size of grapes and low fertility of buds which reduce table grapes quality and yield (CANCELLIER *et al.* 1990).

Sugar content of berries is a multigenically controlled characteristic with heritability coefficients ranging from h^2=0.28 (AVRAMOV *et al.* 1978) to h^2=0.46 (GOLODRIGA and TROCHINE 1978). According to EIBACH (1990) sugar content is strongly influenced by the environment, cultivation methods and yield. It has also been shown that the sugar content tends to correlate more negatively with cluster weight than with the number of clusters per plant (ALLEWELDT and KOEPCHEN 1978). The same is true for the acid content, the genotypic control of which is more pronounced (h^2=0.55-0.58; GOLODRIGA and TROSHIN 1978).

This investigation presents data on the variation of some important characteristics of table grape cultivars, like seedlessness, berry characteristics and fruit quality, under the conditions of Northern Greece. This work complements our previous study (MATTHEOU *et al.* 1995) on important quantitative characters of the same grape cultivars.

Material and methods

The cultivars studied, the viticultural practices as well as the ecogeografic data of the experimental grape germplasm field collection were presented in our previous study (MATTHEOU *et al.* 1995).

The characters studied were: Berry size (length, width and weight); number of seeds per 100 berries; berry texture (resistance to crushing and detachment force from the pedicel); sugar (g/l must) and acid (g tartaric acid/l must) of the must as well as the associated maturity index.

Correspondence to: A. MATTHEOU, N.AG.RE.F., Agricultural Research Center of Makedonia and Thraki, Greek Gene Bank, GR-57001 Thermi of Thessaloniki, Greece. Fax: (031) 471-209.

The results are presented as average values of a 3-year period (1991-1993). The cultivars were characterized using the methods proposed in the Descriptor List for *Vitis vinifera* L. (IBPGR, 1983). Character scores appearing in the Table represent means obtained from 50 berries of each plant for each cultivar.

Total soluble solids (°Brix) was measured by a temperature compensating refractometer (AO Scientific Instruments). Tartaric acid was determined by titration using a N/10 NaOH titration medium and index of phenolphthalein. Detachment force of berries from the pedicel and their resistance to crushing were determined by simple mechanical equipment measuring forces (g) of detachment or crushing.

"Principal Component and Cluster Analysis" were used to explain the variation exhibited by the evaluated germplasm. Factor analysis and cluster analysis were carried out using the SPSS/PC package, procedures Factor and Cluster, respectively. Procedure correlation of the same package was used to find the relation between the various characters. In addition, correlation was also run jointly on data of part I and part II of this study to assess the relation of the maturity and yield parameters to those associated with berry technological and physiological quality.

Results and discussion

It has been shown in our previous paper that the cultivars can be classified into 4 categories on the basis of their ripening characteristics (MATTHEOU *et al.* 1995)

Factor analysis produced 2 principal components with eigen values greater than 1 accounting for 68.1% of the overall variance. Higher loadings on PC_1 had the parameters berry size and structure, while PC_2 had the parameters acid content and maturity index.

Berry size characteristics: Berry size was extremely variable in the germplasm studied (Table). Berry length ranged from 14.8 (Perlette) to 24.1 mm (Italia), berry width from 11.4 (Blank Monukka) to 22.8 mm (Cardinal) and berry weight from 1.9 (Perlette) to 6.2 g (Cardinal). Berry weight was significantly correlated with berry length (r=0.80), berry width (r=0.65) as well as with the number of seeds per 100 berries (r=0.50), the detachment force of the berry from the pedicel (r=0.50) and the resistance of berries to crushing (r=0.46). In contrast, it was negatively correlated with the sugar content (r=-0.55). The correlation between the number of seeds per 100 berries and berry size parameters underlines the physiological role of hormones produced by the seeds during berry development. Berry length is highly correlated to its width (r=0.74) and significantly correlated with the number of seeds per 100 berries (r=0.42), with its resistance to crushing (r=0.47) and berry detachment force from the pedicel (r=0.45).

Cultivars were discriminated on berry size on PC_1 which might be described as a berry size factor (Fig.1). Cultivars with small berries were plotted on the negative side of PC_1 axis, while those with large berries on its positive side. Length, width and weight of berries have higher loadings on this factor (r=0.83, 0.76 and 0.88, respectively).

Number of seeds: Four seedless, early grapevine cultivars (Attiki, Perlette, Black Monukka and Sultanina) were included in the study. The very late season cultivars Mariano, Sideritis and Opsimo Prosotsanis had the highest number of seeds per 100 berries (250 to 270) (Table) The number of seeds was shown to be positively correlated with the detachment force of berries from the pedicel (r=0.56) and its resistance to crushing (r=0.44), while it was negatively correlated to sugar content (r=-0.50) and maturity index (r=-0.38). These data explain the superiority of seeded and late maturing cultivars over early cultivars with regard to the suitability to transport. The seedless cultivars appear on the PC_1 in areas which are separated from these containing seeds (Fig. 1) and they are clustered in a separate group in the dendrogram (Fig. 2).

The combined analysis over all 19 characters (see also MATTHEOU *et al.* 1995) revealed a significant correlation between the number of seeds per 100 berries with the length of maturity time (r=0.51 to 0.65) and yield (r=0.41).

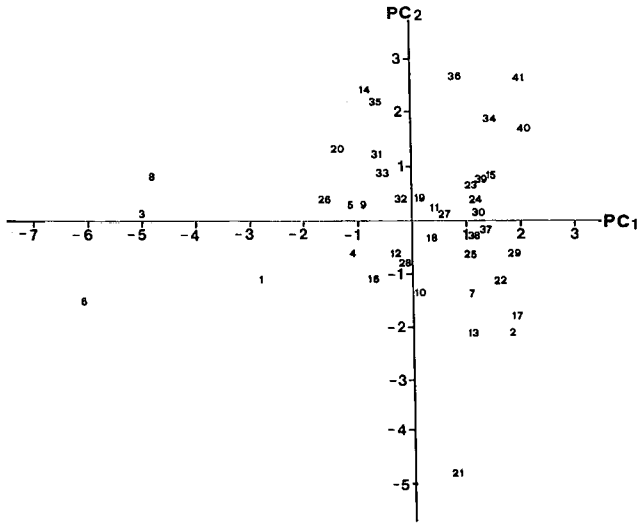

Fig. 1: Projection of cultivars on PC_1 (berry size factor) and PC_2 (maturity index factor). Early seedless cultivars and those with small berries appear on the negative part of PC_1 while the very late maturing cultivars and those with large berries on the positive side. Cultivars high in acidity are separated from those with high maturity index along the PC_2.

Berry detachment force from the pedicel and resistance to crushing: The detachment force of berries from the pedicel and their resistance to crushing are important technological characteristics for exportable grapes and the main indicators to determine the quality of grapes for consumption. The detachment force ranged from < 300 g in seedless and early cultivars to > 500 g in the latest maturing, seeded cultivars (Table). There is a high correlation with the maturity time (r=0.56 to 0.68), yield per vine (r=0.49) as well as with berry resistance to crushing (r=0.63), which means that the berries of late maturing cultivars are strongly attached

T a b l e

Categories of cultivars and characteristics of berry and must

Cultivars	Berry characteristics						must characteristics		
	Length cm	Width cm	Weight g	No of Seeds /100 berries	Attachment to pedicel g	Resistance to crushing g	Sugar g/l must	Acidity tartaric cont. g/l must	Maturity Index Sugar %o / Acid %o
Early									
1 Attiki	23,5	16,7	3,4	0	260	970	165,1	5,2	35,69
2 Cardinal	23,2	22,6	6,2	170	270	1020	166,5	4,8	34,47
3 Perlette	14,6	14,6	1,9	0	165	400	172,6	5,3	32,56
4 Muscat R.D.V.	20,3	18,9	3,2	170	260	860	166,5	5.0	33,70
5 Gold	20,2	16,8	4,0	165	250	950	172,3	5,5	31,32
6 Blanc Moaukka	15,2	11,4	2,2	0	190	780	175,6	4,8	36,66
Average	19,5	16,9	3,5	87,5	232,5	830	173,3	4,3	34.03
Mid season									
7 Victoria	22,1	16,4	5,5	190	320	1020	160,6	4,9	32,77
8 Soultanina	17,5	16,1	2,2	0	190	790	161,2	5,7	31,24
9 Muscat Hambourg	20,2	19,5	3,2	210	240	850	166,7	5,4	31,24
10 Passe Precoce	22,4	19,1	4,1	208	290	810	165,3	4,8	34,43
11 Avgoulato	21,3	20,3	3,9	220	260	1160	169,4	5,4	31,37
12 Muscat Alexand.	22,4	20,2	4,1	190	290	860	175,4	5,2	33,73
13 Razaki	21,8	18,4	4,9	178	390	1250	162,4	4,6	35,30
14 Fokiano	20,5	19,3	3,5	195	330	1050	160,4	6,3	28,63
15 Pileri	22,4	20,1	4,4	195	460	1060	166,7	5,6	29,76
16 Astouychi Lefko	20,7	18,2	4,1	230	300	790	172,5	4,9	35,60
17 Italia	24,1	20,2	5,2	174	460	1460	175,1	4,8	36,47
18 Chourmas	22,5	20,2	4,3	170	310	1100	170,3	5,3	32,13
19 Tachtas	21,2	18,4	3,6	230	340	1230	169,4	5,4	31,37
20 Contegallo	17,5	16,3	3,4	205	320	1200	171,4	5,7	30,07
21 Alfonse Lav.	22,1	18,5	5,0	195	430	1030	162,8	3,8	42,84
22 Astouychi Mavro	22,4	17,7	4,3	195	470	1900	170,3	4,9	34,75
Average	21,3	18,8	4,1	196,3	340,6	1101	170,1	5,17	33,23
Late season									
23 Korithi Aspro	22,8	20,2	4,2	240	330	1350	171,4	5,6	30,60
24 Petinos	20,8	19,2	4,5	190	550	1250	169,5	5,4	31,38
25 Opsimo Souflioy	23,2	17,1	5,1	190	360	1270	167,3	5,2	32,17
26 Krystalli	18,7	16,9	3,9	195	270	940	175,5	5,5	31,90
27 Eftakilo	20,5	18,7	4,2	220	360	1220	164,8	5,3	31,09
28 Opsimo Edessis	20,2	16,2	3,8	175	360	1350	163,2	4,9	33,30
29 Fraoula Kokkini	23,4	20,1	5,5	225	290	1140	162,4	5,2	31,23
30 Emperor	21,2	20,2	4,5	190	470	1270	166,9	5,4	31,27
31 Akiki	20,5	18,6	3,3	225	360	960	178,7	5,7	31,36
32 Syriki	21,5	20,2	3,8	190	260	920	166,8	5,5	30,32
33 Aledo	20,8	18,3	3,2	205	370	1060	173,5	5,6	30,98
Average	21,2	18,7	4,2	202,6	368,1	1191	166,3	5,4	31,42
Very late season									
34 Tokai	22,6	19,8	4,9	230	490	1060	172,6	6,1	28,29
35 Opsimo Proeota.	17,2	16,6	2,9	270	410	1200	170,2	5,9	28,84
36 Muscules	19,8	18,9	3,9	240	460	1100	164,8	6,2	26,58
37 Ohanes	23,2	19,5	4,4	195	415	1220	165,2	5,3	31,16
38 Calmeria	22,1	20,4	4,3	190	430	1160	169,4	5,2	32,36
39 Domiago	23,1	19,2	4,8	205	420	1250	172,1	5,7	30,19
40 Mariano	22,2	19,2	4,7	260	520	1060	163,3	5,9	27,67
41 Sideritis	22,4	19,2	4,7	250	520	1060	166,5	6,3	26,42
Average	21,6	19,0	4,8	226,2	456,8	1144	167,8	5,8	28,84

to the pedicel and they are more resistant to postharvest treatments and transport. The resistance of berries to crushing was found to be associated with the time of maturity (r=0.34 to 0.43) as well as with the number of seeds per 100 berries (r=0.44) and with the berry size parameters. These relations indicate the difficulties to combine earliness, seedlessness, large berry size and firmness in grape breeding.

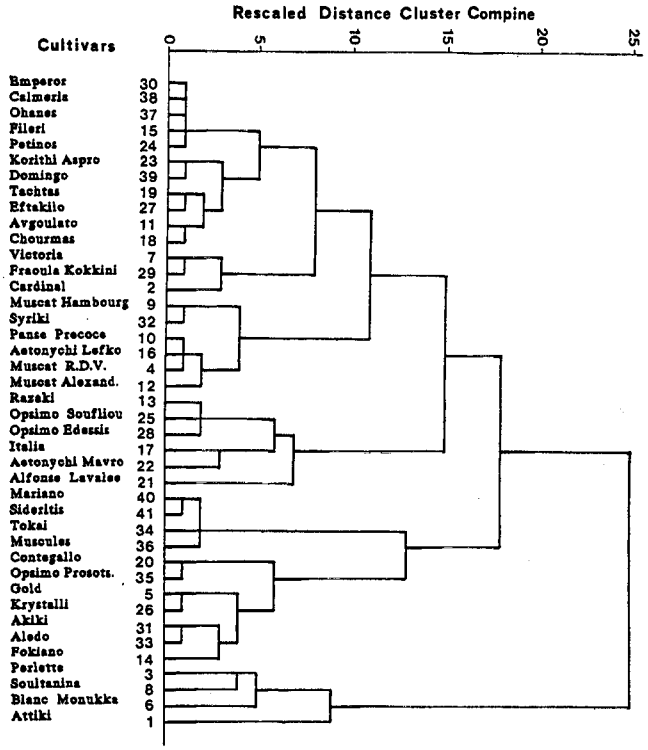

Fig. 2: Dendrogram clearly separating the early ripening seedless cultivars from the late ripening seeded ones.

Conclusions

Among early cultivars only few have large berry size, e.g. Attiki and Cardinal. The late maturing cultivars are characterized by high berry attachment forces to the pedicel and a high resistance to crushing. Most cultivars have 1-2 seeds per berry, few have 2-3 and 4 cultivars were seedless. The very late maturing cultivars had a lower sugar and higher acid content compared to early cultivars.

All characters studied in this work are crucial for a table grape breeding program. Seedlessness, large berry dimensions, firm flesh, resistance to crushing and high detachment forces from the pedicel contribute to the commercial value and storage quality. Also, the maturity index highly affects the sensory quality of the product. The wide variation of the assessed germplasm provides a reliable basis for further successful breeding.

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