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Comparison of methods used for determining the stenospermic trait in *Vitis vinifera* L.

by

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Summary: Grape samples from nine progeny populations totaling 580 individual seedlings were evaluated organoleptically for the stenospermic character by four independent judges. These subjective evaluations were correlated to a standard objective procedure for evaluating stenospermy, as well as other variables associated with the sinker content of each sample. Correlations were diverse between organoleptic evaluations and calculated variables. Organoleptic evaluations more closely agreed with the objective stenospermic evaluation for seeded grapes. Highest correlations were realized between organoleptic evaluation and relative seed mass. These results indicate that organoleptic evaluations should not be used in genetic studies to discern between seeded and stenospermic accessions.

Key words: seedlessness, seed, berry, organoleptic evaluation.

Introduction

Stout (1936) first used the term stenospermic to label types of grapes that were neither parthenocarpic nor seeded. Stenospermic berries have embryos that can be grown into plants using *in ovulo* embryo culture (Emershad and Ramming 1984). Problems occur when researchers attempt to separate seeded and stenospermic types. In genetic studies with a character expressing continuous variation such as seed trace size, the question arises as to where the division between seeded and stenospermic individuals should be. This division has varied between researchers and experiments. Progenies have been divided into seeded and stenospermic classes on the basis of detectability and taste (Spiegel-Roy *et al.* 1990), seed weight and resistance of the seed to a razor blade (Olmo and Baris 1973), or berry polyphenol content (Merin *et al.* 1983). Numerous studies have divided progeny from seeded by seedless crosses into seedless, near-seedless and seeded classes (Spiegel-Roy *et al.* 1990). Alternatively, other studies have treated this character as a quantitative trait with continuous variation (Golodriga *et al.* 1986).

The present study evaluates organoleptic methods to define stenospermy as compared with a standard procedure for determining whether a *Vitis vinifera* accession is seeded or stenospermic (Ledbetter and Shonnard 1991).

Materials and methods

Progeny populations were obtained from planned crosses using a seeded female vine and a variety of seedless male parents (Tab. 1). Ancestry of all male parents used in this study indicates that seedlessness originated from the cultivar Thompson Seedless. Seedlings were planted and maintained in a drip-irrigated vineyard on California State University, Fresno, property.

Two to four clusters from each fruiting vine were harvested at full ripeness for sampling. Since it has been clearly demonstrated that berry size corresponds with increasing number of seeds per berry (Olmo 1946) and that systematic sampling from clusters will reduce experimental variation (Hagiwara *et al.* 1987), sampling was made as uniform as possible. 100 large uniform berries were selected from fruit clusters of each vine. Under size berries were always excluded from the samples. Seeds and abortive seed traces were obtained using previously described methods (Ledbetter and Shonnard 1991). Progeny populations were then subdivided into two phenotypic classes, seeded and stenospermic, based on seed/abortive seed trace content of the berry samples.

Fruit samples were also analyzed and classified organoleptically by a panel of 4 independent judges into seedless and seeded classes. Judges' phenotypic classifications were then correlated with variables associated with sinker characteristics of each sample (Tab. 2 and 3) by use of the adjusted R^2 values from weighted least squares analyses (Neter and Wasserman 1974). Stenospermic evaluation refers to discrete values based on a sinker frequency being greater than one sinker per berry (seeded), or less than one sinker per berry (stenospermic) (Ledbetter and Shonnard 1991). Sinker frequency is a continuous variable expressed as the number of mature seed that sink in water per number of berries. Relative seed mass equals sinker frequency multiplied by average sinker weight. Finally, seed ratio refers to the total seed weight divided by the total fruit weight. The correlation for the stenospermic evaluation results and the organoleptic evaluations by each judge (first row of Tab. 2) was determined by the phi coefficient of agreement (Siegel and Castellan 1988). The phi coefficient is a nonparametric measure of association for nominal data that can take on only one of two possible

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Table 1

Numbers of fruitful progeny and percentage of seedlessness from seeded by seedless crosses, average sinker frequency and weight for seeded and seedless siblings within each progeny.

Cross	Seedlings evaluated	% seedless	Seeded accessions Sinker frequency	Seeded accessions Average sinker weight (mg)	Seedless accessions Sinker frequency	Seedless accessions Average sinker weight (mg)
A81-110 x A32-167	65	83.1	1.77	30.0	0.22	12.2
x A32-140	132	78.0	1.77	36.9	0.25	14.3
x A32-152	40	40.0	1.74	64.2	0.14	19.5
x A32-171	54	44.4	2.02	63.3	0.20	10.7
x A32-173	72	51.4	1.81	60.9	0.19	9.5
x A31-107	62	72.6	1.55	46.4	0.16	15.0
x A31-133	36	36.1	1.72	62.5	0.13	18.7
x A31-151	57	78.9	1.39	51.3	0.22	17.6
x A32-122	62	71.0	1.52	42.9	0.13	14.6

values, in this analysis, seeded and seedless. The phi coefficient varies between 0 and 1, 0 showing no association between two variables and 1 being perfect agreement.

Results and discussion

Progeny sizes and percentages of seedless individuals within each progeny, as well as sinker frequencies and weights are listed in Tab. 1. The first row in Tab. 2 shows the phi coefficients between stenospermic and organoleptic evaluations for each judge over all the combined progeny and all are significant at the $p < 0.001$ level. The remainder of Tab. 2 shows the adjusted Pearson correlation coefficients from a weighted least squares analysis between organoleptic evaluations and the variables relating to sinker characteristics. The correlations are diverse, however, the relative values of the correlation coefficients between judges for a particular sinker characteristics variable are similar. The highest overall correlations are observed with relative seed mass and perhaps seed ratio.

For both sinker frequency and relative seed mass variables, the progenies were split into seeded and seedless siblings. Each judge's correlation coefficients between organoleptic evaluation and these variables were higher for seeded accessions compared to values obtained for seedless selections.

Since relative seed mass yielded, in general, the highest correlations among judges, single progenies were individually correlated with adjusted R^2 values from weighted least squares analyses, for organoleptic evaluations and this variable (Tab. 3). It was demonstrated that progenies with a higher number of seeded grapes were more accurately evaluated than those with many seedless accessions. Correlations between organoleptic evaluation and objectively defined variables were highest in progenies with both a high average sinker weight from seeded accessions and a low average sinker weight from seedless accessions. However, very different correlation coefficients between progenies with similar percentage of seedless grapes were also observed (A81-110 by A32-167 *vs.* A81-110 by A32-140). This confirms the notion that other berry characteristics such as berry flesh crispness, are influencing the perceptivity of the seedless trait (Ledbetter and Ramming 1989).

Regarding the degree of association between the objective stenospermic evaluation and an organoleptic evalu-

Table 2

Phi coefficients of agreement between stenospermic and organoleptic evaluations and correlation coefficients between variables associated with the sinker characteristics and organoleptic evaluations.

	Organoleptic evaluation 1st judge	2nd judge	3rd judge	4th judge
Stenospermic evaluation1)	0.579	0.642	0.604	0.610
Sinker frequency	0.405	0.368	0.374	0.510
-seeded accessions	0.451	0.148	0.380	-0.002
-seedless accessions	0.011	-0.004	0.002	0.022
Sinker weight	0.471	0.556	0.295	0.420
Relative seed mass	0.510	0.795	0.633	0.545
-seeded accessions	0.537	0.552	0.488	0.390
-seedless accessions	0.019	-0.005	0.008	0.059
Seed ratio	0.480	0.379	0.579	0.534

1)Phi coefficients of agreement

ation, the accuracy of the judges was greater in recognizing seeded grapes than the seedless accessions. The difficulty with seedless types may be in that large seed traces give a "seeded" perception although they are not truly seeded. STRIEM *et al.* (1992) suggested that seed coat hardness as well as endosperm and embryo development should be considered as different traits or "subtraits" of stenospermocarpy. The expression of these subtraits may influence the perception of stenospermic seedlessness in grapes.

When variables more related to the consumer perception were used, a better correlation with the organoleptic evaluation was obtained. Hence, variables like relative seed mass and seed ratio, gave a higher correlation which means that judges were influenced by the "seed content" in each berry, as well as the characteristic of the berry flesh.

We must conclude that an organoleptic evaluation is disadvisable when the stenospermic character is being determined for use in genetic studies. Seed/seed trace characteristics as well as specific factors associated with the berry flesh may greatly influence an organoleptic evaluation and therefore skew phenotypic ratios. However, from a grape breeding program viewpoint, the consumer perception is paramount. Seed coat hardness as well as seed or seed trace size should be evaluated organoleptically and used as a subjective criteria for determining whether or not an accession should be released as a cultivar.

Table 3

Correlation coefficients from weighted least squares analyses between relative seed mass variable and organoleptic evaluation within each progeny.

Cross		Organoleptic evaluation			
		1st judge	2nd judge	3rd judge	4th judge
A81-110	x A32-167	-0.03	0	-0.01	-0.10
	x A32-140	0.21	0.07	0.37	0.10
	x A32-152	0.71	0.91	0.59	0.69
	x A32-171	0.74	0.53	0.76	0.51
	x A32-173	0.92	0.92	0.83	0.88
	x A31-107	0.52	0.09	0.63	0.47
	x A31-133	0.76	0.53	0.86	0.91
	x A31-151	0.56	0.36	0	0.27
	x A32-122	0.56	0.90	0.79	0

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