

THE SICILIAN OLIVE GERMPLASM AND ITS CHARACTERIZATION BY USING STATISTICAL METHODS

E. Barone, L. Di Marco, A. Motisi and T. Caruso
Istituto di Colture Legnose Agrarie e Forestali
University of Reggio Calabria, 89061
Gallina (RC) - Italy

Abstract

Fruit, pit and leaf biometric characters were evaluated for their ability to discriminate olive cultivars. Recordings from 25 indigenous Sicilian cultivars were used. Data showed a large amount of variability among the accessions that can be considered as a valuable source of genetic traits for breeding programmes. Discriminant functions calculated using fruit characters classified correctly 87% of the observations but only less than 50% using leaf and leaf colour. No identities between cultivars were detected. Principal components analysis on the between-cultivars correlation matrix for all variables extracted 6 unrelated variables explaining >95% of total variance and showed few patterns of similarities between cultivars.

Introduction

Biometrics characters have been widely utilized in olive for descriptive purposes (Bottari & Spina, 1952; Barranco & Rallo, 1984) and are commonly used for distinguishing cultivars.

About the real taxonomic value of some of these characters there are only few works carried out mainly in the fifties, using univariate statistics (Baldini & Scaramuzzi, 1952; 1955). First study on the use of multivariate statistics on this subject was performed by Damigella in 1960 using discriminant functions, but no other studies were reported thereafter.

This paper deals with the characterization of the Sicilian olive germplasm on the basis of multivariate analysis of biometric traits with the following purposes:

- determine the overall degree of polymorphism of the characters;
- verify the taxonomic value of the biometric traits;
- assess the presence of synonymies in our collection;
- detect similarities/dissimilarities among the cultivars.

Material and Methods

A collection of more than 40 indigenous Sicilian olive cultivars was established in 1985 by topworking 20-year-old trees in an experimental orchard located at Menfi (AG), Italy. Each cultivar was replicated three times.

In 1992, trees of 25 cultivars bearing an adequate crop were chosen for observations. Samples of 50 fruits and leaves were taken randomly from the trees of each cultivar for the measurements. The colour of the leaves was recorded by a Minolta CR300 Chroma Meter using the CIELAB (L*, a*, b*) color system; a* and b* values were used to calculate the polar coordinates in the color space (chroma C and the hue angle h°).

A total of 17 variables was used for statistical analyses. Standard descriptive statistics were calculated within and between cultivars together with univariate F-tests for differences between genotypes for each variable.

Discriminant analyses (Wilk's lambda method) were performed separately for fruit, leaf and leaf colour data. Cross-validation of the discriminant functions was performed repeating the analyses on 10 random sub samples of about half the dataset.

All variables were averaged by cultivar to calculate a between-cultivars correlation matrix for all possible pairs of variables which was submitted to principal components analysis (PCA) as an ordination method of the cultivars.

3. Results

Highest coefficients of variation were observed for fruit and pit weight (37 and 29 %, respectively). Fruit weight ranged from 1.8 (cv. 'Castricianella Rapparina') to 8.4 g (cv. 'Giarraffa'). The highest Flesh to Pit ratio recorded was 10.7 (cv. 'Giarraffa') while the lowest was 3.9 (cv. 'Minuta').

A lower variation was instead observed for leaf hue (1.2%) and fruit length to width ratio (8.6%). Leaf length and width varied respectively from 39.3 to 68.28 mm and from 9.68 to 17.54 mm.

Discriminant analyses were highly significant and none of the calculated discriminant functions was excluded. Predicted vs. actual group membership of the observations was coincident in 87%, 49% and 45% of cases, respectively for fruit, leaf and leaf colour analyses.

Cross-validation performed on 10 random sub samples of about half the size of the whole sets showed a similar result, with only a small decay in the predictive power.

The first two discriminant functions calculated on fruit variables accounted for more than 70% of total variance. Fruit weight and pit weight loaded high, with opposite sign, on the first function while on the second loaded pit weight and pit length, again with opposite sign.

PCA reduced the dimensions of the data by eliminating redundancies caused by correlations among variables. Out of the initial 17 variables, PCA identified 6 principal components that explained more than 95% of the total variance. A specific meaning could be attributed to each of the 6 new, unrelated, variables as follows:

- 1st, related to variables expressing fruit size; 40% of total variance (t.v.);
- 2nd, reflects the negative correlation between shape of fruit (length/width) and leaf size; 22% of t.v.;
- 3rd, related to leaf colour (hue and brightness mostly); 15.6% of t.v.;
- 4th, related to leaf length to width ratio; 9.5% of t.v.;
- 5th, related to differences among cultivars for flesh to pit ratio; 5.3% of t.v.;
- 6th, residual correlations of difficult interpretation between pit shape, leaf Chroma and leaf size; 4.8% of t.v.

According to the meaning of first two principal components the plot of the scores reveals a consistent ordination of the cultivars by fruit size, and leaf and fruit shape. For example cv. Nocellara del Belice (NBE) which has a round, large fruit and broad leaves, is located in the lower right corner of the graph while cv. Brandofino (BRA) also with large fruit but with narrow leaves and elongated fruit shape is located in the upper right corner. Plots of remaining principal components, however, did not reveal clear patterns in the distribution of the cultivars.

4. Discussion

A considerable amount of variation in morphological traits was found between cultivars. A higher polymorphism was observed for fruit rather than leaf characters.

Accordingly, discriminant analyses showed that only fruit characters were effective in separating the 25 cultivars studied. No identities between cultivars were detected by discriminant analysis thus excluding possible cases of synonymy in our set of cultivars. Cross-validations essentially confirm these results.

Among the factors extracted by PCA no unexpected associations between characters were found with the exception of a negative correlation emerged for fruit shape vs. leaf size that deserves further observations. PCA helped to single out a few cultivars with distinctive characters from the others but, on the whole, no close similarities among the cultivars could be found.

On the basis of these results it seems that the cultivars included in this study are genetically apart and could likely have distinct origins. These conclusions confirm the idea that the Sicilian olive germplasm is in a large extent the result of several introductions of genetic material from a wide spectrum of countries, together with local selections.

References

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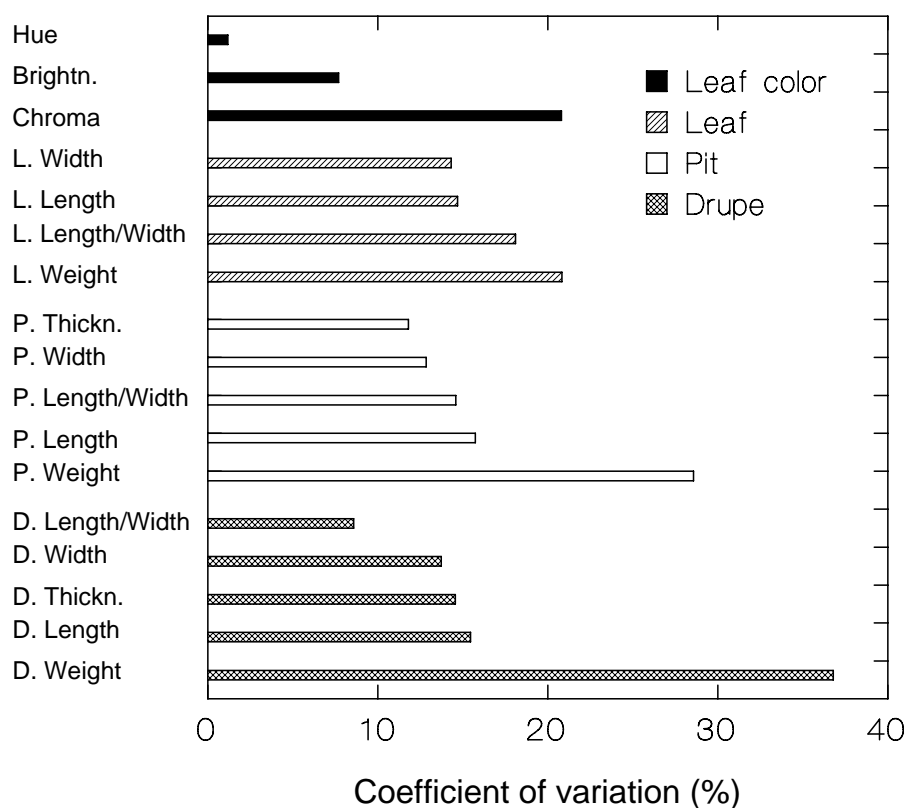


Figure 1 - Between-cultivars coefficients of variation for leaf and fruit biometric traits.

