Olive Genetic Improvement: Thirty Years of Research

E. Bellini and E. Giordani
Dipartimento di Ortoflorofrutticoltura
University of Florence - Italy
E-mail: elvio.bellini@unifi.it

M.V. Parlati and S. Pandolfi
Istituto Sperimentale per l'Olivicoltura
S.O.P. of Spoleto - Italy
E-mail: isolspoleto@libero.it

Keywords: *Olea europaea* L., breeding, table cultivar, oil cultivar, dual purpose cultivar

Abstract

A breeding program has been established down since 1971 with the aim of obtaining new valuable olive cultivars for table, oil and dual purpose. A set of 127 combinations have been obtained by crossing 12 table and 5 oil cultivars, for a total amount of 5,000 seedlings planted during 1975-77. The progenies have been analysed for traits of the tree (juvenility, vigour, habit, flowering entity, fruit set, productivity, ripening time), of the leaves (size, shape, colour), of the drupes (size, shape, skin and flesh colour, skin colour change, stone size and shape) and of the rooting capability. In 1987 the evaluation of data gathered during precedent years allowed to identify 200 selections, valuable mainly for the drupe traits (weight, size, shape variability, skin colour, precocity and period of colour change), and tree characteristics such as vigour degree, plant habit, flowering entity and productivity. During 1992-99 data about vegetative, productive and fruit characteristics (both analytical and technological parameters) were collected for all selections under study in three different Italian environments. Till now three new cultivars have been released.

INTRODUCTION

The current techniques of genetic improvement applied to olive, apart from the new biotechnologies, are clonal selection, mutation breeding and cross-breeding. As a matter of fact clonal selection mainly addresses the evaluation, the identification and the exploitation of already existing clones; on the other hand, the achieved results by mutation breeding with the cultivar "Briscola" (Roselli and Donini, 1982) and by cross-breeding with cultivars "Barnea" (Lavee et al., 1986), "Maalot" (Lavee et al., 1999) and "FS 17" (Fontanazza et al., 1990), are not yet enough to cover the still strong demand of new olive genotypes.

Such narrow results are due to specific traits (olive is highly heterozigous, most cultivars are self-sterile, the juvenile phase is very long) and to the limited number of breeding programs carried on worldwide.

In 1971 the former Istituto di Coltivazioni Arboree (now Dipartimento di Ortoflorofrutticoltura) of the University of Florence and the former Centro di Studio (now Istituto) of CNR sulla Propagazione delle Specie Legnose, started a breeding program on olive with the aim of obtaining new table, oil and dual purpose cultivars (Bellini, 1979, 1988).

MATERIALS AND METHODS

The crosses regarded 17 cultivars (12 for table - "Aglandau", "Ascolana", "Bouteillan", "Giarraffa", "Gordal", "Grossanne", "Manzanilla", "Nocellara Etnea", "Picholine", "Sorba", "Tanche", "Verdale" and 5 for oil use - "Coratina", "Frantoio", "Leccino", "Puntino", "Razzo"), for a total amount of 127 different progenies. Even if paternity can not be completely assessed, most of maternal parents were totally self-incompatible (Morettini et al., 1972) and the percentage of possible seedlings obtained by self-pollination is practically insignificant for the findings and the conclusions here reported. In order to assess paternity, results on self- pollination and the evaluation of more than 5,000 F_1 seedlings grown since 1975-77 by the farm “Il Casone” at Scarlino (GR), allowed to individuate 200 selections, valuable for productive traits of drupes

(weight, size, shape, skin and flesh colour, ripening time) and of the tree (vigour, habit, productivity) (Bellini, 1990, 1992, 1993).

RESULTS

Data and observations made during the last thirty years allowed us to select superior genotypes and also to gather interesting information for future breeding programs of olive.

Studies on progenies: phenotypic variability and parental contribution. The observation carried on progenies confirms that olive is highly heterozygous. Taking into account data on 15-year-old trees, the coefficient of variability found within progenies is very close to that calculated on the whole population for traits such as tree vigour and tree habit (table 1). As regards juvenility, the progenies with a higher percentage of adult seedlings were "Leccino x Aglandau" (98%) and "Leccino x Gordal" (92%); on the contrary "Grossanne x Frantoio" and "Picholine x Coratina" had the higher percentage of juvenile seedlings (40% and 28% respectively). Totaly juvenile seedlings were found after 25 years of planting. Seed germinating ability is more directly influenced by maternal parent (Bini and Bellini, 1975), and seeds derived from "Picholine", both as pollinated and pollinator, showed a high germinating capacity in comparison to other progenies.

On the 12 progenies with more than 100 seedlings, data were collected and analysed on morphological traits of both leaves (size and shape) and fruits (size and shape of drupes, skin and flesh colour, size and shape of stone). The number of seedlings with drupes heavier than 4g was very low (<5%) in the progenies "Picholine x Coratina", "Picholine x Puntino" and "Leccino x Aglandau"; on the contrary it was very high (>80%) in "Picholine x Manzanilla", "Picholine x Gordal", "Picholine x Grossanne" and "Leccino x Manzanilla". An approximate contribution of each progeny to drupe colour (skin and flesh) together with drupe and stone shape, can be appreciated in figure 1, where progenies are plotted on the first two Principal Components against the vectors of original variables. Other collected data regarded flowering entity, fruit set, productivity and ripening time (Bellini, 1993; Bellini et al., 1995).

Studies on selections: rooting ability. On a first set of 150 selections the variability of rooting ability was studied both on treated (IBA at 2,000 ppm) and on control cuttings. A high variability was individualized; the higher percentage of rooted cuttings was found within the "Picholine" progenies (Bellini *et al.*, 1990).

Pre-selection of seedlings and evaluation of selections. A pre-selection of seedlings has been carried out taking into account vegetative and productive parameters, and using a hierarchical strategy (main and secondary traits), and pointing out genotypes interesting for a given specific trait.

Self-rooted cuttings were planted in 1988 in 3 experimental farms in Spoleto (Az. sperimentale ISO – Sezione di Spoleto), in Metaponto (Az. sperimentale Pantanello della Regione Basilicata) and in Rossano Calabro (Az. sperimentale dell'ISO di Cosenza), in order to evaluate their behaviour and to choose the superior genotypes as new dual purpose olive cultivars (Bellini et al., 1990, 1993). Data collected regarded the tree habit and vigour, flowering time and entity, fruit set, fertility and productivity and traits on drupes (weight, size, shape, skin and flesh colour, time of colour changing, flesh/stone weight ratio, oil content) and resistance to the main pest and diseases of olive.

Among the different progenies, "Picholine x Manzanilla" showed the highest number of promising selections. The tree vigour for 60% of selections was intermediate, while it was low and high for the remaining 40% of selections in the same proportion. The trait upright tree habit is present in 60% of progeny. Regarding drupes, 80% of selections brings medium to medium-large fruits (3-7 g) while 10% of them has large or very large sizes (> 7 g). The prevailing fruit shapes are oval and elliptic. A little amount of selections (5%) changes colour of drupes in very early and early periods, while in 80% this occurs at the end of October.

Three new cultivars ("Arno", "Tevere" and "Basento") for dual purpose have been

released; other advanced selections are under evaluation.

ACKNOWLEDGEMENTS

The Authors wish to thank P. Arcuti, S. D'Alessandro, G. D'Ascanio, S. Martelli and A. Silletti of the farm "Pantanello" (Metaponto - Italy).

Literature Cited

Bellini, E. 1979. Costituzione di cultivar di olivo da tavola attraverso l'incrocio. Agricoltura Toscana, supp. al N° 12.

Bellini, E. 1988. Miglioramento genetico dell'olivo per la costituzione di nuove cultivar, con particolare riferimento a quelle da tavola. Centro Sperimentale per la Ortoflorofrutticoltura della Maremma Toscana, Relazione dell'attività svolta, Follonica: 61-62.

Bellini, E. 1990. Behaviour of some genetical characters in olive seedlings obtained by cross-breeding. Proceedings XXIII International Horticultural Congress, ISHS-SOI, Florence (Italy). Abstracts of contributed papers. 2. Poster, 3062.

Bellini, E. 1992. Miglioramento genetico dell'olivo: osservazioni sul comportamento ereditario di alcuni caratteri. Atti giornate scientifiche SOI, Ravello 8-10 aprile: 394-395.

Bellini, E. 1993. Genetic variabiltiy and heritability of some characters in cross-bred olive seedlings. Olivae 49: 21-34.

Bellini, E., Parlati, M.V. and Pandolfi, S. 1990. Response of crossed olive trees to seedling rootings. Proceedings XXIII International Horticultural Congress, ISHS-SOI, Florence (Italy). Abstracts of contributed papers. 2. Poster, 3054.

Bellini, E., Parlati, M.V., Pandolfi, S., Giordani, E., Perri, E. and Silletti, A. 1995. Miglioramento genetico dell'olivo: prime osservazioni su selezioni ottenute da incrocio. Italus Hortus, 2 (1-2): 3-12.

Bini, G. and Bellini, E. 1975. Influenza dei genitori sulla facoltà germinativa dei semi. Ricerche sull'olivo. Riv. Ortoflofrutt. It., 59 (5): 371-384.

Fontanazza G., Baldoni L. and Corona C. 1990. Osservazioni preliminari sul valore agronomico di una nuove cultivar di olivo: "Fs-17". Proceedings Problematiche qualitative dell'olio d'oliva. Accademia Nazionale dell'Olivo, Spoleto.

Lavee S., Haskal A. and Wodner M. 1986. "Barnea". A new olive cultivar from first breeding generation. Olea 17: 95-99.

Lavee S., Harshemesh H., Haskal A., Trapero A. and Metzidakis I.T. 1999. "Maalot" a new cultivar for oil extraction resistant to *Spilocaea oleagina* (Cast.). Acta Hort., 474:125-128.

Morettini A., Bini G., Bellini E. 1972 - Comportamento di alcune cultivar di olivo da tavola francesi e spagnole nella Maremma toscana. Riv. Ortoflorofrutt. It., (56)1: 3-19.

Roselli, G. and Donini, B. 1982. "Briscola". Nuova cultivar di olivo a sviluppo compatto. Riv. Ortoflofrutt. It., 66(2): 103-114.

Tables

Table 1. Mean values (see legend) and coefficient of variability (CV) of 12 progenies with at least 100 seedlings for 3 traits in comparison to the mean of the population

Progeny	Juvenility		Tree vigour		Tree habit	
	Mean	CV	Mean	CV	Mean	CV
Picholine x Manzanilla	3.3	35.5	2.0	30.0	1.5	54.1
Picholine x Coratina	2.6	53.0	1.8	35.3	1.4	44.5
Picholine x Aglandau	3.2	38.1	2.0	24.6	1.4	52.0
Picholine x Gordal	3.0	43.4	2.0	20.4	1.4	52.3
Picholine x Grossanne	3.4	30.0	2.3	29.2	1.3	46.0
Picholine x Puntino	3.4	28.9	2.1	28.5	1.4	41.9
Grossanne x Frantoio	2.4	46.5	1.8	22.8	1.4	56.2
Grossanne x Picholine	3.6	22.9	1.9	33.2	1.9	46.8
Leccino x Coratina	3.4	22.9	1.9	23.6	2.0	46.3
Leccino x Aglandau	4.0	3.5	1.9	25.9	1.3	48.3
Leccino x Manzanilla	3.7	16.7	2.1	26.9	1.7	53.3
Leccino x Gordal	3.9	9.3	2.1	23.0	1.4	62.3
Mean for progenies	**3.3**	**29.2**	**2.0**	**26.9**	**1.5**	**50.3**
Standard error	**0.14**	**4.33**	**0.04**	**1.29**	**0.07**	**1.66**
Mean for population	**3.3**	**32.4**	**2.0**	**27.9**	**1.5**	**52.9**

Legend: Juvenility: 1 - totally juvenile, 2 - partially adult, 3 - partially juvenile, 4 - totally adult. Tree vigour: 1 - low, 2 - medium, 3 - high. Tree habit: 1 - upright, 2 - bushy, 3 - horizontal, 4 -weeping).

Figures

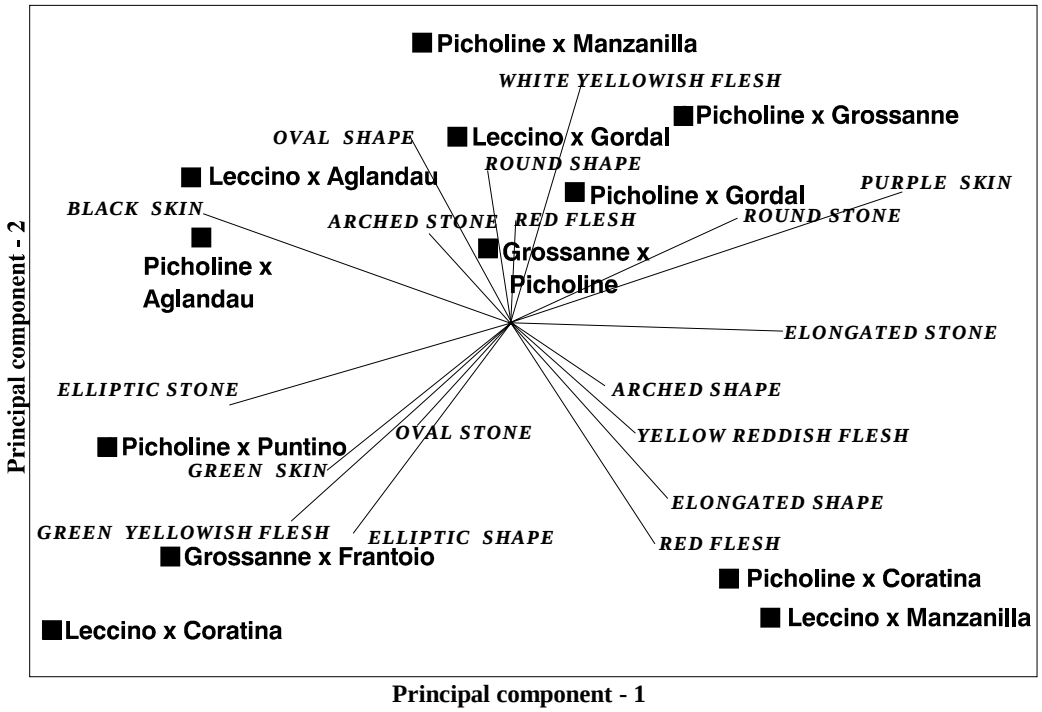

Fig. 1. Vectors (shape, skin and flesh colour of fruits; shape of stones) and progenies plotted on the first two principal components.