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in

Ak B.E. (ed.).
XI GREMPA Seminar on Pistachios and Almonds

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 56

2001
pages 123-128

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=1600164>

To cite this article / Pour citer cet article

Godini A., Barbera G., Catania F., Insero O., Mattatelli B., Palasciano M., Senesi E. **The Italian almond evaluation project**. In : Ak B.E. (ed.). *XI GREMPA Seminar on Pistachios and Almonds*. Zaragoza : CIHEAM, 2001. p. 123-128 (Cahiers Options Méditerranéennes; n. 56)



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The Italian almond evaluation project

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SUMMARY – In order to support and coordinate the regular development of Italian horticulture, the Italian Department of Agriculture launched and funded in 1993 a national programme aiming to the evaluation of the performance of new and old cultivars of pome and stone fruits, including almonds. The author of the present paper succeeded in 1998 Francesco Monastra as National coordinator of the subprogramme "Almonds". As a result of a many-years of activity carried out mainly by Italian research Institutions, both selected old and new almond cultivars have been included into the Programme and introduced into evaluation orchards. The Californian paper shelled cultivars were kept out from any consideration according to the outcome of several GREMPA meetings and considering their poor performance all over the Mediterranean basin. So, 11 Italian, 3 French and 4 Spanish cultivars were included. The studies concerning the horticultural performance of the cultivars are carried out in six evaluation orchard by many units all sited in southeast Italy, as follows: Apulia, Basilicata, Calabria, Campania, Sardinia and Sicily. A seventh unit charged with the evaluation of the technological characteristics of the cultivars is sited in Lombardia (northern Italy). The cultivars are grafted onto sweet almond seedlings and were produced by a commercial nursery. Due to the great horticultural importance attached to the self- fruitfulness, 9 cultivars under evaluation out of 14 have been chosen among those able to bear a crop with their own gametes. The 9 self fruitful almonds are: (i) the Italian Falsa barese, Genco, Pepparudda, Sannicandro, Supernova and Tuono; (ii) the French Lauranne and Steliette; and (iii) the Spanish Moncayo. The remaining self-unfruitful cultivars are: (iv) the Italian Fascionello, Fellamasa, Fragiulio grande, Pizzuta d'Avola and Trianella; (v) the French Ferragnès; and (vi) the Spanish Francolí, Glorieta and Masbovera. The appreciation of the above cultivars by the seven units is in progress.

Key words: Almond, varieties, phenology, pomology.

RESUME – "Le projet italien d'évaluation des amandiers". Afin de soutenir et de coordonner un développement régulier de l'horticulture italienne, le Ministère de l'Agriculture d'Italie a lancé et financé en 1993 un programme national qui terminait par l'évaluation des performances de cultivars nouveaux et anciens de fruits à pépins et à noyau, y compris les amandes. L'auteur du présent travail a succédé en 1998 à Francesco Monastra comme coordinateur national du sous-programme "Amandier". Comme résultat des activités de plusieurs années menées principalement par des institutions de recherche italiennes, les cultivars sélectionnés tant anciens que nouveaux, ont été incorporés au programme et introduits dans les vergers d'évaluation. Les cultivars californiens à coque tendre n'ont pas été pris en considération, suivant les résultats de plusieurs réunions du GREMPA et compte tenu de leurs faibles performances dans tout le bassin méditerranéen. Ainsi l'essai a également porté sur 11 cultivars italiens, 3 français et 4 espagnols. Les études concernant les performances horticoles des cultivars ont été menées dans six vergers d'évaluation par autant d'unités toutes situées dans le sud-est de l'Italie, comme suit : Les Pouilles, Basilicate, Calabre, Campanie, Sardaigne et Sicile. Une septième unité chargée de l'évaluation des caractéristiques technologiques des cultivars se trouve en Lombardie (nord de l'Italie). Les cultivars sont greffés sur des plants d'amandes douces et ont été produits par une pépinière commerciale. En raison de la grande importance horticole attachée à l'autofructification, 9 cultivars sous évaluation sur 14 ont été choisis parmi ceux capables de porter une production ayant leurs propres gamètes. Les 9 amandiers à autofructification sont : (i) les italiens Falsa barese, Genco, Pepparudda, Sannicandro, Supernova et Tuono ; (ii) les français Lauranne et Steliette ; et (iii) l'espagnol Moncayo. Les cultivars restants à non autofructification sont : (iv) les italiens Fascionello, Fellamasa, Fragiulio grande, Pizzuta d'Avola et Trianella ; (v) le français Ferragnès ; et (vi) les espagnols Francolí, Glorieta et Masbovera. L'appréciation des cultivars mentionnés auparavant par les sept unités est actuellement en cours.

Mots-clés : Amande, variétés, phénologie, pomologie.

The Italian project for drawing up lists of recommended varieties for Italian fruit growing

Over the last 30 years fruit breeders have worked industriously and the obtaining of new fruit tree varieties has occasionally assumed frenetic rhythms throughout horticulturally advanced countries. The number of new varieties annually available continues to increase and new proposals covered by exclusive patent rights are offered to fruit growers and technicians to flank or replace the traditional varietal platforms. The incessant rate with which new varieties (and also new rootstocks) are put on sale is the most peculiar aspect of modern horticulture. However, it must be also considered that the continuous proposal of new varieties ends up by disorientating even experienced technicians and fruit growers. Moreover, each new proposal not always maintains the promises of intriguing advertising campaigns, and the same new proposal does not always perform equally well in any environment.

Given this situation, in 1993 the Italian Ministero delle Politiche Agricole decided to fund a "Project for drawing up lists of recommended varieties for Italian fruit growing". The project involves the most important fruit tree species, such as pome fruits (apples and pears), stone fruits (almonds, apricots, nectarines, peaches, plums, prunes, sweet cherries) and strawberries.

The project is to be intended as a service for the benefit of Italian fruit growers: for each considered species, the goal is the drawing up of faithful and up-to-date lists of recommended varieties according to environmental conditions. The lists are the result of a national experimentation co-ordinated by the Istituto Sperimentale per la Frutticoltura, Rome. Pomologists/horticulturists of different Italian Universities and specialists of Regional Extension Services have been invited to take part in the project. For each species, the list is the result of plurennial observations carried out in "evaluation orchard" established in the most important growing regions. Pomological schedules have been prepared during joint project meetings, and severe and calibrated criteria are applied in order to evaluate the varieties. Overall, 30 Institutions co-operate and 672 varieties have been delivered between 1993 and 1999 as shown in Table 1.

Table 1. Species, varieties and Institutions involved in the Project

Species	Variety no.	Institutions no.
Almonds	18	7
Apricots	37	15
Apples	100	14
Pears (including Nashi pears)	47	11
Peaches (clingstones)	19	18
Peaches (freestones)	141	18
Peaches (nectarines)	85	18
Plums	62	13
Prunes	7	13
Strawberries	156	15

However, the same Institution has not always been called to evaluate all the considered fruit species. For example, the Istituto di Coltivazioni Arboree, University of Bari auto-excluded itself from the evaluation of pome fruit varieties, because of the scarce diffusion of apples and pears in Apulia; this Institute also auto-excluded itself from the strawberry evaluation, since this species is not within its competence.

As a rule, the varieties considered worthy to be taken into consideration are budded by commercial nurseries and then distributed to the Institutions and planted in the "evaluation orchards". As concerns the varieties protected by patent rights, the researcher responsible for each Institution is bound by letter not to cede, distribute and diffuse those varieties. After the first two years of production, the varieties judged "promising" are classified in "List C", whereas those considered poor are eliminated.

After 5 years of production:

(i) Varieties with excellent horticultural (i.e. phenological, biological, morphological and technological) characteristics and suited to large diffusion are classified in "List A".

(ii) Varieties suited to particular industrial features, of local interest, limited acreage, and particular markets are classified in "List B".

(iii) Varieties evaluated negatively are classified in "List X".

The symbol Δ means varieties present in evaluation orchards as non-bearing young trees.

The Italian almond industry

The official statistics indicate that in the 1960s the Italian almond industry produced more than 200 thousand tons of inshell almonds. Thirty years later, the Italian production of inshell almonds dropped to 90 thousand tons, as a consequence of a constant regressive trend, apparently irreversible. Nevertheless, the total acreage is still about 90,000 ha, the value of the present yield is assessed between 150 and 175 billion lire and therefore still higher than that provided by apricots and plums, respectively. Moreover, the Italian nursery activity concerning almonds is still alive due to an annual production of more than 100,000 young almond trees (rootstock and budded tree).

The sub-project "Almonds"

It is well known that the main trait of Mediterranean almond growing is its considerably high number of varieties. Each country, including Italy, possesses a particular varietal platform; at the same time, most of the local varieties, however, possess poor horticultural characteristics, such as early blooming and/or self-sterility and/or low production and/or high doubles, etc. Therefore, among the fruit tree species taken into consideration by the project for establishing lists of recommended varieties for Italian fruit growing almonds were also included as a sub-project. Between 1993 and 1997, the almond sub-project has been co-ordinated by Ciccio Monastra; from 1998 onward the co-ordination has been entrusted to Prof. Godini, the author of the present paper, who also co-ordinates the sub-project "Sweet Cherries".

Considering the area of Italian almond growing, six Agricultural Faculties and Extension Services in southern regions have been called on to co-operate in the project. An additional Institution, located in northern Italy, is involved in evaluation of the technological traits of these varieties (Table 2). Some of the Institutions involved (i.e. Caserta, Istituto Sperimentale per la Frutticoltura; Bari and Palermo, Istituto di Coltivazioni Arboree) had good previous experience on this field and already possessed almond varietal collections. Other Institutions were called on *ex novo* to take part to the project establishing the orchards as in 1993. This explains the different evaluation stages of a single variety: sometimes completed, sometimes in progress. The main parameters under evaluation are: bearing precocity, blooming time, self-fertility and related crop consistency and constancy, nut quality as kernel size and shape, shelling and doubles percentage.

There are six almond "evaluation orchards" located in southern Italy. Following an experimental randomized design, in each orchard the observations are carried out on four trees for each variety. The trees are budded onto sweet almond seedlings, trained according to the open centre (vase) system, spaced 6 x 5 meters and rainfed grown.

During the preparation of the project, the group of researchers and specialists agreed with the conclusions of several GREMPA meetings and therefore decided previously on the exclusion of all Californian paper-shelled varieties, because of:

(i) Low bearing consistency and constancy which were uniformly repeated all over the Mediterranean basin.

(ii) Inadequate kernel protection from bird and rodent attacks.

(iii) High kernel sensibility to navel orange worm (NOW) and carcinogenic aflatoxins-producing fungi.

Table 2. Institutions called on to co-operate in the almond sub-project

Institutions	Researchers/Extensionists
1. Agenzia Regionale per i Servizi e lo Sviluppo in Agricoltura, Regione Calabria (Arssa-CZ)	F. Catania [†] , P. Gallo, F. Longo, G. Spagnolo
2. Centro Regionale Agrario Sperimentale, Cagliari (Cras-CA)	M. Pala [†] , G. Lovicu, M. Farci
3. Istituto di Coltivazioni Arboree, Università di Bari (Ica-BA)	A. Godini [†] , M. Palasciano
4. Istituto di Coltivazioni Arboree, Università di Palermo e Regione Sicilia (Ica, Reg. Sic.-PA)	G. Barbera [†] , T. La Mantia, G. Bivona, A. Femminella
5. Azienda dimostrativa "Pantanello", Metaponto (Reg. Bas.)	B. Mattatelli [†] , P. Arcuti, A. Silletti
6. Istituto Sperimentale per la Frutticoltura, Sezione Operativa di Caserta (Isf-CE)	O. Insero [†]
7. Istituto Sperimentale per la Valorizzazione dei Prodotti Agricoli, Milano (Ivtpa-MI)	E. Senesi [†] , A. Rizzolo

[†]Institutions Research Chief.

The Italian working group refrained from taking into consideration the Apulian Cristomorto, well-known and appreciated in France and Spain only because of its late blooming, even if lacks other interesting features.

With reference to the choice of the almond varieties to be evaluated, it must be remembered that the periodical meetings of the Groupe de Recherches et d'Etudes Méditerranéennes pour le Pistachier et l'Amandier (GREMPA) during the last 26 years have testified to the fact that in the Mediterranean area the almonds have become object of several breeding programs aiming at improving the local traditional platforms. The almond breeding programs were particularly active in France and Spain. Moreover, it is well known that among the Italian regions, Apulia is the birthplace of a rich and interesting almond germplasm. We refer mainly to self-fertile varieties and to their contribution, as parent in breeding programs, in improving the quali-quantitative standard of French and Spanish varieties.

Since the importance of self-fertile almond germplasm was underestimated by Italian almond growers, the scientific committee of the sub-project decided to mainly emphasize those varieties, selecting from within the local population those possessing additional positive characteristics. In 1993, when the project started, 11 varieties were considered: 10 native to Italy and 1 native to France but related to Apulian germplasm (Ferragnès). Six of ten Italian varieties were native to Apulia (Falsa barese, Fragiulio grande, Genco, Pepparudda, Sannicandro, Tuono) and three to Sicily (Fascionello, Pizzuta d'Avola, Supernova). Among the Sicilian varieties we also included Supernova, an artificial mutant of the Sicilian Fascionello.

Nevertheless, the project could not ignore the progress of breeding programs carried out in Europe, mainly in France and Spain. In 1994, four new varieties were introduced: the French Lauranne, the Spanish Francolí and Moncayo plus Trianella, an old Apulian variety. In 1997, four additional varieties were introduced into the evaluation orchards: the French Steliette, the Spanish Glorieta and Masbovera and the Sicilian Fellamasa (Casteltermini). Nowadays, the number of almond varieties present in orchards has risen to eighteen. Since the project aims at introducing the Spanish varieties Ayles and Guara, in the next future we estimate that in the year 2000 the total number of almond varieties under evaluation will be twenty. Table 3 reports the essential traits of the varieties evaluated till now.

Table 3. Essential traits of almond varieties till now evaluated

Variety	Origin	Blooming time	Harvesting time	Self- fertility	Shelling (%)	Doubles (%)
Falsa barese	Italy	Late	Sept. 20-30	Yes	34-37	0-3
Fascionello	Italy	Early	Sept. 1-10	No	23-25	5-10
Ferragnès	France	Late	Sept 10-20	No	37-40	0-3
Fragiulio grande	Italy	Medium	Sept. 1-10	No	28-30	5-15
Francolí	Spain	Late	Sept. 1-10	No	30-33	0-4
Genco	Italy	Late	Sept. 20-30	Yes	33-37	0-4
Lauranne	France	Late	Sept. 1-10	Yes	35-38	3-10
Moncayo	Spain	Late	Sept. 20-30	Yes	25-28	3-10
Pepparudda	Italy	Medium	Sept. 10-20	Yes	25-28	3-5
Pizzuta d'Avola	Italy	Very early	Sept. 1-10	No	21-23	0-3
Sannicandro	Italy	Early	Sept. 1-20	Yes	20-23	0-2
Supernova	Italy	Late	Sept. 1-10	Yes	38-40	10-15
Trianella	Italy	Late	Sept. 20-30	No	28-30	10-15
Tuono	Italy	Late	Aug. 20-30	Yes	38-40	10-20

It is worth pointing out that a constant component of the genealogy of the new French and Spanish almond varieties is Apulian blood, with up to 75% of incidence. Firstly, Apulian self-sterile late blooming Cristomorto was used in breeding programs; in a second stage, Apulian self-fertile Tuono was introduced into the programs in order to transfer self-fertility into the genome of the offsprings. Since all offsprings inherited the tendency of Tuono to produce medium-high doubles (10-20%), following our suggestion, more recently also Spanish breeders have started off by using the Apulian low doubles Falsa Barese and Genco as new parents for self-fertility.

As concerns the genealogy of French varieties included into the project, it must be remembered that:

(i) Self-sterile Ferragnès is the daughter of Apulian Cristomorto and possesses 50% of Apulian blood.

(ii) Self-fertile Lauranne and Steliette are both daughters of Tuono and Ferragnès, and therefore granddaughter of Cristomorto, thus possessing 75% of Apulian blood.

With regards to the genealogy of Spanish varieties introduced into the project, we do underline that:

(i) Self-sterile Francolí, Glorieta and Masbovera are daughters of Cristomorto and possess 50% of Apulian blood.

(ii) Self-fertile Moncayo is the daughter of Tuono and possesses 50% of Apulian blood.

Table 4 reports the state of the art concerning the recommendations for varieties and their placement in "List A", "List B", "List C" and "List X", respectively. Some varieties, which produced kernels suited to local, limited and specific uses (candy-coated, caramels/pralines) received evaluations not always encouraging: the Sicilian Fascionello and Pizzuta d'Avola were considered negatively in continental Italy in that they are self-sterile and bloom too early; on the other hand, the Apulian self-fertile Pepparudda and Sannicandro, were judged negatively in Sicily because of the low shelling percentage and the production of roundish kernels. Only five varieties received almost unanimous positive evaluation: Ferragnès and Tuono, classed 4 times in "List A", Genco and Supernova, 3 times in "List A", Falsa barese, 2 times in "List A" and 1 time in "List B".

Four of the above five varieties (Falsa barese, Genco, Supernova and Tuono) possess the same biological characteristic, i.e. self-fertility; four of the above five varieties (Falsa barese, Ferragnès,

Genco and Tuono) have an Apulian origin in common. It is of interest to note that within the group of promising varieties appear Lauranne, Francolí and Moncayo, each possessing at least 50% of Apulian blood.

Table 4. Recommended almond varieties for 1999

Variety	Institution					
	Arssa CZ	Cras CA	Ica BA	Ica PA	Isf CE	Reg. Bas.
Falsa barese	Δ	C	A	B	A	C
Fascionello	Δ	C	X	B	B	C
Ferragnès	C	C	A	A	A	A
Fragiulio grande	Δ	Δ	B	B	B	Δ
Francolí	Δ	Δ	C	Δ	C	C
Genco	Δ	Δ	A	A	A	Δ
Lauranne®	Δ	C	C	C	V	C
Moncayo	Δ	C	C	Δ	C	C
Pepparudda	Δ	C	B	X	C	C
Pizzuta d'Avola	Δ	C	X	B	B	C
Sannicandro	Δ	C	B	X	C	C
Supernova	Δ	C	A	C	A	A
Trianella	Δ	Δ	C	Δ	Δ	C
Tuono	C	C	A	A	A	A

It is easy to conclude that the almond breeders working in Europe and the Italian researchers involved in the almond evaluation project judged positively some characteristics such as late blooming, good shelling percentage, low doubles and, above all, self-fertility. Considering the general blooming earliness of the species and the problems arising when the weather conditions are unable to assure optimal cross-pollination, the capacity of self-fertile varieties to set fruits with their own gametes continues to be considered the trait of highest horticultural importance in the case of almonds.

Acknowledgements

Research funded by the Ministero delle Politiche Agricole (MiPA), special Grant Progetto Finalizzato "Formulazione di liste di orientamento varietale dei fruttiferi e dei portinnesti". Paper no. 133.