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# Fertility index, flowering aspects and pomological traits on almond genotypes from different areas

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**SUMMARY** – Since 1997 an "on farm" collection and evaluation orchard has been set up in Sicily in order to collect a large part of the vast almond germplasm. GF677 trees were planted in 1996 at 6x4 m and grafted with budsticks collected throughout the traditional almond growing areas of Sicily. Many cultivars native to different parts of Italy and of the world have also been included to compare the main aspects related to vegetative and reproductive behaviour. The aim of this paper was to carry out a preliminary evaluation work on some of the cultivars collected in order to describe their behavior in terms of flowering biology and nut traits.

**Key words:** Almond, germplasm, genetic resources, flowering biology, nut traits.

**RESUME** – "Indice de fertilité, aspects de la floraison et caractères pomologiques de génotypes d'amandier de différentes zones". Depuis 1997 est réalisée une collection "ex situ" afin de rassembler la vaste biodiversité de l'amandier sicilien. En 1996 ont été placées aux champs des plantes de GF 677 à une distance de 6 x 4 mètres, et elles ont été greffées dans la même année avec du matériel provenant des principales aires de culture de la Sicile. En outre, beaucoup de variétés ont été introduites, qui sont cultivées dans d'autres régions de l'Italie et du monde et un travail de recherche a été entrepris afin de comparer le comportement végétatif et reproductif des diverses variétés de la collection. Dans ce travail est présentée une première évaluation de certaines variétés de la collection soit du point de vue de la biologie florale, soit du point de vue des caractéristiques des fruits.

**Mots-clés :** Amandier, biodiversité, ressources génétiques, biologie florale, caractéristiques des fruits.

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## Introduction

Although traditionally diffused in Sicily, the almond growing areas showed a strong decrease in terms of hectares and, obviously, in terms of production (Crescimanno and Sottile, 2003). An evaluation of the causes of this contraction, similarly occurred in other parts of Italy, showed that this species, according to its ability to survive in arid conditions, has been usually adopted in marginal conditions characterized by poor soils without any water resources. In these growing areas almond rapidly lost its economic value becoming mainly destined to preserve marginal soils from the desertification.

The almond diffusion in Sicily has been deeply described by Bianca in 1871 in a monograph containing a description of more than 700 different "types". The author also reported the most concentration of almond "types" in Agrigento province, which is traditionally reported as the most important producing area in Sicily. More or less one hundred years after, a review on almond cultivars was described mainly for the Eastern part of Sicily showing a very large cultivar presence in the most important growing areas and also evidencing a possible synonymy among many of the cultivar listed for a restricted area (AA.VV., 1958).

In more recent years, other fruit trees species have rapidly developed in more specialized growing systems, mainly grapes, citrus and olives, which represented for many years the main fruit production in Sicily. In this way, in few years, almond, as well as other minor fruit trees species, rapidly declined in acreage and production assuming a marginal role. This decline has been certainly due to the high cost of production, mainly for harvest, and to the difficulty to enhance this technical practice because of a high land fragmentation and of a non specialized planting system.

In the last decade, since many traditional Mediterranean species undergo a heavy economic crisis, a strong diversification of the fruit species growing areas occurred in Sicily with a high diffusion of

fresh stone fruits, mainly peaches, in irrigated and fertile soils (Caruso and Sottile, 1999; Sottile, 2002). In this way, although less significant in comparison with other species, the almond cultivation has been also reconsidered in specialized irrigated orchards planted according to innovative systems that allow mechanical harvest and high yield efficiencies. The most part of the production is destined to the food industry. It is usually gained with self-fertile Italian cultivars and actually shows a feasible new diffusion of the species in Sicily.

In this way, as innovative strategy for the valorization of the wide Sicilian germplasm, it appeared extremely interesting to better study the fertility aspects and pomological traits of some Sicilian cultivars collected in the last five years in an on farm collection orchard located in the Temple Valley (Agrigento – see related paper) in order to evaluate their suitability to be introduced as alternative cultivars for specific productions.

On 18 cultivars, all aspects related to fertility index, fruit set, yield and pomological traits have been evaluated. Data were collected according to the most diffused methodologies in terms of fertility and fruit traits and submitted to statistical evaluation.

## Materials and methods

The on farm collection has been performed in Agrigento (Sicily) in the center of the Temple Valley Park. Trees of GF 677 have been grafted in 1997 using vegetative material recovered through the Sicilian territory mainly interested on almond. The trees were spaced 6x4 m between and on the rows respectively and modern fruit trees growing cultural techniques have been applied for summer and winter pruning and disease protection. The orchard was not permanently irrigated but emergency irrigations were applied when very dry conditions occurred.

During 2002 growing season, 18 cultivars were submitted to several observations as below reported. Five trees per cultivar were selected and, on those, fertility aspects from dormancy to fruit set and growth were recorded on five fruiting shoots per tree.

The fertility index was evaluated by recording the number of flowering buds per cm of fruiting shoots while fruit set was evaluated on sampling shoots by the fruits number/flowers number ratio. On the same trees, flowering biology aspects related to self-fertility were observed by a double bagging methodology in order to verify the literature reports for these cultivars (AA.VV., 1958).

At harvest, according to the almond descriptor list, nut traits were observed on 100 hulled nuts per cultivar and on the relative seeds. Double seeds frequency was also recorded. All data were submitted to statistical analysis.

## Results

'Don Pitirino' and 'Bottara' showed the highest fertility index values, 4 times more than the general average, probably revealing a particular fruiting habit that concentrates many flowering buds on very short spurs. Overall, the fertility indexes ranged between 0.2 and 0.7. 'Genco' and 'Tuono', Apulian cultivars, as well as 'Ferragnès' showed an intermediate fertility index (Table 1).

Considering the flowering biology and self-fertility aspects, our results evidenced a perfect accordance to the literature reports for the same cultivars. 'Marino', not evaluated in previous researches for such aspects, revealed an interesting self-compatibility behaviour that is also associated to a medium-late blooming time.

The vegetative organs density showed large differences among the cultivars evidencing specific behaviour in terms of growth habit. 'Marino' showed the highest density of vegetative buds per cm of fruiting shoot while 'Gruttisa' and 'Buscarina' the lowest. On the whole, the cultivars ranged between 2.8 and 6.9 vegetative buds per cm of fruiting shoot.

Table 1. Fertility index, flower biology and vegetative aspects of 18 almond cultivars

Cultivar	Fertility index (flowering buds per cm of fruiting shoot)	Self-fertility	Vegetative buds number per cm of fruiting shoot
'Don Pitirino'	2.27 ± 0.15	No	3.56 ± 0.21
'Bottara'	1.65 ± 0.33	No	4.08 ± 0.21
'Marino'	0.64 ± 0.11	Yes	6.93 ± 1.04
'Buscarina'	0.29 ± 0.07	No	2.96 ± 0.22
'Genco'	0.42 ± 0.07	Yes	4.11 ± 0.30
'Tuono'	0.41 ± 0.10	Yes	3.71 ± 0.37
'Fastuchina'	0.48 ± 0.09	No	4.43 ± 0.46
'Selvatica Favata'	0.22 ± 0.03	No	3.46 ± 0.26
'Mastraciccìa'	0.22 ± 0.06	No	2.98 ± 0.19
'Scacciuñara'	0.49 ± 0.09	(1)	4.26 ± 0.48
'Bari Rachele'	0.62 ± 0.08	Yes	3.32 ± 0.33
'Pizzuta d'Avola'	0.39 ± 0.08	No	4.72 ± 0.27
'Gruttisa'	0.37 ± 0.07	(1)	2.87 ± 0.31
'Vinci a tutti'	0.41 ± 0.09	No	5.35 ± 0.46
'Sarbanedda'	0.56 ± 0.07	No	4.38 ± 0.31
'Fascionello'	0.39 ± 0.04	No	4.31 ± 0.43
'Scummissa'	0.71 ± 0.11	No	5.44 ± 0.38
'Ferragnès'	0.47 ± 0.06	No	3.53 ± 0.26

(1) Data not observed.

Regarding the nut traits (Table 2), 'Pizzuta d'Avola', a well-known cultivar for the food industry adaptation of the whole seed, showed the highest in-shell nut weight as well as high longitudinal/transverse diameter ratio but also evidenced the lowest shelling percentage due to a very low seed weight. With these nut traits, also associated to the low double seeds percentage, it confirmed its peculiarities. 'Genco' showed the lowest nut weight, similar to that emerged in 'Tuono', 'Mastraciccìa' and 'Gruttisa', while 'Pizzuta d'Avola', 'Selvatica Favata' and 'Buscarina' revealed the highest. 'Genco' and 'Ferragnès' showed the highest shelling percentage (31% and 30% respectively) while 'Don Pitirino', 'Buscarina', 'Scummissa' and 'Pizzuta d'Avola' evidenced the lowest values (<20%). Very high values of double-seeds percentage emerged on 'Vinci a tutti' (approaching to 50%), 'Bottara' (25%) and 'Fascionello' (21%) while the remaining cultivars showed lower values mostly approaching to 0-2%.

## Conclusions

As already evidenced, this study reports just preliminary observations on flowering and reproductive behaviour of a minor set of cultivars among those collected in the field above described. The results obtained clearly show a very large diversity among the tested cultivars but, at the same time, open up very interesting research hypothesis to be approached in the following growing seasons. A more deep study should be carried out on the vegetative growth habit that evidenced a high genetic diversity among the cultivars observed. This aspect could likely have determined the high variability in terms of fertility indexes and vegetative growth behaviour, which are considered notable traits in order to adopt the right cultural techniques for managing the annual vegetative and reproductive cycle.

The relative low yield of the cultivars which, although already bearing, still did not reach the full mature phase may have affected in some way the flowering behaviour but all the results concerning self-fertility and nut traits evidenced that some cultivars may be re-evaluated in order to consider their diffusion for an innovative almond industry in Sicily.

Table 2. Main nut traits observed on 18 almond cultivars

Cultivar	In-shell nut weight (g)	In-shell nut longitudinal to transverse diameter ratio	Seed weight (g)	Shelling (%)	Seed longitudinal to transverse diameter ratio	Double seeds (%)
'Don Pitrino'	5.92 ± 0.09	1.46 ± 0.01	1.09 ± 0.019	18.56 ± 0.26	1.53 ± 0.02	7
'Bottara'	6.65 ± 0.14	1.40 ± 0.01	1.50 ± 0.026	23.74 ± 0.57	1.75 ± 0.01	25
'Marina'	3.80 ± 0.08	1.26 ± 0.01	1.00 ± 0.021	26.97 ± 0.50	1.51 ± 0.01	13
'Buscarina'	6.44 ± 0.11	1.33 ± 0.01	1.17 ± 0.016	18.43 ± 0.23	1.61 ± 0.01	0
'Genco'	3.52 ± 0.06	1.35 ± 0.01	1.08 ± 0.018	31.03 ± 0.36	1.61 ± 0.01	4
'Tuono'	3.67 ± 0.05	1.37 ± 0.01	1.00 ± 0.015	27.61 ± 0.34	1.61 ± 0.02	6
'Fastuchina'	3.87 ± 0.08	1.30 ± 0.02	0.81 ± 0.018	21.17 ± 0.23	1.57 ± 0.01	0
'Selvatice Favata'	6.58 ± 0.11	1.23 ± 0.02	1.33 ± 0.023	20.31 ± 0.28	1.34 ± 0.01	<2
'Mastraciccìa'	3.62 ± 0.10	1.30 ± 0.01	0.82 ± 0.024	22.83 ± 0.68	1.59 ± 0.02	<2
'Scacciunara'	3.98 ± 0.08	1.41 ± 0.01	1.12 ± 0.018	28.28 ± 0.24	1.64 ± 0.01	0
'Bari Rachele'	3.84 ± 0.09	1.35 ± 0.01	1.05 ± 0.024	27.72 ± 0.43	1.63 ± 0.01	4
'Pizzuta d'Avola'	7.78 ± 0.16	1.57 ± 0.01	1.22 ± 0.020	16.35 ± 0.42	2.01 ± 0.02	3
'Gruttisa'	3.77 ± 0.08	1.30 ± 0.01	1.08 ± 0.024	28.41 ± 0.75	1.49 ± 0.02	47
'Vinci a tutti'	4.73 ± 0.13	1.44 ± 0.01	1.12 ± 0.029	24.20 ± 0.45	1.78 ± 0.01	10
'Sarbanedda'	4.72 ± 0.08	1.50 ± 0.01	0.97 ± 0.015	20.67 ± 0.26	1.73 ± 0.03	2
'Fascionello'	5.77 ± 0.11	1.61 ± 0.01	1.17 ± 0.027	20.49 ± 0.48	1.93 ± 0.02	21
'Scummissa'	5.29 ± 0.11	1.52 ± 0.01	1.01 ± 0.020	19.24 ± 0.25	1.65 ± 0.01	0
'Ferragnès'	5.26 ± 0.08	1.45 ± 0.01	1.56 ± 0.026	29.70 ± 0.18	1.84 ± 0.02	0

Moreover, in the near future, a correlation between nuts traits and their relative importance on the food industry should be carried out in order to evidence the peculiarities of some cultivars and/or accessions, which could be considered for specific market needs. As a matter of fact, the new trend that shows an increasing interest for the almond production, in Sicily, should take into account several aspects related to the opportunity to adopt cultivars suitable to innovative orchards in terms of training systems, growing habits and, overall, to modern cultural practices. In this way and with these aims, the evaluation of old traditional cultivar could represent an interesting approach in order to recover, preserve and re-propose old almond tastes and flavors.

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