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ABSTRACT

This paper reports on a five-year research on almond tree in Sardinia aimed to select, from among the extremely heterogeneous local genetic material, individuals having some of the characteristics which are thought to be suitable to any profitable cultivation.

Ninety two individuals —some of them represented by one tree— were chosen on the basis of a few elements considered interesting such as late blooming, shape of the endosperm (oblong, ovate and round), shell consistency (soft or semi-hard).

A trial field is being prepared, in which the new cultivars will be studied in the same growing conditions and at the same time, compared with the most appreciated Italian and foreign varieties for a more reliable evaluation.

RESUME

Dans cet exposé sont illustrés les résultats d'une recherche conduite, pendant cinq années, sur la sélection de nombreuses lignées d'amandier choisies entre le patrimoine génétique de la Sardaigne, en vue d'obtenir des types avec des caractéristiques de grande valeur.

On a, pour cela, choisi quatre-vingt-douze sélections, en tenant en considération quelques caractéristiques intéressantes, comme l'époque de floraison, la forme de l'endosperme (oblongue, ovée et arrondie) et la consistance de la coque.

On a prédisposé, en outre, un verger expérimental, où actuellement on étudie le comportement des différentes sélections indigènes dans les mêmes conditions culturales, en comparaison avec les plus importantes variétés nationales et étrangères.

INTRODUCTION

In Sardinia, interest in almond growing has increased of late. It has become important to preserve the endemic genetic patrimonies that are in danger of extinction in various regions even though the varietal patrimony has been preserved almost intact because of the typical insular character of Sardinia. Last but not least almond growing seems to be giving better economic returns than in the past.

The first studies on Sardinian almond varieties, as mentioned before by Agabbio and Frau (1979), were conducted by Sirotti (1935) and Milella (1957, 1959, 1972) who described the main characteristics of the most important cultivars. These studies have recently been enhanced by other authors (Agabbio, Ortu, 1974; Agabbio, Frau, 1979).

The present study is based on peculiarities of the Sardinian almond patrimony, the population of which is very heterogeneous because of the indiscriminate implantation by seed and seedlings. This, on one hand, has made a rational system of cultivation difficult, but on the other, has brought about the selection of many varying individuals, sometimes highly valid, already acclimated to local conditions (Milella, Agabbio, 1977, 1979; Frau, Agabbio, 1979).

The peculiar characteristics of ninety two individuals selected during the first five years of research are discussed in this report.

MATERIAL AND METHOD

From 1977 to 1982 the main almond growing areas of Sardinia were inspected and some individuals within the genetic patrimony were discovered to be particularly interesting from an agronomic and commercial point of view.

The elements or characteristics considered most valid for selection were, among others, late or semi-late blooming, endocarp softness, particular shape of the endosperm, low percentage of double kernels and the absence of empty fruit, this as well as high yielding, late ripening and facilitation in harvesting and hulling.

The selected genetic material has been labellel IAM-Ma (Mediterranean Institute of Arboricolture - Almond) followed by a progressive reference number[1]; the fruit was analysed in order to verify those characteristics which had determined their selection in the field.

In compiling data, consideration was given not only to the most important nut and kernel characteristics (size, shape, weight of the kernel, softness of the shell, kernel, yield, etc.), but also to other aspects such as blooming and ripening time, easiness of harvesting and adherence of hull to nut, all elements which are considered important for a complete characterization of selected individuals.

The most interesting selections were assembled to form an experimental almond collection under constant observation, since many of these individuals were found in such conditions of neglect as to hinder a rigorous and complete study.

Productivity level of these selections will be studied with particular attention, since given the extremely precarious heterogeneous conditions which we have mentioned, productivity could vary greatly under better growing conditions.

RESULTS AND DISCUSSION

In the course of five years of observation in the main almond producing areas of Sardinia ninety two individuals were selected on the basis of presenting one or several of the prized characteristics.

During the research it was not possible to discover the origins of these individuals, since they were almost always represented by one tree, often quite old whose origins were unknown. It seems, however, from the information collected, that a small number are clones derived from important Sardinian varieties, and most are natural hybrids widely spread out in Sardinia through the usage of seedling propagation.

The ninety two samples selected were divided in four groups, each including those selections which possessed the most distinctive characteristics of the group.

The first element examined was the late or semi-late blooming time (table 1), which would allow the plant to escape, at least somewhat, the excessive winter cold; Sardinia is subject to cold weather in January and February which damages the flowers and reduces the plant yield. In this context fifteen trees were chosen; the earliest blooming at the end of February and the latest coming to full bloom after the middle of March. In some cases there were season to season variations in the blooming time of these fifteen selections but a clear distinction was maintained between them and the early-flowering varieties. All of them were hard shelled (except IAM-Ma 8 semi-hard shelled) and of moderate yield.

The second and third group contained selections chosen for consistency (soft or semi-hard) of the shell, which is a prized characteristic in view of its ease in shelling. Eighteen selections were included in these groups, seven soft and eleven semi-hard shelled (table 2).

The selections producing soft shelled fruit are very valuable for their high kernel percentage and for their very papery endocarp, in particular IAM-Ma 77 and 53 whose yield is about 60 %. Generally all the

(1) In a previous report (Agabbio, Frau, 1979) the individuals that had been selected until then were labelled ICAS-Ma to show that the research was conducted initially at the Institute of Arboricolture of the University of Sassari.

Table 1

Characteristics of the late blooming selections

Selections	Time of fruit maturity	Harvesting	Hulling	Nut shape	Nut weight g	Shell softness	Kernel shape	Kernel size			Kernel weight g	Double kernel %	Empty fruit %	Kernel yield %
								length mm	width mm	thickness mm				
IAM-Ma 0	6.9	difficult	easy	Oblong	6.94	hard	Oblong	25.8	15.4	8.4	1.60	—	—	23.05
IAM-Ma 1	6.9	difficult	easy	Ovate	6.76	hard	Oblong	26.1	15.1	8.0	1.53	—	2.0	23.18
IAM-Ma 7	23.8	easy	easy	Ovate	6.54	hard	Ovate	21.5	14.9	8.1	1.39	16.0	2.0	20.79
IAM-Ma 8	25.0	easy	easy	Ovate	3.28	semi-hard	Ovate	22.5	14.3	8.1	1.33	—	2.0	39.63
IAM-Ma 11	29.8	easy	easy	Oblong	5.50	hard	Oblong	27.5	17.5	17.5	2.00	—	—	36.36
IAM-Ma 13	6.9	easy	easy	Ovate	7.74	hard	Ovate	25.6	16.9	6.7	1.43	2.0	2.0	18.08
IAM-Ma 18	20.8	easy	easy	Ovate	4.48	hard	Ovate	20.5	14.8	8.1	1.14	4.0	12.0	22.32
IAM-Ma 22	25.8	easy	easy	Ovate	4.90	hard	Oblong	21.5	14.5	8.3	1.22	4.0	2.0	24.48
IAM-Ma 31	25.8	easy	easy	Oblong	5.44	hard	Oblong	22.0	15.0	7.8	1.25	4.0	4.0	22.05
IAM-Ma 33	4.9	difficult	easy	Round	7.86	hard	Round	23.0	15.4	8.4	1.60	—	—	20.35
IAM-Ma 36	27.8	easy	easy	Oblong	4.98	hard	Oblong	21.6	12.9	7.4	0.98	—	2.0	19.27
IAM-Ma 43	29.8	easy	easy	Ovate	5.04	hard	Ovate	18.1	12.1	8.1	0.88	2.0	—	17.40
IAM-Ma 44	29.8	easy	easy	Ovate	5.12	hard	Oblong	20.4	11.8	6.9	1.39	—	2.0	26.56
IAM-Ma 47	23.8	easy	easy	Round	3.88	hard	Round	19.8	13.4	9.1	1.18	12.0	—	30.41
IAM-Ma 48	29.8	easy	difficult	Ovate	3.36	hard	Oblong	20.0	12.1	7.6	1.02	28.0	2.0	29.76

Table 2

Selections producing soft and semi-hard shelled fruit

Selections	Time of fruit maturity	Harvesting	Hulling	Nut shape	Nut weight g	Kernel shape	Kernel size length mm	Kernel size width mm	Kernel size thickness mm	Kernel weight g	Double kernel %	Empty fruit %	Kernel yield %
SOFT													
IAM-Ma 21	20.8	easy	easy	Oblong	3.16	Ovate	23.2	15.5	8.2	1.38	8.0	4.0	43.67
IAM-Ma 32	25.8	difficult	easy	Ovate	3.41	Round	18.8	13.5	9.3	1.17	—	—	34.26
IAM-Ma 51	6.9	easy	easy	Oblong	3.34	Oblong	27.1	15.2	8.5	1.68	4.0	—	50.29
IAM-Ma 53	14.9	easy	easy	Ovate	3.50	Ovate	23.9	16.1	9.3	2.06	44.0	—	58.85
IAM-Ma 56	7.9	easy	easy	Oblong	2.93	Oblong	22.6	14.6	10.0	1.49	—	3.0	49.25
IAM-Ma 76	15.9	easy	easy	Oblong	2.70	Oblong	27.0	13.0	9.0	1.38	—	—	51.14
IAM-Ma 77	77.9	easy	easy	Oblong	2.06	Round	20.8	14.3	10.4	1.26	1.9	—	61.15
SEMI-HARD													
IAM-Ma 8	25.8	easy	easy	Ovate	3.28	Ovate	22.5	14.3	8.1	1.33	—	2.0	39.63
IAM-Ma 12	29.8	easy	easy	Ovate	4.53	Ovate	24.0	16.6	8.4	1.33	2.5	2.5	33.14
IAM-Ma 20	20.8	easy	easy	Ovate	2.76	Oblong	21.7	14.8	7.7	1.20	4.0	—	43.47
IAM-Ma 53a	20.8	easy	easy	Oblong	2.36	Oblong	24.0	13.3	9.3	1.13	8.6	5.7	45.17
IAM-Ma 57	7.9	difficult	difficult	Ovate	5.95	Ovate	24.4	16.5	9.4	2.07	4.1	26.5	24.14
IAM-Ma 58	3.9	easy	easy	Ovate	4.70	Ovate	23.7	17.5	7.5	1.27	—	—	27.00
IAM-Ma 62	20.8	easy	easy	Oblong	3.24	Ovate	21.4	15.0	9.6	1.35	—	3.4	40.22
IAM-Ma 63	20.8	easy	easy	Ovate	5.70	Ovate	24.5	16.8	7.4	1.33	—	1.6	22.99
IAM-Ma 65	20.8	easy	easy	Oblong	3.28	Ovate	23.3	15.6	7.9	1.43	—	8.1	40.11
IAM-Ma 74	5.9	easy	easy	Oblong	2.50	Oblong	25.7	12.9	8.6	1.29	—	—	51.83
IAM-Ma 84	15.9	difficult	easy	Ovate	3.20	Oblong	23.9	12.8	7.8	1.20	—	—	39.50

Table 3

Almond selected for the kernel shape

Selections	Time of fruit maturity	Harvest-ing	Hull-ing	Nut shape	Nut weight g	Shell softness	Kernel shape	Kernel size			Kernel weight g	Double kernel %	Empty fruit %	Kernel yield %
								length mm	width mm	thickness mm				
IAM-Ma 1	6.9	difficult	easy	Ovate	6.76	hard	Oblong	26.1	15.1	8.0	1.53	—	2.0	23.18
IAM-Ma 6	13.9	easy	easy	Oblong	6.10	hard	Oblong	24.6	14.5	8.5	1.39	2.4	—	22.78
IAM-Ma 16	13.9	difficult	difficult	Round	2.80	hard	Round	17.2	11.7	9.7	1.07	20.0	8.0	35.00
IAM-Ma 23	20.8	easy	easy	Ovate	4.20	hard	Oblong	23.1	12.7	7.4	1.02	2.0	—	24.48
IAM-Ma 24	27.8	easy	easy	Ovate	6.72	hard	Oblong	24.2	14.8	8.2	1.40	—	—	20.83
IAM-Ma 26	20.8	easy	easy	Round	3.40	hard	Round	14.9	12.2	10.7	0.75	4.0	4.0	21.17
IAM-Ma 32	26.8	difficult	easy	Ovate	3.41	soft	Round	18.8	13.5	9.3	1.17	—	—	34.26
IAM-Ma 44	29.8	easy	easy	Ovate	5.12	hard	Oblong	20.4	11.8	6.9	1.39	—	2.0	26.56
IAM-Ma 51	6.9	easy	easy	Oblong	3.34	soft	Oblong	27.1	15.2	8.5	1.78	4.0	—	50.29
IAM-Ma 57	7.9	difficult	difficult	Ovate	5.95	semi-hard	Ovate	24.4	16.5	9.4	2.07	4.1	26.5	24.14
IAM-Ma 64	20.8	easy	easy	Ovate	3.20	hard	Round	16.9	12.8	8.6	0.84	3.0	—	26.37
IAM-Ma 71	7.9	easy	easy	Oblong	8.56	hard	Oblong	21.3	16.3	7.5	1.41	—	—	16.48
IAM-Ma 75	30.8	easy	easy	Ovate	6.03	hard	Ovate	24.7	18.1	7.7	1.38	1.0	1.0	23.07
IAM-Ma 77	7.9	easy	easy	Oblong	2.06	soft	Round	20.8	14.3	10.4	1.26	1.9	—	61.15
IAM-Ma 85	20.9	easy	easy	Oblong	4.90	hard	Oblong	23.0	14.0	7.0	1.10	8.0	—	22.30
IAM-Ma 88	10.9	difficult	difficult	Ovate	8.90	hard	Ovate	25.0	18.1	7.0	1.50	—	—	16.80
IAM-Ma 90	15.9	easy	easy	Oblong	6.20	hard	Ovate	29.6	11.0	7.0	1.10	16.0	15.0	17.60
IAM-Ma 91	10.9	easy	easy	Ovate	7.50	hard	Ovate	22.5	18.2	6.5	1.40	1.0	2.0	16.80
IAM-Ma 92	5.9	difficult	easy	Ovate	10.50	hard	Oblong	32.0	16.1	6.5	1.70	4.0	—	18.80

soft and semi-hard shelled selections carry fruit which is easily hulled and harvested. The latter is an interesting characteristic in view of mechanized harvesting.

IAM-Ma 76 and 74 (the former soft and the latter semi-hard shelled) are especially interesting for their high kernel yield, excellent size and shape of kernel, and total absence of double kernels and empty fruits.

IAM-Ma 51, which carries fruit with soft shell, possesses a number of very positive characteristics, notwithstanding a certain tendency to have double kernels (4 %).

Kernel shape was the factor which determined the choice of selections in group four (table 3). Three particular shapes were isolated with a possible commercial use in mind: the oblong (typical amigdaloid) shape, ideal for sugared almonds (IAM-Ma 1, 23, 51, 71 and 85); an ovate shape which could be used for salted or sugared almonds (IAM-Ma 57, 75, 88, 90, 91 and 92); then a round shape which could be substituted for hazel-nuts in some cases (IAM-Ma 16, 26, 32, 64 and 77).

Given the above mentioned heterogenic patrimony of almond varieties a great number of trees producing kernels of various shapes and sizes were examined; however, we have selected not only individuals producing fruit of viable commercial shape but at the same time those characterized by other prized qualities.

Ultimately, we have the group composed of selections chosen for their valuable characteristics not already listed (table 4) such as: late ripening (IAM-Ma 16,6 and 83) which prolongs the selling period of fresh fruit, single kernel (IAM-Ma 32, 74 and 76) and the absence of empty fruit (IAM-Ma 23, 45 and 85) not to mention high productivity (IAM-Ma 7, 40, 83, 84 and 92). This last characteristic is as yet relatively uncertain given the poor growing conditions and the neglect of the trees; from this point of view clearer results will be obtained in the second phase of this research, from trees planted for control at the experimental orchard.

IAM-Ma 33, which was found in the country side near Selargius in the province of Cagliari, could be particularly interesting as an ornamental plant. The flowers are deep pink and almost twice the size of those on other trees. The tree is of medium vigor and upright-growing.

CONCLUSIONS

The results obtained confirm the extreme heterogeneity of almond varieties found in Sardinia among which there are many examples of specimens with promising characteristics. The first phase of the work has been mainly limited to the isolation and selection of individuals with characteristics somehow related to increasing productivity or commercial value.

Over these five years of research many specimens have been selected either for their possible commercial value (size or shape of fruit, yield) or in view of some future scientific or agronomical use.

Ninety two specimens in all have been held promising and will be studied further on experimental stations, compared with the best national and foreign almond cultivars. It will therefore be possible to eliminate uncertainties and to examine the flowering characteristics (blooming period, self-fertilization, fruit setting, etc.) and productivity which, notwithstanding the other valuable characteristics of the fruit, should not be disregarded.

However, among the selections chosen at the present time, IAM-Ma 11, 26, 74, 76, 83, 85 and 92 seem to represent the most valid selections with respect to the characteristics taken into consideration.

Table 4

Almond selected for special characteristics (productivity, ripening time, etc.)

Selections	Time of fruit maturity	Harvesting	Hulling	Nut shape	Nut weight g	Shell softness	Kernel shape	Kernel size length mm	Kernel size width mm	Kernel size thickness mm	Kernel weight g	Double kernel %	Empty fruit %	Kernel yield %
IAM-Ma 7	23.8	easy	easy	Ovate	6.54	hard	Ovate	21.5	14.9	8.1	1.39	16.0	2.0	20.79
IAM-Ma 9	13.9	difficult	easy	Ovate	5.18	hard	Oblong	20.6	14.1	10.0	1.35	—	—	26.13
IAM-Ma 16	13.9	difficult	difficult	Round	2.80	hard	Round	17.2	11.7	9.7	1.07	20.0	8.0	35.00
IAM-Ma 19	25.8	easy	easy	Ovate	4.80	hard	Ovate	23.7	15.9	8.4	1.49	—	2.0	30.41
IAM-Ma 25	20.8	easy	easy	Ovate	3.44	hard	Ovate	18.8	13.7	10.7	1.64	14.0	—	47.67
IAM-Ma 33	4.9	difficult	easy	Round	7.86	hard	Round	23.0	15.4	8.4	1.60	—	—	20.35
IAM-Ma 37	25.8	easy	easy	Oblong	5.80	hard	Oblong	25.1	14.5	7.7	1.32	—	6.0	21.37
IAM-Ma 38	6.9	easy	difficult	Round	6.86	hard	Oblong	23.0	15.1	8.5	1.40	—	6.0	19.24
IAM-Ma 39	20.8	easy	easy	Round	4.88	hard	Oblong	18.2	11.1	8.2	0.85	4.0	6.0	16.39
IAM-Ma 40	25.8	easy	easy	Oblong	5.92	hard	Oblong	25.8	14.6	7.0	1.24	—	—	20.94
IAM-Ma 42	29.8	difficult	easy	Oblong	8.92	hard	Oblong	25.5	15.1	7.8	1.49	4.0	2.0	16.36
IAM-Ma 45	29.8	easy	easy	Ovate	5.40	hard	Round	20.2	13.3	8.0	1.26	2.0	—	23.33
IAM-Ma 46	22.8	easy	easy	Oblong	5.18	hard	Oblong	25.0	13.5	6.9	1.25	—	4.0	23.39
IAM-Ma 50	6.9	easy	difficult	Ovate	3.08	hard	Ovate	17.9	11.8	7.8	0.82	—	10.0	24.02
IAM-Ma 72	7.9	easy	easy	Oblong	6.29	hard	Oblong	26.0	14.0	9.0	1.47	—	23.1	18.02
IAM-Ma 74	5.9	easy	easy	Oblong	2.50	semi-hard	Oblong	25.7	12.9	8.6	1.29	—	—	51.83
IAM-Ma 76	15.9	easy	easy	Oblong	2.70	soft	Oblong	27.0	13.0	9.0	1.38	—	—	51.14
IAM-Ma 83	20.9	difficult	easy	Oblong	6.60	hard	Oblong	20.4	10.5	7.5	1.30	53.8	—	26.80
IAM-Ma 84	15.9	difficult	easy	Ovate	3.20	semi-hard	Oblong	23.9	12.8	7.8	1.20	—	—	39.50
IAM-Ma 86	5.9	easy	difficult	Ovate	6.30	hard	Ovate	21.5	15.5	8.0	1.40	7.0	7.0	19.20
IAM-Ma 87	15.9	easy	easy	Oblong	5.10	hard	Oblong	24.0	13.5	6.5	1.10	4.0	—	20.20

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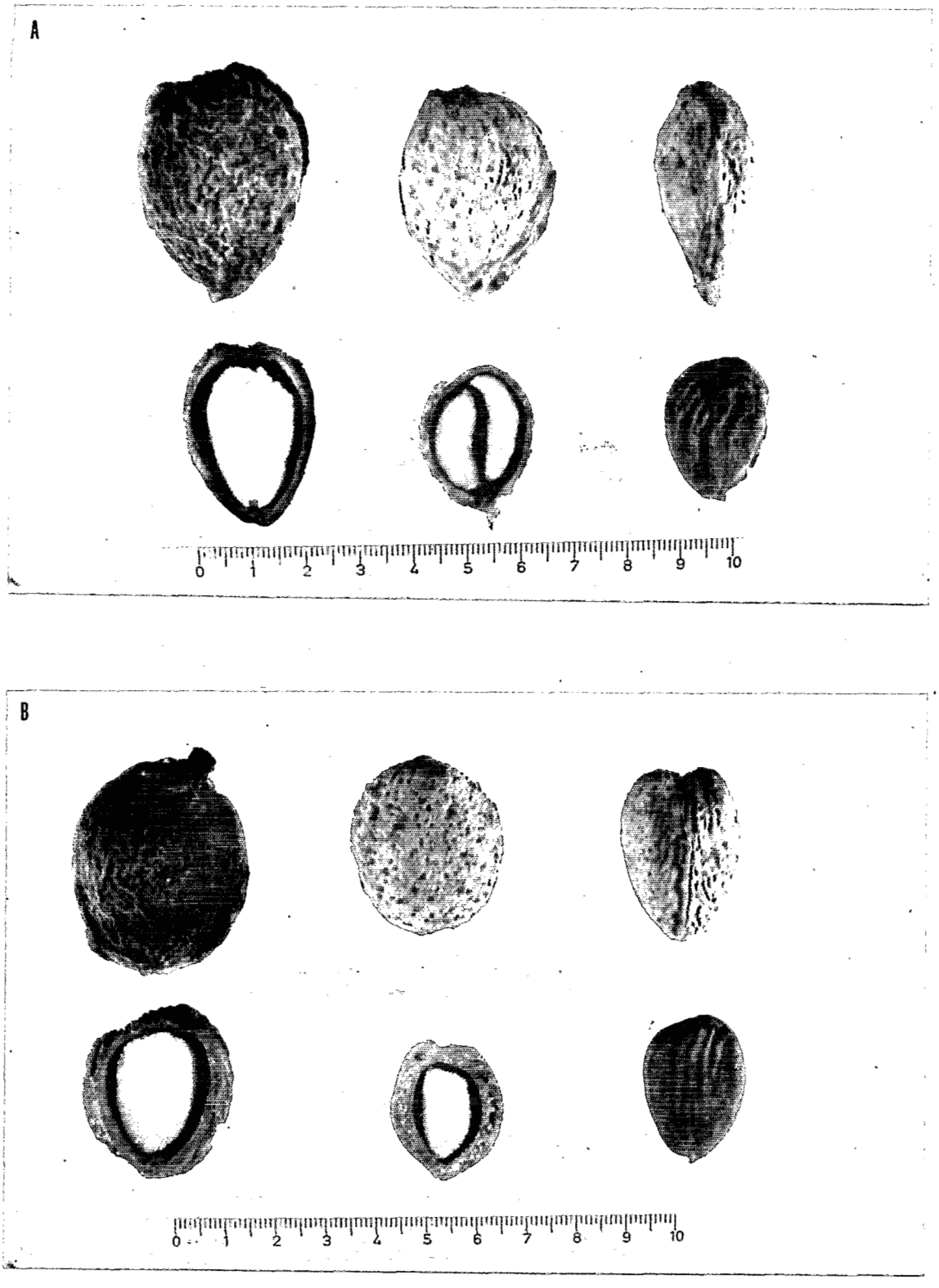


Fig. 1. Selection IAM-Ma 53 (above) producing soft-shelled fruit with an high percentage of kernels, but showing a certain tendency to have double kernels, and IAM-Ma 57 selected for the semi-hard shelled fruit.

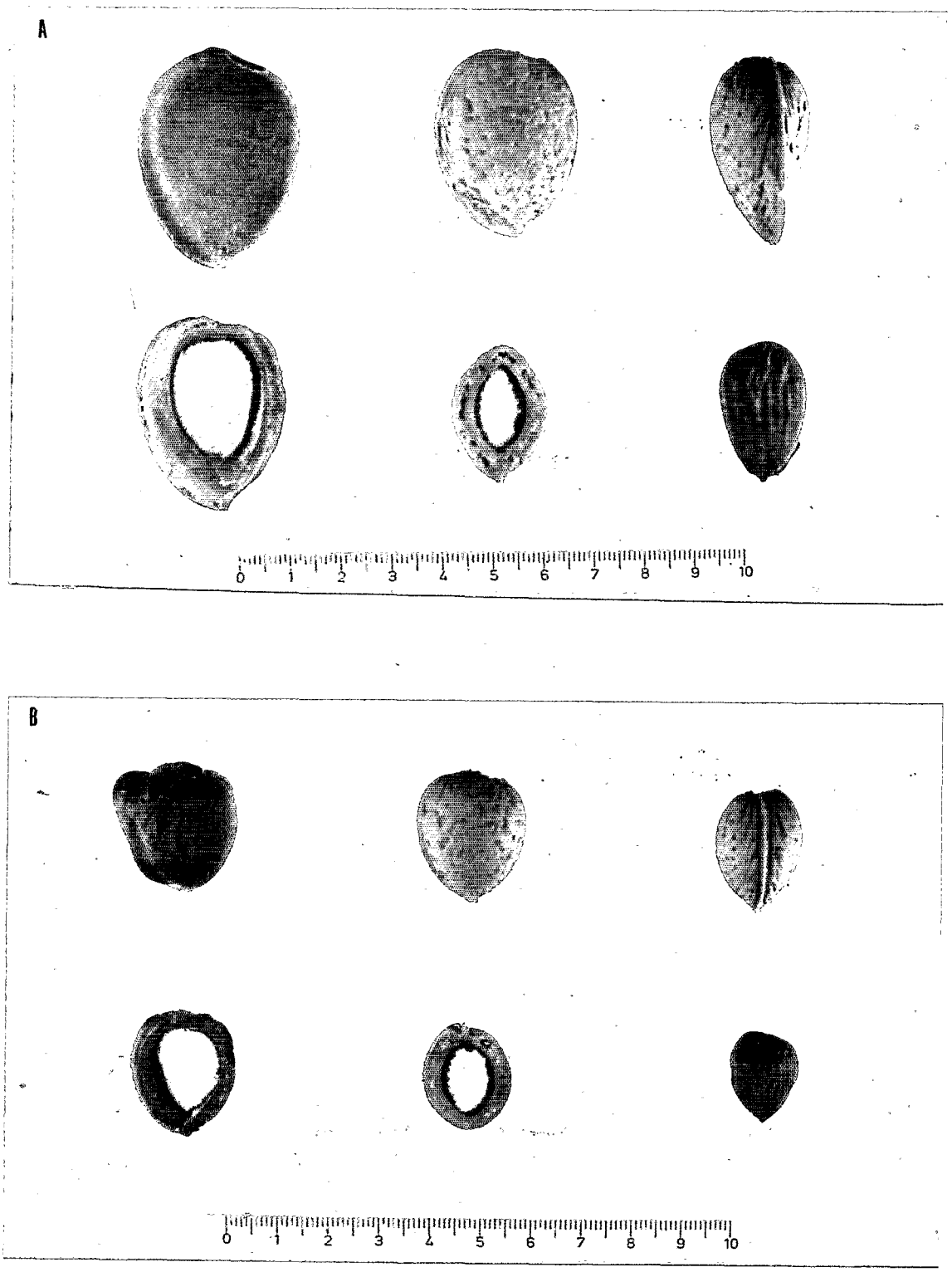
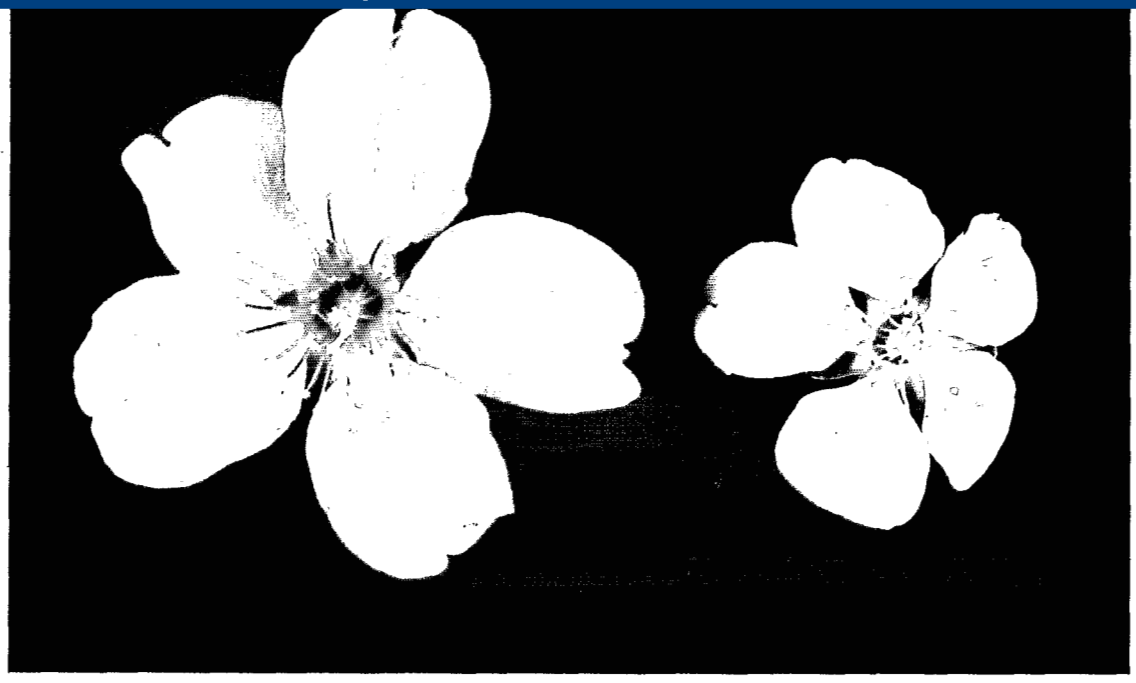
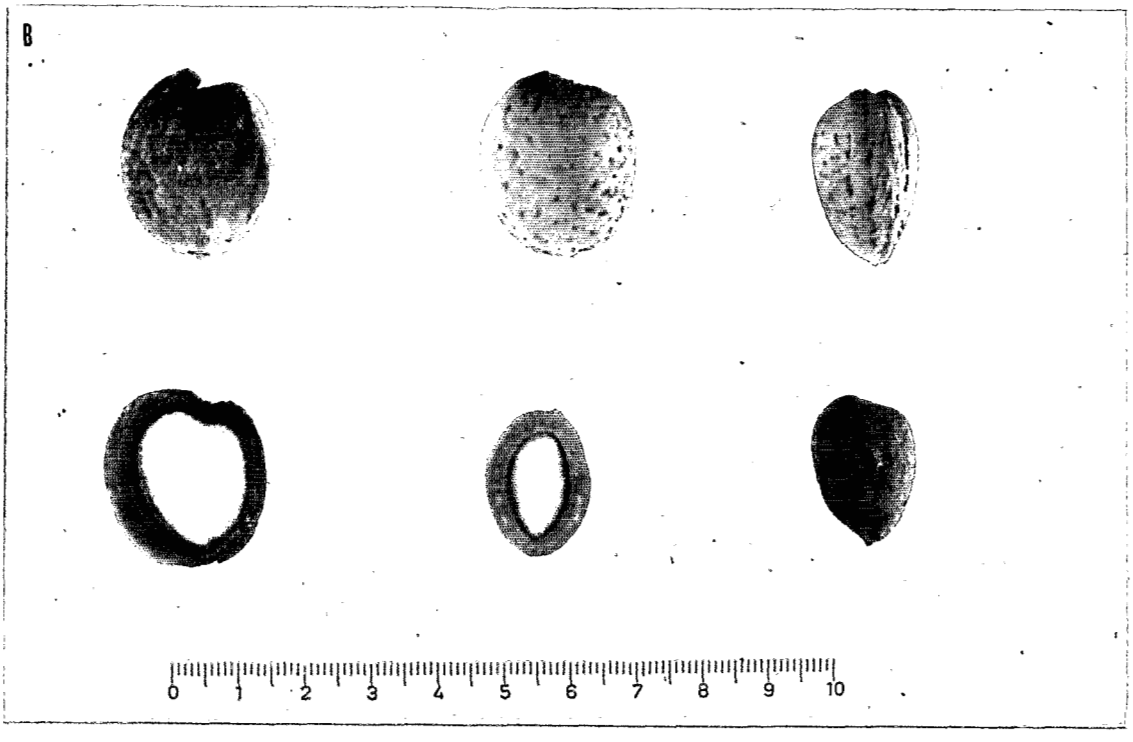


Fig. 2. Selection IAM-Ma 44 (above) selected for the oblong shape of the kernel and for the late blooming time; selection IAM-Ma 64 chosen for the round shape of the kernel.





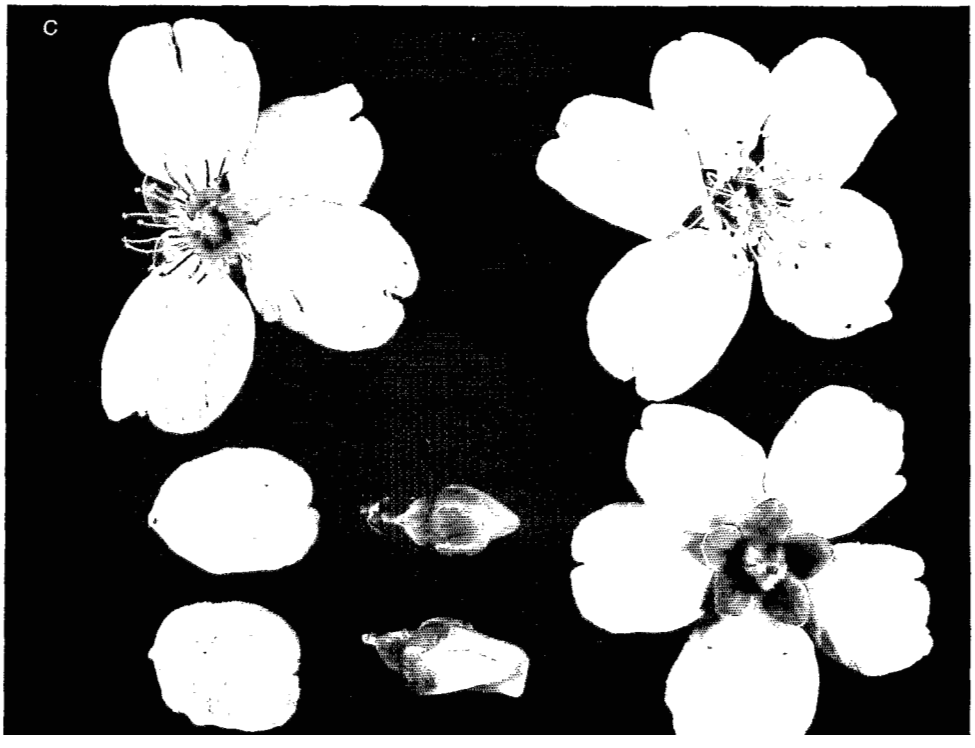


Fig. 3. Fruits and flowers of selection IAM-Ma 33 interesting as an ornamental plant; the flowers are deep pink coloured and almost twice the size of those on other trees.