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Blooming and leafing time in pistachio progenies

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SUMMARY – Blooming and leafing dates were observed in 7 year old pistachios, obtained from 15 controlled crosses between 6 females and 8 males. The leafing date was recorded for all seedlings (1204) and the blooming date only in seedlings which had overcome the juvenile period (749). Significant differences between the average blooming dates of the analysed families were found. 'White Ouleimy' × 'M-502' and 'Larnaka' × 'M-502' stood out for their lateness, and 'Batoury' × 'C', 'Mateur' × 'C' and 'Larnaka' × 'B' for their earliness. In relation with their parents, the late blooming of the offsprings of 'White Ouleimy' (female) and 'M-502', 'M-36' and 'Enk' (males) and the early blooming of the progenies of 'Mateur' and 'Aegina' (females) and 'B' and 'C' (males) could be pointed out. A significant correlation was found (r = 0.69) between the average blooming of the parents and the average blooming of their progenies. Referring to the leafing dates, results were similar. A significant correlation was found (r = 0.58) when blooming and leafing data were compared in 749 seedlings analysed. Significant differences were also found between the average leafing dates of the families. 'White Ouleimy' × 'M-502', 'Sfax' × 'M-502' and 'Larnaka' × 'M-502' stood out for their late leafing, and 'Mateur' × 'Tunez', 'Larnaka' × 'B', 'Batoury' × 'C' and 'Mateur' × 'C' for their early leafing. Regarding parents, the late leafing of the offsprings of 'White Ouleimy' and 'Sfax' (females) and 'M-502' and 'M-36' (males) and the earliness of the progenies of 'Mateur' and 'Aegina' (females) and 'B', 'C' and 'Tunez' (males) could be outlined. Also, a significant correlation was found (r = 0.83) between the average leafing of the parents and their progenies.

Key words: Pistachio, *Pistacia vera* L., breeding, progenies, cultivars, blooming time, leafing time.

RESUME – *"Date du débourrement et de la floraison des descendances du pistachier". La date du débourrement et de la floraison ont été observées sur pistachiers âgés de 7 ans, obtenus à partir de 15 croisements contrôlés entre 6 femelles et 8 mâles. La date du débourrement a été enregistrée sur la totalité des arbres des descendances (1204) et celle de la floraison, sur seulement ceux qui ont dépassé la phase juvénile (749). On a trouvé des différences significatives entre les dates de la floraison moyenne des familles analysées. 'White Ouleimy' × 'M-502' et 'Larnaka' × 'M-502' se distinguent par leur tardiveté, alors que 'Batoury' × 'C', 'Mateur' × 'C' et 'Larnaka' × 'B' par leur précocité. En relation avec les géniteurs, on remarque la floraison tardive des descendants de 'White Ouleimy' (femelle) et 'M-502', 'M-36' et 'Enk' (mâles) et précoce des descendants de 'Mateur' et 'Aegina' (femelles) et 'B' et 'C' (mâles). On a trouvé une corrélation significative (r = 0,69) entre la floraison moyenne des parents et des descendants. Quant à la date de débourrement, les résultats étaient similaires. On a trouvé une corrélation significative (r = 0,58) quand on a comparé les données de la floraison et celles du débourrement pour les 749 arbres analysés. On a trouvé aussi des différences significatives entre les dates de débourrement moyennes des familles. 'White Ouleimy' × 'M-502', 'Sfax' × 'M-502' et 'Larnaka' × 'M-502' se distinguent par leur tardiveté, alors que, 'Mateur' × 'Tunez', 'Larnaka' × 'B', 'Batoury' × 'C' et 'Mateur' × 'C' par leur précocité. En relation avec les géniteurs, on remarque la tardiveté des descendants de 'White Ouleimy' et 'Sfax' (femelles) et 'M-502' et 'M-36' (mâles) et la précocité des descendants de 'Mateur' et 'Aegina' (femelles) et 'B', 'C' et 'Tunez' (mâles). Egalement, on a trouvé une corrélation significative (r = 0,83) entre le débourrement moyen des parents et des descendants.*

Mots-clés : *Pistachier,* Pistacia vera *L., amélioration génétique, croisements, variétés, date de floraison, date de débourrement.*

Introduction

Pistachio (*Pistacia vera* L.) has been cultivated since antiquity and it is spread over large extensions all over the world, however a reduced number of cultivars have reached some diffusion. In contrast to other fruit trees, only a very small number of pistachio cultivars have been described. This can be due to several reasons: need to graft (to reduce the excessive number of unfruitful male trees obtained from germination of seeds and to use as rootstocks trees of several wild *Pistacia* species), long life of the tree, selective environmental pressure, human selection, scarcity of studies, etc. (Maggs, 1973).

Usually, in every pistachio productive area only its native cultivars are grown. Cultivars have extended very little out of their areas of origin, probably due to the propagation difficulty of the species. There are considerable differences between cultivars grown in different zones (Whitehouse, 1957; Spiegel-Roy *et al*., 1972; Kaska, 1990; Gökçe and Akçay, 1993; Hadj-Hassan and Kardouch, 1995; Vargas *et al*., 1995c).

Until recently, works related to pistachio cultivars breeding have been very scarce (Vargas *et al*., 1996; Chao *et al*., 1998). Therefore, very little is known on pistachio genetics. Probably, most of its wide genetic variability has not been exploited to solve production drawbacks. The genetic potential has not been fully expressed. There are good prospects for the development of new cultivars, crossing superior male and female cultivars from distinct geographical origins. However, breeding of new pistachio varieties faces some important limitations: it is a dioecious species, and therefore the potential of male parents for any nut related character is unknown, and it shows late bearing, and thus long generation cycles (Parfitt, 1990, 1995).

A reduced crossing programme was started in 1989 at IRTA-Mas Bové which produced about 2000 seedlings, derived from 31 crosses among 10 female and 12 male parents (Vargas *et al*., 1996). This pistachio cultivar improvement project has begun to give information about the interest of some cross-combinations for some important traits (Vargas *et al*., 1995a,b; Vargas and Romero, 1998a,b).

In this paper, observations on blooming and leafing time in 15 pistachio progenies are presented. These characteristics are related to the production capacity and the adaptation degree of the cultivars to different climates: probability of damages by late frost weather during the pollination and fertilization processes and, very important, chilling requirements. Thus, in some climates late blooming cultivars will be needed, while in others the most important condition may be the low chilling requirements. There are important differences between cultivars referring to these important characters (Vargas *et al*., 1997).

Materials and methods

Controlled crosses were made in the pistachio collection of IRTA-Mas Bové during the years 1989 and, mainly, 1990. The seedlings were planted in the field in April 1992. The progenies analysed in this paper are reflected on Table 1. A total number of 1204 seedlings from 15 controlled crosses were observed. Female and male parents used in the crosses are given on Table 2. Six female and 8 male cultivars, from different countries, were used.

Table 1. Crosses and number of seedlings

Cross	No. of seedlings
'Mateur' × 'M-502'	161
'Mateur' × 'M-38'	145
'Larnaka' × 'Nazar'	127
'Mateur' × 'Nazar'	98
'Mateur' × 'C'	93
'Larnaka' × 'M-38'	92
'Aegina' × 'M-502'	83
'Sfax' × 'M-502'	70
'Larnaka' × 'M-502'	65
'Mateur' × 'M-36'	60
'Batoury' × 'C'	57
'Aegina' × 'Enk'	50
'Larnaka' × 'B'	37
'White Ouleimy' × 'M-502'	35
'Mateur' × 'Túnez'	31
Total	1204

Dates for full blooming and leafing start (number of days from the end of February) of the seedlings (7 years old trees) and their parents were recorded in March-April 1999. The leafing date was recorded for all seedlings (1204) and the blooming date only for seedlings which overcame the juvenile period (749).

Table 2. Female and male parents used

Females			Males		
Name	Origin	No. seedlings	Name	Origin	No. seedlings
'Mateur'	Tunisia	588	'M-502'	Italy	414
'Larnaka'	Cyprus	321	'Nazar'	Israel	225
'Aegina'	Greece	133	'C'	Greece	150
'Sfax'	USA	70	'M-38'	Syria	237
'Batoury'	Syria	57	'M-36'	Syria	60
'White Ouleimy'	Syria	35	'Enk'	Israel	50
			'B'	Greece	37
			'Túnez'	Tunisia	31
Total		1204			1204

Results and discussion

The mean full blooming dates of parents and progenies are given on Table 3. Important and significant differences between the analysed families were found. 'White Ouleimy' × 'M-502', 'Larnaka' × 'M-502' and 'Larnaka × M-38' resulted to be outstanding for their lateness, while 'Batoury' × 'C', 'Mateur' × 'C' and 'Larnaka' × 'B' showed early blooming. Significant correlations were found between the mean full blooming dates of the parents and progenies (r = 0.69) and of the female and male progenies (0.84) (Table 7).

Table 3. Mean full blooming date of parents and progenies. Number of days from the end of February, 1999

Cross	Parents mean	Progenies					
		Female seedlings		Male seedlings		Female and male seedlings	
		No.	Mean	No.	Mean	No.	Mean[†]
'White Ouleimy' × 'M-502'	38.5	7	37.6	12	36.8	19	37.1 a
'Larnaka' × 'M-502'	35.5	14	37.7	21	36.1	35	36.8 ab
'Larnaka' × 'M-38'	37.0	16	37.8	25	34.8	41	36.0 ab
'Aegina' × 'Enk'	37.0	10	37.1	17	34.8	27	35.7 abc
'Mateur' × 'M-36'	33.0	14	35.5	14	35.1	28	35.3 abc
'Sfax' × 'M-502'	35.5	17	34.0	33	35.8	50	35.2 abc
'Aegina' × 'M-502'	34.0	22	35.4	25	34.0	47	34.7 bc
'Mateur' × 'M-502'	31.5	45	33.5	62	35.5	107	34.6 bc
'Larnaka' × 'Nazar'	35.5	43	34.7	51	32.5	94	33.5 cd
'Mateur' × 'M-38'	33.0	36	31.7	37	33.1	73	32.4 d
'Mateur' × 'Nazar'	31.5	20	33.3	40	31.7	60	32.2 d
'Mateur' × 'Túnez'	29.0	4	31.3	10	31.7	14	31.6 de
'Batoury' × 'C'	35.5	23	28.3	25	31.7	48	30.1 ef
'Mateur' × 'C'	31.5	38	27.8	37	29.6	75	28.7 f
'Larnaka' × 'B'	29.5	13	28.5	18	27.6	31	28.0 f
Total		322	33.0	427	33.3	749	33.2

[†]Comparison of means by Duncan's Multiple Range Test.

[a,b,c,d,e,f]Values with the same letter are not significantly different (95%).

The comparison of some progenies with common female or male parents is given on Table 4. The late blooming of the offsprings of 'White Ouleimy' and 'Larnaka' (female) and 'M-502', 'M-36' and 'Enk' (males) and the early blooming of the progenies of 'Mateur' and 'Aegina' (females) and 'B' and 'C' (males) stood out.

Table 4. Full blooming dates. Comparison of some progenies with common female o male parent (extracted from Table 3)

Cross	Mean	Cross	Mean
'Larnaka' × 'M-502'	36.8 ab	'White Ouleimy' × 'M-502'	37.1 a
'Larnaka' × 'M-38'	36.0 ab	'Larnaka' × 'M-502'	36.8 ab
'Larnaka' × 'Nazar'	33.5 cd	'Sfax' × 'M-502'	35.2 abc
'Larnaka' × 'B'	28.0 f	'Aegina' × 'M-502'	34.7 bc
		'Mateur' × 'M-502'	34.6 bc
'Mateur' × 'M-36'	35.3 abc		
'Mateur' × 'M-502'	34.6 bc	'Larnaka' × 'M-38'	36.0 ab
'Mateur' × 'M-38'	32.4 d	'Mateur' × 'M-38'	32.4 d
'Mateur' × 'Nazar'	32.2 d		
'Mateur' × 'Túnez'	31.6 de	'Larnaka' × 'Nazar'	33.5 cd
'Mateur' × 'C'	28.7 f	'Mateur' × 'Nazar'	32.2 d
'Aegina' × 'Enk'	35.7 abc		
'Aegina' × 'M-502'	34.7 bc		

Regarding to the leafing dates, the results were similar. A significant correlation was found (r = 0.58) when full blooming and start leafing dates were compared in 749 seedlings analysed (Table 7). Significant differences were also found between the average leafing dates of the families (Table 5). 'White Ouleimy' × 'M-502', 'Sfax' × 'M-502' and 'Larnaka' × 'M-502' stood out for their late leafing, and 'Mateur' × 'Tunez', 'Larnaka' × 'B', 'Batoury' × 'C' and 'Mateur' × 'C' for their early leafing. A significant correlation (r = 0.83) was also found between the average leafing dates of parents and their progenies (Table 7).

Table 5. Mean start leafing date of parents and progenies. Number of days from the end of February 1999

Cross	Parents mean	Progenies	
		No. of seedlings	Mean[†]
'White Ouleimy' × 'M-502'	36.0	35	26.5 a
'Sfax' × 'M-502'	29.0	70	25.8 ab
'Larnaka' × 'M-502'	30.5	65	24.8 bc
'Mateur' × 'M-502'	29.0	161	23.8 cd
'Larnaka' × 'M-38'	30.5	92	23.7 cd
'Aegina' × 'M-502'	30.0	83	23.7 cd
'Mateur' × 'M-36'	26.5	60	23.6 cd
'Larnaka' × 'Nazar'	28.0	127	23.3 d
'Aegina' × 'Enk'	27.5	50	23.2 d
'Mateur' × 'M-38'	29.0	145	23.0 d
'Mateur' × 'Nazar'	26.5	98	23.0 d
'Mateur' × 'Túnez'	25.5	31	21.8 e
'Larnaka' × 'B'	27.0	37	21.3 e
'Batoury' × 'C'	25.5	57	20.1 f
'Mateur' × 'C'	24.0	93	19.2 f
Total		1204	23.1

[†]Comparison of means by Duncan's Multiple Range Test.
[a,b,c,d,e,f]Values with the same letter are not significantly different (95%).

Regarding parents, the late leafing of the offspring of 'White Ouleimy' and 'Sfax' (females) and 'M-502' and 'M-36' (males) and the earliness of the progenies derived from 'Mateur' and 'Aegina' (females) and 'B', 'C' and 'Tunez' (males) stood out (Table 6).

Table 6. Start leafing dates. Comparison of some progenies with common female or male parent (extracted from Table 5)

Cross	Mean	Cross	Mean
'Larnaka' × 'M-502'	24.8 bc	'White Ouleimy' × 'M-502'	26.5 a
'Larnaka' × 'M-38'	23.7 cd	'Sfax' × 'M-502'	25.8 ab
'Larnaka' × 'Nazar'	23.3 d	'Larnaka' × 'M-502'	24.8 bc
'Larnaka' × 'B'	21.3 e	'Mateur' × 'M-502'	23.8 cd
		'Aegina' × 'M-502'	23.7 cd
'Mateur' × 'M-502'	23.8 cd		
'Mateur' × 'M-36'	23.6 cd	'Larnaka' × 'M-38'	23.7 cd
'Mateur' × 'M-38'	23.0 d	'Mateur' × 'M-38'	23.0 d
'Mateur' × 'Nazar'	23.0 d		
'Mateur' × 'Túnez'	21.8 e	'Larnaka' × 'Nazar'	23.3 d
'Mateur' × 'C'	19.2 f	'Mateur' × 'Nazar'	23.0 d

Table 7. Correlations. Bloming and leafing dates between parents and progenies

Correlations	N	r	S.L.
Mean start leafing dates. Parents and progenies	15	0.83	0.0001
Mean full blooming dates. Parents and progenies	15	0.69	0.0045
Mean full blooming dates. Female and male progenies	15	0.84	0.0001
Full blooming and start leafing dates. Seedlings	749	0.58	0.0001

Conclusions

Significant and important differences in blooming time between pistachio progenies were observed. 'White Ouleimy' × 'M-502', 'Larnaka' × 'M-502' and 'Larnaka × M-38' stood out for their lateness, while 'Batoury' × 'C', 'Mateur' × 'C' and 'Larnaka' × 'B' showed early blooming. Regarding parents, the late blooming of the offsprings of 'White Ouleimy' and 'Larnaka' as females and 'M-502', 'M-36' and 'Enk' as males and the early blooming of the progenies of 'Mateur' and 'Aegina' (females) and 'B' and 'C' (males) stood out.

In relation to leafing dates, the results were similar. 'White Ouleimy' × 'M-502', 'Sfax' × 'M-502' and 'Larnaka' × 'M-502' stood out for their late leafing, and 'Mateur' × 'Tunez', 'Larnaka' × 'B', 'Batoury' × 'C' and 'Mateur' × 'C' for their early leafing. Regarding parents, the late leafing of the offspring of 'White Ouleimy' and 'Sfax' (females) and 'M-502' and 'M-36' (males) and the earliness of the progenies of 'Mateur' and 'Aegina' (females) and 'B', 'C' and 'Tunez' (males) could be pointed up.

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