

Breeding of New Pistachio Cultivars by Hybridization in Turkey

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Abstract

This study was carried out at the Pistachio Research Institute to obtain new male and female pistachio cultivars by hybridization of domestic and foreign cultivars since 1996. Siirt, Ohadi, Haciserifi, Kalehghouchi and Sel 14 cultivars have been used as female, and Uygur, Atli and Kaska used as male parent in this research. The seeds of Kalehghouchi and Akbari cultivars were sown in the pots in order to obtain chance seedlings. To get new pistachio genotypes, 3500 F1 hybrid plants and chance seedlings were obtained and planted in Pistachio Research Institute's area by 90 x 40 cm in space in 1997 and 1998. Five male types have been selected among the plants with respect to phenological characteristics, pollen production, pollen germination and flowering period. Four female types selected for more yield, high splitting ratio, largeness, kernel ratio, kernel colour, suture opening and dehulling easiness as to Weighted-Rankit.

INTRODUCTION

The genus *Pistacia* is a member of the *Anacardiaceae* family and consists of at least eleven species, including *Pistacia vera* L. which is believed to be the most ancestral species and the other species are probably its derivatives (Zohary, 1952). The cultivated pistachio (*Pistacia vera* L.) has edible nuts and is of considerable economical importance. Pistachio is a dioecious and wind-pollinated fruit species. The pistillate and staminate flowers are produced in large inflorescences on different trees.

Turkey has a large population of wild pistachio and several pistachio cultivars, because it is the genetic centre of pistachio (Tekin et al., 2001). Pistachios have been grown in Turkey for over one thousand years and it has one of the largest pistachio germplasm collections in the world (Kaska, 1990). Turkey is the third pistachio producer country in the world after Iran and U.S.A. (FAO, 2008).

Many pistachio cultivars are grown in several countries and have different characteristics, especially for fruit shape and the color of kernel, which varies from light yellow to deep green. The major cultivars in the world are 'Mumtaz', 'Akbari', 'Ohadi' and 'Kalehghouchi' for Iran; 'Kerman' for the U.S. and 'Kirmizi', 'Uzun', 'Halebi' and 'Siirt' for Turkey. The current cultivated cultivars of Turkey couldn't respond to the demands of international markets.

The aim of our study was to obtain new hybrid pistachio cultivars which produce more yield, high splitting ratio, large kernel, attractive and easily shelled, high kernel ratio, low alternate bearing and green kernel by hybridization of domestic and foreign pistachio cvs. The new male cultivars which have high pollen production, high pollen germination, long flowering period and synchronized with popular female cultivars, have also been added in the study.

MATERIALS AND METHODS

This study has been carried out to obtain new male and female pistachio cultivars by hybridization among domestic and foreign cultivars at the Pistachio Research Institute in Gaziantep province of Turkey since 1996.

The cultivars and types used in the hybridization are Siirt, Kalehghouchi, Ohadi, Haciserifi, Selection 14 as female parent; and Uygur, Atli and Kaska as male parent. The hybridization studies were conducted in 1996, and the seeds were sown to the pots.

Besides, the seeds of Kalehghouchi and Akbari were also sown in the pots in order to obtain chance seedlings. The hybrid plants and chance seedlings were obtained and planted in the Pistachio Research Institute's area by 90 x 40 cm in space in 1997 and 1998 years. Hybrids plot has been irrigated with drip irrigation system.

The male hybrids were selected with respect to phenological characteristics (beginning of blooming, full blooming, end of blooming and blooming period (day)) and pollen characteristics (pollen germination ratio (%), number of flowers per cluster and number of pollen grains per cluster); the female hybrids selected as to yield (1-5 rank), quality characteristics (100 nut weight (g), split nut ratio (%), kernel ratio (%), kernel dry weight / nut dry weight x 100), suture opening, kernel colour, and dehulling easiness). Weighted-Rankit test was applied to yield and quality characteristics for female hybrids (Table 1).

RESULTS AND DISCUSSION

The hybridization was performed between the female and male cultivars and types in 1996, then 3500 F1 hybrids and chance seedlings were obtained and planted to the hybrid plot.

Five male types have been selected among the plants with respect to phenological characteristics, pollen production, pollen germination and flowering period. They were 9-64, 11-143, 12-119, 16-32 and 21-125 types. The beginning of blooming was between 12 and 17 April; full blooming between 16 and 24 April; and end of blooming between 24 and 30 April. The flowering period of selected male types was between 13 and 16 days (Table 2).

The pollen germination rates of hybrids were high and about 90%, the highest germination percentage of 93.49% was obtained from 21-125, while the lowest value 89.45% was obtained from 12-119. Number of flowers per cluster was between 133 and 217; and number of pollen grain per cluster between 48.9 and 122.6 million (Table 3). 16 female pistachio types have been selected and marked among the 3500 hybrids and chance seedlings for their special characteristics.

The yield of 14-58, 23-100 and 24-16 was very high, while the yield of 14-28 and Siirt was high and that of others were moderate. The highest 100 nuts weight of 128 g was obtained from 23-100, while the lowest value, 78 g was obtained from Uzun cultivar. The kernel ratio was between 48% (18-48) and 59% (24-16), and split nut ratio between 40% (18-48) and 96% (Siirt cultivar) (Table 4).

The other qualitative quality characteristics were determined as suture opening, kernel colour and dehulling easiness. The suture opening of the hybrids and chance seedlings was moderate and wide. The kernel colour of 9-5, 18-9, 18-60, 23-100 and 24-16 was green, while the other were yellowish-green. The dehulling easiness of hybrids was easy and difficult (Table 4).

Sixteen female pistachio types have been selected and marked among the hybrids and chance seedlings. The selected hybrids were compared with Siirt and Uzun which are the two most widespread pistachio cultivars in Turkey, by using the Weighted-Rankit test. Total points of females were between 510 and 770 point. The Weighted-Rankit point of 14-28, 14-58, 23-100 and 24-16 hybrids and chance seedlings were over 680, while the point was 610 in Siirt and 510 in Uzun cultivar. The highest value obtained from 24-16 as 770 point (Table 5).

There are eight main domestic cultivars, which are called as Uzun, Kırmızı, Halebi, Siirt, Beyazben, Sultani, Değirmi and Ketten Gömleği, in Turkey (Ak and Acar, 2001). Although traditional Turkish pistachio cultivars have green kernel and tasty, they have strong alternate bearing, and their nuts are small and not attractive for demand of international markets. However, the pistachio is widely used in the food industry, particularly for creamcakes, desserts, candies, chocolate and ice cream (Tekin et al., 2001; Okay, 2002). For this reason, a demand has become for the new pistachio cultivars which have more yielding, high splitting ratio, large kernel, attractive and easily shelled, high kernel ratio and low alternate bearing.

Results of our study showed that the flowering time of five selected male hybrids was more synchronizing for widespread pistachio cultivars and their flowering periods were longer than that of Atli, Uygur and Kaska male cvs (Atli et al., 1995). Pollen germination percentages and pollen productivity of the male hybrids were high enough in order to an adequate pollination and fertilization (Table 2 and 3).

Sixteen female pistachio types have been selected and marked among the 3500 hybrids and chance seedlings for their special characteristics. Four superior females were marked among the 16 selected types and compared with Siirt and Uzun cultivars for yield and quality characteristics with respect to Weighted-Rankit test. The types taken 680 and more points were selected as superior cultivar candidates among the bearing hybrids and chance seedlings. They were 14-28 and 14-58 (Kalehghouchi chance seedling), 23-100 (Siirt x Atli hybrid) and 24-16 (Kalehghouchi x Uygur hybrid).

According to the Weighted-Rankit test; '14-28', '14-58', '23-100' and '24-16' hybrids and chance seedlings have been determined as superior pistachio genotypes among the all hybrids and seedlings used in the study.

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Tables

Table 1. Weighted-Rankit diagram for female hybrids.

Characteristics	Coefficient	Category	Category interval	Points
Yield (1-5)	20	Very High	5	9
		High	3	7
		Moderate	1	5
100 Nut Weight (g)	20	Very high	131 - and more	9
		High	116 - 130	7
		Moderate	101 - 115	5
		Low	100 and less	3
Split Nuts (%)	20	High	90 and more	9
		Middle	75 - 89	7
		Low	61 - 74	5
		Very Low	60 and less	3
Kernel Ratio (%)	15	High	56 and more	9
		Middle	53 - 55	7
		Low	50 - 52	5
		Very Low	49 and less	3
Suture Opening (1-3)	10	Wide	3	9
		Moderate	2	7
		Narrow	1	5
Kernel Colour (1-3)	10	Green	3	7
		Yellowish-Green	1	3
Dehulling Easiness (1-3)	5	Easy	3	7
		Difficult	1	3

Table 2. Phenological characteristics of some selected male hybrids.

Hybrid No	Beginning of Blooming	Full Blooming	End of Blooming	Blooming Period (day)
9-64	16 April	24 April	29 April	14
11-143	15 April	21 April	30 April	16
12-119	12 April	16 April	24 April	13
16-32	17 April	20 April	29 April	13
21-125	16 April	20 April	28 April	13

Table 3. Pollen characteristics of some selected male hybrids.

Hybrid No	Pollen Germination Ratio (%)	Number of flowers per cluster	Number of pollen grains per cluster (x 1000)
9-64	91.68	182.3 b	102 225 b
11-143	92.44	207.0 a	122 642 a
12-119	89.45	217.0 a	73 992 c
16-32	93.23	133.3 c	48 883 e
21-125	93.49	159.0 b	63 783 d
LSD($p \leq 0.05$)	NS	23.77	7 757

Letters next to numbers indicate different groups determined by LSD test ($p \leq 0.05$)

Table 4. Yield and quality characteristics of some selected hybrids (in shell).

Hybrid No	Yield	100 nut Weight (g)	Kernel Ratio (%)	Split Nuts (%)	Suture Opening	Kernel Colour	Dehulling Easiness
9-5	Moderate	109	54	73	Wide	Green	Easy
12-1	Moderate	97	53	95	Moderate	Yell-Green	Difficult
12-2	Moderate	124	48	66	Wide	Yell-Green	Difficult
13-18	Moderate	104	53	94	Wide	Yell-Green	Easy
14-28	High	113	56	85	Wide	Yell-Green	Easy
14-58	Very High	116	57	55	Wide	Yell-Green	Easy
16-5	Moderate	95	58	77	Wide	Yell-Green	Easy
16-14	Moderate	120	52	63	Wide	Yell-Green	Difficult
17-33	Moderate	109	53	63	Wide	Yell-Green	Easy
18-9	Moderate	104	54	68	Moderate	Green	Difficult
18-11	Moderate	118	53	65	Moderate	Yell-Green	Difficult
18-48	Moderate	131	48	40	Wide	Yell-Green	Difficult
18-60	Moderate	118	51	58	Wide	Green	Easy
23-100	Very High	128	54	27	Moderate	Green	Easy
24-13	Moderate	126	54	76	Moderate	Yell-Green	Easy
24-16	Very High	122	59	65	Wide	Green	Easy
Siirt	High	110	52	96	Wide	Yell-Green	Difficult
Uzun	Moderate	78	53	67	Moderate	Yell-Green	Easy

Table 5. Weighted-Rankit point of some selected hybrids.

Hybrid No	Yield	100 nut Weight	Kernel Ratio	Split Nuts	Suture Opening	Kernel Colour	Dehulling Easiness	Total Points
9-5	100	100	140	75	90	70	35	610
12-1	100	60	140	135	70	30	15	550
12-2	100	140	60	75	90	30	15	510
13-18	100	100	140	135	90	30	35	630
14-28	140	100	180	105	90	30	35	680
14-58	180	140	180	45	90	30	35	700
16-5	100	60	180	105	90	30	35	600
16-14	100	140	100	75	90	30	15	550
17-33	100	100	140	75	90	30	35	570
18-9	100	100	140	75	70	70	15	570
18-11	100	140	140	75	70	30	15	570
18-48	100	180	60	45	90	30	15	520
18-60	100	140	100	45	90	70	35	580
23-100	180	140	140	45	70	70	35	680
24-13	100	140	140	105	70	30	35	620
24-16	180	140	180	75	90	70	35	770
Siirt	140	100	100	135	90	30	15	610
Uzun	100	60	140	75	70	30	35	510

