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Effects of soil type and irrigation on yield and quality of 'Kirmizi' pistachio cultivar

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SUMMARY – This work was conducted for the determination of yield and quality of 'Kirmizi' pistachio cv. grown in: (i) arid and poor soils; and (ii) fertile soils. Both soils receive treatments with and without irrigation. The experiments were designed with 4 treatments and 3 replicates. There were 5 trees in each replicate and each tree was treated as one replicate. The whole experiment consisted of 60 trees. The trees were in their "on" year. They were all 30 years old. The harvested nuts were weighed fresh and dried (sun dried for 5 days). Pomological and physical characteristics of the nuts were determined. According to the results obtained, yield, nut size, shelling and splitting percentages increased with irrigation in both poor and fertile soils.

Key words: Pistachio, soil quality, irrigation, yield, nut quality.

RESUME – *"Effets du type de sol et de l'irrigation sur le rendement et la qualité du cultivar de pistachier 'Kirmizi'". Cette étude a été menée pour déterminer le rendement et la qualité du cultivar de pistachier 'Kirmizi' établi sur : (i) des sols arides et pauvres ; et (ii) des sols fertiles. Ces deux types de sols étaient avec ou sans irrigation. Les expériences ont été conçues selon 4 traitements avec 3 répétitions. Dans chaque répétition il y avait 5 arbres et chaque arbre était considéré comme une répétition. Donc l'expérimentation dans son ensemble a porté sur 60 arbres. Les arbres étaient dans leur année de production forte. Ils avaient tous 30 ans d'âge. Les fruits récoltés ont été pesés en vert et en sec (séchés au soleil pendant 5 jours). Les caractéristiques pomologiques et physiques des fruits ont été déterminées. Selon les résultats obtenus, le rendement, la taille des fruits, les pourcentages au cassage et de fruits ouverts ont augmenté avec l'irrigation pour les sols pauvres et pour les sols fertiles.*

Mots-clés : *Pistachier, qualité du sol, irrigation, rendement, qualité du fruit.*

Introduction

Pistachio (*Pistacia vera* L., Anacardiaceae) is the only edible crop of 11 species of the genus *Pistacia.* The pistachio originated in Asia Minor, entered Mediterranean Europe in the beginning of the Christian era, and was introduced in California in 1890 (Ferguson, 1998).

Pistachio grows under dry and bad soil conditions in Turkey. Because of this reason the yield is low and alternate bearing is heavy depending on the cultivars. 'Kirmizi' is also heavy alternating cultivar as well. It was accepted that pistachio is a plant for marginal areas. It can be grown easily in dry land and rainfed conditions. But it has a higher yield and better quality under fertile soil and irrigated conditions.

Pistachio trees are not irrigated generally in Syria and Turkey. But in Iran and USA, all the trees are irrigated (Ak, 2002). Of course to get high yield and quality the main requirements are irrigation and fertilization (Tekin *et al.*, 1995).

The main pistachio cultivars in Turkey are 'Kirmizi' and 'Siirt'. 'Kirmizi' has been used as a cultivar for many years, but, according to Ak (1998a), 'Siirt' has become a common cultivar since 1980. This cultivar is the least alternate bearing cultivar amongst the Turkish cultivars. 'Siirt' cultivar is yielding 7 kg to 27 kg per tree according to eight years average under unirrigated conditions. If these trees grow under irrigated areas the yield and quality will be increased. In addition, the nut number is generally 17 per cluster. In fact this number should be 25 to 30 per cluster.

Ak (1998b) reported that, fruit set per cluster changed from 8 ('Vahidi') to 25 ('Kirmizi') while 'Siirt' cultivar has 17 nuts, according to three years averages.

Under irrigated conditions, expected changes (Goldhamer *et al.*, 1987; Ak, 1992; Kanber *et al.*, 1993; Monastra *et al.*, 1998) on pistachio trees are as follows: (i) trunk growth will be increased; (ii) alternate bearing severity will be decreased; (iii) the yield per tree will be increased; (iv) leaf size will be increased; (v) current years' shoot and length of shoot will be increased; (vi) nut size and splitting rate will be increased; and (vii) blank nut rate will be decreased.

The objective of this work was to determine the effect of irrigation and of good or fertile soil conditions on yield and quality of *Pistacia vera* cv. 'Kirmizi'.

Materials and methods

This experiment was conducted at Birecik town in Sanliurfa, Turkey. A 30-year old 'Kirmizi' pistachio cultivar was planted 7 m x 7 m on *Pistacia vera* rootstock. The general traits of 'Kirmizi' are given in Table 1 (Gokce and Akcay, 1993; Ak and Acar, 2001) and climate features of 'Birecik' are given in Tables 2 and 3.

Table 1. Some traits of domestic cultivars

Traits	'Uzun'	'Kirmizi'	'Halebi'	'Siirt'
Habit	Semi-erect	Semi-erect	Erect	Semi-erect
Inflorescence	Mid-early	Mid-early	Early	Intermediate
Fruiting rachis	Intermediate	Dense	Intermediate	Sparse
Ripening period	Intermediate	Mid-early	Early	Mid-late
Bearing	Significant	Significant	Significant	Moderate
Nut size (mm)				
Nut length	19.57	19.86	19.13	19.91
Nut width	10.58	11.53	10.43	11.55
Nut thickness	9.56	9.83	10.54	11.02
Nut shape	Elongated	Elongated	Elongated	Ovoid
Nut colour	Dark ivory	Dark ivory	Dark ivory	Ivory
Hull characteristics				
Hull dehiscence	Non-dehiscent	Non-dehiscent	Non-dehiscent	Slightly dehiscent
Hull tip	Pronounced	Pronounced	Strongly pronounced	Strongly pronounced
Hull colour	Red group	Red-purple group	Red group	Yellow-orange group
Hull colour homogeneity	No	Yes	No	No
Split nuts %	69	67	78	92
Suture opening	Narrow	Narrow	Moderate	Wide
Kernel flavour	Satisfactory	Satisfactory	Satisfactory	Satisfactory
Kernel colour	Yellowish green	Yellowish green	Yellowish green	Yellowish
Oil content %	56.64	59.89	56.27	56.70
Protein content %	22.26	21.77	23.47	20.83

Orchard and tree selection

4 type orchards were chosen: (i) irrigated orchard – fertile soil; (ii) irrigated orchard – poor or arid soil; (iii) unirrigated orchard – fertile soil; and (iv) unirrigated orchard – poor or arid soil.

Experimental design

Three replications, each replication has 5 trees. For each treatments, 15 trees were determined. In total 60 trees were controlled.

Irrigation

The orchard was irrigated 5 times beginning from June (irrigated orchards have been irrigating for 5 years).

Table 2. Monthly averages of some important climatic factors of Birecik town for 8 years

Months	Min. temp. (°C)	Max. temp. (°C)	Average temp. (°C)	Relative humidity (%)
January	–4.13	16.63	5.76	74.33
February	–4.23	18.28	6.31	71.15
March	–1.67	23.60	10.36	66.95
April	2.48	31.21	15.41	63.95
May	7.53	38.10	21.33	55.16
June	11.33	41.98	27.46	44.96
July	15.78	43.55	30.75	44.37
August	15.61	43.60	30.18	45.82
September	9.27	40.22	25.03	49.28
October	5.91	35.37	19.41	58.04
November	0.38	26.41	11.57	70.95
December	–2.57	17.75	7.37	77.32
Averages	4.64	31.39	17.57	60.19

Table 3. Rainfall at Birecik province for 8 years

Years	1989-1990	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	Mean
Rainfall (mm)	365	305.6	318	343.6	368.3	320.5	514.1	406.4	366.48

Harvesting

Trees were harvested when the nuts of the adjacent trees in the same plot with the experimental trees were ready to harvest, that is when their exocarps can be easily dehulled (Ayfer, 1964; Crane, 1978; Ak, 2001). The harvested fruits were sun dried.

The evaluations were made on: (i) yield: kg per tree as fresh and dried; (ii) physical traits: splitting rate, blank nut rate, total filled nuts rate; and (iii) pomological traits: nut and kernel dimensions (Fig. 1), weight and shelling percentage calculated as kernel to shell ratio (Ak, 1998c).

Statistical analyses

Harvesting time fruits sampled as 25 fruits each replication. Three replications were used. The data measured were subjected to variance analysis variables and the averages were compared to the LSD test (Bek, 1983).

Results and discussion

Yield

The yield was calculated as fresh after harvest and dry after sun dried. The obtained results are given in Table 4. Under irrigated conditions, the average yield per tree was 26.40 kg while in non-irrigated was 20.88 kg. Yield also changes with soil conditions. For poor soil conditions yield was 18.85 kg while for fertile was 28.44 kg. As it is seen clearly the best result (31.00 kg/tree) was obtained from fertile and irrigated soil conditions. Comparing the factors, irrigation and soil type, it is seen that the first effective factor is soil type. That means, a fertile soil is better than an irrigated poor soil.

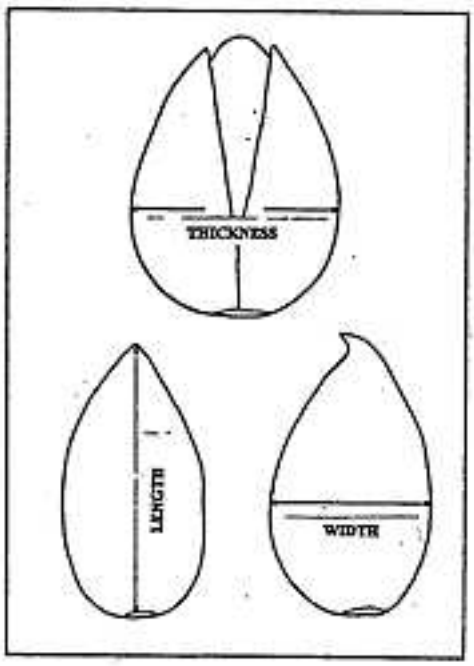

Fig. 1. Measurement of dimensions in pistachio fruit.

Table 4. Yield per tree (kg)

Soil type	Irrigated orchard	Unirrigated orchard	Average
Poor soil	21.80† (12.58)††	15.90 (9.22)	18.85 (10.90)
Fertile soil	31.00 (17.04)	25.87 (13.50)	28.44 (15.27)
Average	26.40 (14.81)	20.88 (11.36)	23.64 (13.09)

†Fresh weight (average of 15 trees).
††Sun-dried weight.

Physical traits

The effect of soil type and irrigation on splitting rate was determined (Table 5). According to this table, the best result (54.93%) was obtained form fertile irrigated soil. The worst value was obtained from unirrigated poor soil. When comparing soil type and fertility, the effect of fertility was preferable.

The blank or empty nut rates are given in Table 6. The lowest rate (10.60%) was obtained from fertile with irrigated combination. According to the results, poor soil with irrigation and fertile without irrigation were similar to each other. These results show that the orchard first should be established under fertile conditions. Then it should be irrigated. That means that fertile soil conditions are preferable to irrigation.

Table 5. Split nut rate (%)

Soil type	Irrigated orchard	Unirrigated orchard	Average
Poor soil	44.42 a	24.11 b	34.27
Fertile soil	54.93 a	45.91 a	50.42
Average	49.68	35.01	42.35

LSD (%5): 16.03.

Table 6. Blank nut rate (%)

Soil type	Irrigated orchard	Unirrigated orchard	Average
Poor soil	24.22 b	35.20 a	29.71
Fertile soil	10.60 c	24.80 b	17.70
Average	17.41	30.00	23.71

LSD (%5): 7.99.

Total filled nut rates are given in Table 7. The best result (89.40 %) was obtained from fertile soil with irrigation. Similar results were obtained above other physical characters. Of course, fertile soil conditions and irrigation were more effective than other combinations.

Table 7. Total filled nut rate (%)

Soil type	Irrigated orchard	Unirrigated orchard	Average
Poor soil	75.78 b	64.80 c	70.29
Fertile soil	89.40 a	75.20 b	82.30
Average	82.59	70.00	76.29

LSD (%5): 7.99.

Pomological traits

Pomological traits such as nut weight, length, width, thickness and shelling percentages were determined either in irrigated or different soil type conditions. The obtained results are given in Table 8. Some characters were found to be statistically different.

According to the obtained results, dehulled nut weight is affected positively. The nut weight and length were higher under fertile soil and irrigated conditions. Only width is not statistically affected. In Table 8, kernel characters are similar to dehulled nuts. All the characters but width were affected statistically. The highest kernel weight (47.06 g/100 nuts) was obtained from fertile and irrigated combination.

Shelling percentages varied between 51.92% and 50.37%. The averages are not statistically different from each other.

Table 8. Pomological traits, shelling (%) of nut and kernel

Traits	Fertile soil		Poor soil		LSD (%5)
	Irrigated	Unirrigated	Irrigated	Unirrigated	
Dehulled nut					
100 nut weight (g)	91.45 a	81.90 c	87.68 ab	85.50 bc	4.79
Length (mm)	19.93 a	18.86 b	18.89 b	18.69 b	0.43
Width (mm)	10.60	10.32	10.65	10.60	NS
Thickness (mm)	9.76 ab	9.16 c	9.90 a	9.52 b	0.30
Kernel					
100 nut weight (g)	47.06 a	41.26 b	45.53 a	43.60 ab	3.66
Length (mm)	16.81 a	15.65 b	15.89 b	15.75 b	0.43
Width (mm)	8.31	7.95	8.26	8.19	NS
Thickness (mm)	7.68 ab	7.09 c	7.90 a	7.56 b	0.32
Shelling (%)	51.45	50.37	51.92	50.99	Ns

Conclusions

In the future, rootstocks will be the main problem in Turkey. There were no irrigation facilities at Southeast Anatolia region where pistachio grows mainly in Turkey. But now in these areas there are already 3 dams (Ataturk, Birecik and Karakaya). This means that in the next coming years the pistachio culture in Turkey will be irrigated using water provided by the Southeast Anatolia Project (Kaska, 1995). Although *P. vera* is preferred as a rootstock because of its first growing habit for the budding process (Ayfer *et al.*, 1990), its seedling is sensitive to *Verticillium* spp. and *Phytophthora parasitica* (Garcia, 1980). For that reason, *P. vera* seedlings are not suitable for use as rootstocks for pistachio under irrigated conditions. It was reported that pistachio trees on *P. terebinthus* and *P. atlantica* rootstocks died from *Verticillium* in the USA, where pistachio trees are commonly irrigated (Crane and Maranto, 1988).

As a summary: (i) pistachio trees should be grown under good, fertile soil conditions; (ii) irrigation is main effective factor to obtain high yield as well as other cultural practices; (iii) it is possible to obtain more split nuts, big sized nuts, low blank fruit and more yield under fertile soil and irrigation conditions; and (iv) the more favourable conditions, the more yielding and quality.

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