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Research on leaf properties and stomata distribution of some *Pistacia* spp.

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SUMMARY – Stomata are found on most aerial surfaces of plants, including the epidermis, stems and flowers. Stomata control the loss of water and the exchange of gas and thus control water relations and metabolism. Differences in leaf features and stomata distribution among the species and cultivars growing in the same environment are important aspects of their environmental physiology. For this reason, stomata number was determined on the leaf epidermis. This study has been designed to obtain knowledge on stomatal size and distribution in *Pistacia* species and cultivars. Leaf samples were collected from different species and cultivars growing in Manisa-Yunt Mountain. There were some variations among the species and cultivars.

Key words: *Pistacia* spp., pistachio stomata, leaf.

RESUME – *"Recherches sur les propriétés des feuilles et la distribution des stomates de quelques espèces de* Pistacia*". Il existe des stomates sur la plupart des surfaces aériennes des plantes, y compris l'épiderme, les tiges et les fleurs. Les stomates interviennent dans la perte d'eau et les échanges gazeux, et ainsi contrôlent les relations hydriques et le métabolisme. Des différences de caractéristiques des feuilles et de distribution des stomates parmi les espèces et cultivars cultivés dans un même environnement sont des aspects importants de leur physiologie environnementale. Pour cette raison, le nombre de stomates sur l'épiderme des feuilles a été déterminé. Cette étude a été conçue pour acquérir des connaissances sur la taille et la distribution des stomates chez les espèces et cultivars de* Pistacia*. Les échantillons de feuilles ont été collectés à partir de différentes espèces et cultivars plantés dans les montagnes de Manisa-Yunt. Il y avait quelques variations parmi les espèces et cultivars.*

Mots-clés : *Espèces de* Pistacia*, stomates du pistachier, feuille.*

Introduction

Stomata are assumed to be characteristic for the aerial generation. Stomata are found on most aerial surface of plants often including the adaxial epidermis, stems and flowers (Esau, 1977). Leaves of some species have stomata on abaxial and adaxial surfaces. Stomatal structure vary greatly in concert with species habitat and leaf architecture.

Stomatal openings control the loss of water and the exchange of gases in the aerial environment of a plant thus control its water relations and metabolism. Stomatal responses to light (Sharkey and Ogawa, 1987), CO_2 concentrations (Morison, 1987), abscisic acid (Raschke, 1987), auxins (Davies and Mansfield, 1987), air humidity and soil drought (Schulze *et al*., 1987) were stated in different researchers.

The plant environment is continuously changing and stomatal apertures adjust accordingly. Stomatal function is important on the physiology, adaptation and productivity of plants. For drought tolerance, some researchers have found that an intensive stomatal apparatus permitting continued assimilation during drought may be preferable (Henzell *et al*., 1976).

It is stated that there are large heritable differences between species in stomatal dimensions, distribution and morphology. For instance, stomatal distribution per unit area indicated significant variations amongst apple rootstocks (Pathak *et al*., 1976), chestnut types (_ahin and Soylu, 1991) and Sarılop clones (Mısırlı and Aksoy, 1994). In addition, dimensions, and especially frequency can change more than two fold in response to radiation, to water status or according to developmental stages (Jones, 1987).

Pistachio growing have undergone under drought conditions without irrigation in the Yunt Mountain of Manisa province (Turkey). There are some *Pistacia* spp. and varieties in that area. This study was planned to obtained information stoma size and frequency in these materials.

Materials and methods

Leaf samples were collected from *Pistacia* spp. such as *P. atlantica*, *P. terebinthus* and cultigens such as Siirt (male), Uzun types (Topan and Söbü) and Kırmızı types (Alyanak and Çatlayan) growing in the Manisa-Yunt Mountain.

In July, the third leaf from the apex was sampled in the north side of trees. In the experiment, two trees and two shoots in each tree were used.

Stomata counts were made on the middle portion of the terminal leaflet by nail polish on the upper and lower surfaces (Gülcan and Mısırlı, 1990). The prepared slides were investigated using a 15 x ocular and a 16 x objective. In addition, the length and width of stomata (mean of 20 stomata) were measured.

The length and width of leaf and terminal leaflet samples (mean of 10 fully expanded leaf) were measured. Leaflet numbers were evaluated as well.

Data were statistically analysed by using SPSS statistical programs.

Result and discussion

The data in relation to stoma number per unit area on adaxial surface indicated that there were significant variations among the investigated species and types (Table 1). *P. terebinthus* ranked the first row with 510.80 no/mm^2. This species was followed by *P. atlantica* (439.81 no/mm^2) and it formed the second group alone. No statistical differences between *P. vera* and Siirt (male) were found.

Table 1. Stoma numbers on adaxial surfaces of leaves

	Stomata number (no/mm^2)	Stomata length (µ)	Stoma width (µ)
Female			
Çatlayan kırmızı	308.63 d	18.22 bc	31.92 ab
Alyanak	307.09 d	19.66 ab	31.16 b
Topan	263.88 e	19.11 ab	34.45 a
Söbü	296.29 d	18.26 bc	33.72 ab
Average	293.97	18.81	32.65
Male			
Pistacia vera	353.38 c	15.27 d	25.71 c
Siirt	350.30 c	18.37 bc	27.55 c
Pistacia atlantica	439.81 b	16.77 cd	28.31 c
Pistacia terebinthus	510.80 a	20.59 a	26.44 c
Average	413.57	17.75	27.00

[a,b,c,d,e]Mean separation, within columns, by Duncan's multiple range test, 5%.

Although in female pistachio types, the highest value was obtained from Çatlayan kırmızı (308.63 no/mm^2), this type was located in the same statistical group with Alyanak and Söbü. Topan possessed the lowest value (263.88 no/mm^2).

The mean stomata number of adaxial surface in Kırmızı types were higher than the Uzun types. This value was also low in *P. vera* among male trees (Table 1). Similar results were obtained in

pistachio and *Pistacia* spp. (Ça_lar and Tekin, 1998). Besides, as could be seen on the Table 1, mean stoma numbers per unit area of male trees (413.57 no/mm^2) were higher than the female types (293.97 no/mm^2). In another study, it was found that the mean stoma number was different in female and male fig varieties (Mısırlı *et al*., 1998). The results of our study show similarity to this experiment.

The stomata width of adaxial surface differed significantly according to the species and types (Table 1). *P. terebinthus* ranked the first (20.59 µ) and made up the top group alone. It was followed by Alyanak and Topan. The lowest stoma width occurred in *P. vera*. Variation in stoma width was between 15.27-20.50 µ for male species, and between 18.22-19.66 µ for female pistachio. Taking into consideration mean value, female pistachios had higher value (18.81 µ) than the others (17.75 µ).

The stomata length of adaxial surface showed statistically differences based on species and types (Table 1). Topan had the highest stoma length (34.45 µ). The other female types followed this type. The shortest stoma length was found in male *P. vera*. All of the male species located in the same group. Mean of stoma length in female types was higher (32.65 µ) than the male species (27 µ).

Stoma number, stoma width and length in the abaxial surface is presented in Table 2. Species and types showed significant difference in stoma number. Alyanak ranked the first (174.37 no/mm^2). It was followed by Çatlayan kırmızı, Topan, Söbü, *P. vera* and Siirt (male). The lowest value was obtained in *P. atlantica* (81.78 no/mm^2).

Table 2. Stoma numbers on abaxial surfaces of leaves

	Stomata number (no/mm^2)	Stomata length (µ)	Stoma width (µ)
Female			
Çatlayan kırmızı	165.11 a	19.27 b	31.96 bc
Alyanak	174.37 a	20.22 b	31.09 bc
Topan	149.68 a	20.29 b	33.43 ab
Söbü	160.49 a	20.01 b	35.85 a
Average	162.41	19.94	33.08
Male			
Pistacia vera	165.11 a	17.14 c	27.11 d
Siirt	152.77 a	20.72 ab	30.05 c
Pistacia atlantica	81.78 b	18.85 b	36.28 a
Pistacia terebinthus	85.64 b	17.14 c	34.08 ab
Average	121.32	18.46	31.88

[a,b,c,d]Mean separation, within columns, by Duncan's multiple range test, 5%.

Stoma width indicated considerable variations (Table 2). Siirt (male) ranked in the first place (20.72 µ), *P. atlantica* ranked as the last row.

Stoma length showed statistically significant differences (Table 2). *P. atlantica* had the longest stoma (36.28 µ) and *P. vera* possessed the shortest stoma (27.11 µ).

Average stoma number, width and length in male species were 121.32 no/mm^2, 18.46 µ and 31.88 µ, respectively. The data in relation to these parameters in male trees were lower than the female ones.

The distribution of stoma indicated statistically significant difference in accordance with adaxial and abaxial surface (Table 3). The stoma number of adaxial surface (353.78 no/mm^2) was higher than the other surface (141.87 no/mm^2). Confirming this, it was reported that stoma number on abaxial surface ranged between 114-151 and adaxial surface between 171-221 (Ça_lar and Tekin, 1998).

The width and length of leaf and terminal leaflet and number of leaflets showed statistically significant difference according to investigated species and varieties as could be seen in Table 4. Leaf width varied between 17.77 cm and 20.37 cm in female trees, between 9.45 cm and 16.77 cm in male

trees. Leaf length was determined to range between 18.07-22.47 cm for females, 11.60-19.92 cm for males.

Table 3. Stomata numbers on adaxial and abaxial surfaces of leaves

Leaf surface	Stoma number (no/mm^2)
Adaxial	353.78 a
Abaxial	141.87 b

[a,b]Mean separation, within columns, by Duncan's multiple range test, 5%.

Table 4. Leaf properties of *Pistacia* spp. and pistachios

	Leaf length (cm)	Leaf width (cm)	Leaflet number	Length of terminal leaflet (cm)	Width of terminal leaflet (cm)
Female					
Ç. kırmızı	18.07 bc	17.77 bc	4.00 cd	10.22 c	7.92 b
Alyanak	18.75 bc	18.45 abc	3.00 d	12.40 ab	8.97 ab
Topan	22.47 a	19.45 ab	5.00 c	13.60 a	9.75 a
Söbü	20.25 b	20.37 a	4.00 cd	11.87 b	8.97 ab
Average	19.88	15.86	4.00	12.02	8.90
Male					
P. vera	17.40 c	15.80 d	5.00 c	9.40 c	5.10 c
Siirt	19.92 b	16.77 cd	7.00 b	10.35 c	5.42 c
P. atlantica	14.15 d	10.00 e	9.00 a	5.12 d	1.90 d
P. terebinthus	11.60 e	9.45 e	5.00 c	5.00 d	2.32 d
Average	15.76	13.00	6.50	7.46	3.68

[a,b,c,d,e]Mean separation, within columns, by Duncan's multiple range test, 5%.

The range of variation was 7.92-9.75 cm for females, 1.90-5.42 cm for males in the width of terminal leaflet. The variations of terminal leaflet length in female and male trees were between 10.22-13.60 cm and 5-10.35 cm, respectively.

The mean leaf properties of female types were higher than that of the males. *P. atlantica* had the most leaflets. Alyanak had the lowest value (Table 4).

Correlations among the examined parameters were found (Table 5). There was a negative correlation between stoma number and the width and length of leaf and terminal leaflet on adaxial surface. On the contrary, positive correlation occurred on abaxial surface. Negative correlation was seen between abaxial and adaxial surface in terms of stoma number. In abaxial surface, it was determined negative correlation between stoma number and length.

Conclusions

It was found that average stoma number differed according to male and female trees. This result is of great importance from the point of stomatal index. Because, stomatal index is fairly constant for leaves of a particular species (Meidner, 1987). Also, stomatal density was positively correlated with the stomatal index (Sack, 1987). Taking this into consideration, detailed investigations may be continued on this matter.

Table 5. Correlations between leaf properties and stomatal characteristics†

	L.L.	L.W.	L.N.	T.L.	T.W.	Ab.SN	Ab.SL	Ab.SW	Ad.SN	Ad.SL	Ad.SW
L.L.	1.00	0.76**	0.19	0.70**	0.67**	0.43*	–0.11	0.02	–0.80**	0.23	–0.12
L.W.	0.76**	1.00	–0.08	0.79**	0.71**	0.54**	–0.02	0.07	–0.74**	0.34	–0.02
L.N.	0.19	–0.08	1.00	–0.16	–0.26	–0.20	0.14	–0.27	–0.21	0.08	–0.32
T.L.	0.70**	0.79**	–0.16	1.00	0.80**	0.52**	–0.09	0.12	–0.78**	0.31	0.05
T.W.	0.67**	0.71**	–0.26	0.80**	1.00	0.38*	0.14	0.28	–0.69**	0.41*	0.22
Ab.SN	0.43*	0.54**	–0.20	0.52**	0.38*	1.00	–0.50**	–0.08	–0.42*	–0.19	–0.18
Ab.SL	–0.11	–0.02	0.14	–0.09	0.14	–0.50**	1.00	0.42*	0.02	0.67**	0.36*
Ab.SW	0.02	0.07	–0.27	0.12	0.28	–0.08	0.42*	1.00	0.10	0.27	0.76**
Ad.SN	–0.80**	–0.74**	–0.21	–0.78**	–0.69**	–0.42*	0.02	0.10	1.00	–0.33	0.23
Ad.SL	0.23	0.34	0.08	0.31	0.41*	–0.19	0.67**	0.27	–0.33	1.00	0.38*
Ad.SW	–0.12	–0.02	–0.32	0.05	0.22	–0.18	0.36	0.76**	0.23	0.38**	1.00

†L.L. = Leaf length; L.W. = Leaf width; L.N. = Leaflet number; T.L. = Terminal leaflet length; T.W. = Terminal leaflet width; Ab.SN = Stoma number on abaxial surface; Ab.SL = Stoma length on abaxial surface; Ab.SW = Stoma width on abaxial surface; Ad.SN = Stoma number on adaxial surface; Ad.SL = Stoma length on adaxial surface; Ad.SW = Stoma width on adaxial surface.
*Significant 5%; **Significant 1%.

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