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Full Length Research Paper

Comparison of leaf stomatal features in some local and foreign apricot (*Prunus armeniaca* L.) genotypes

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The objective of this study was to determine the leaf stomatal features of some local and foreign apricot (*Prunus armeniaca* L.) cultivars. Stomata frequency, size and stomatal conductance of leaves of twenty apricot genotypes from inside and outside of Turkey were measured. The leaf stomatal frequency significantly varied among the apricot cultivars. The highest leaf stomata frequency was found in cv. Orange Red (349 stomata/mm^2) and lowest was in cv. Cnef (182.2 stomata/mm^2). Mean stomata size was 81.8 µm. In 2006 stomatal conductance was the lowest (84 mmol m^{-2} s^{-1}) in 'Roxana' and the highest (263 mmol m^{-2} s^{-1}) in 'Thyrinthe' cultivars. In 2007, the lowest stomatal conductance (143 mmol m^{-2} s^{-1}) was found in 'Hasanbey' cultivar and the highest (405 mmol m^{-2} s^{-1}) was in 'Cnef' cultivar. Generally in the second year counductance values were higher which was probably due to higher values of maximum air temperature. The differences in leaf stomatal conductance values that existed among the genotypes can be taken into consideration as selection criteria for apricots to be grown in regions with higher summer temperatures.

Key words: Apricot, stomata frequency, stomatal conductance.

INTRODUCTION

Fruit tree adaptation studies mainly include the horticulturistic characteristics of the newer cultivars in a given environment where the experiments are set up. But in practice, trees are often planted in more or less different environments which may negatively affect both the plant development and yield. Apricot is one of the economically important fruit trees which are known to be particularly prone to erratic fruit production (Mehlenbacher et al., 1990) and the causes for this behaviour are not completely understood. Recent climatic changes (that is, global warming) can adversely affect tree growth by evaporation of water from the leaves because of increased heat load (Coder, 1996). The mechanism developed by plants as a response to water stress may be found in adaptations by roots, stems, leaves and fruits; the leaf modifications include the size and number of stomata (Kozlowski, 1976).

Leaf surfaces are equipped with small openings called stomata, which allow carbon dioxide to enter the leaf and oxygen to escape, facilitating photosynthesis. The cost to the plant for this vital exchange is water loss. It is estimated that 99% of the water absorbed by the roots of the plant is lost by the leaves in transpiration. Apricot trees bear large canopies, representing a great evaporative surface and show low levels of root and stem hydraulic conductivity (Alarcon et al., 2000). Under high day temperatures, these characteristics may result in a transpiration rate, which exceeds the water absorption capacity, resulting in a water stress. Stomatas on plant leaves are considered to have an important role for adaptability to varying environmental conditions (Salisbury and Ross, 1992). Stomatal frequency differs greatly from species to species, ranging from 125 to over 1000 per square milimeter (Ryugo, 1988). Stomata frequency may vary in response to the amount of annual rainfall in different regions (Misirli and Aksoy, 1994). Caglar and Tekin, (1997) reported the significant variations among the stomatal density of pistachio cultivars grafted on different rootstocks grown under arid condition. Sahin and Soylu (1991) showed the effect of drought on the stomata frequency of selected chesnut types. In annual plants stomatal conductance was found to be related to yield in some instances. Ulloa et al. (2000)

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confirmed that high stomatal conductance was associated with high cotton lint yields at supra-optimal temperatures for the cotton crop under irrigated environments.

The objective of this study was to compare leaf stomatal characteristics and stomatal conductance of twenty apricot genotypes from different origins. An understanding of the relationship between stomatal features and environmental factors would be of considerable importance for the better fruit tree growth on the warming globe.

MATERIALS AND METHODS

This study was carried out at the apricot adaptation orchard of the Horticultural Department of Faculty of Agriculture of KSU- Turkey in 2006 and 2007. The orchard was 8 year old and planted at a spacing of 5 x 5 m. The soil of apricot orchard was sandy loam with low organic material content. The orchard was located at 37° 56' N latitude and 36° 56' E longitude and at an altitude of 850 m above sea level. The annual precipitation on average over 10 years was 600 mm. Trees were grown with regular cultural practices under drip irrigation system. The following cultivars were used in the study: Goldrich, Harcott, Palstein, Roxana, Orange Red, Katy, Npeu, Castelbrite, Pisana, Cnef, Thyrinthe, Bebeco, Beliana, Priana, Feriana, A. Errani B. De Mole, Soganci, Sekerpare, H.Haliloglu, Hasanbey. The latter four cultivars were Turkish origin and grown intensively as a local cultivars.

For stomata counting, the epidermis layer of the abaxial side of leaf was painted with clear fingernail polish, and a piece of transparency sheet (2 cm^2) was pressed on it by fingers. Later, the imprint of stomata was obtained by striping the transparency sheet from the leaves (Schehter et al., 1992). Two imprints were taken from each side of the main vein of a leaf (total 4 imprints per leaf). Four of the youngest fully expanded leaves located on the tip of two branches facing two different directions (south and north) per tree were collected for all measurements, with readings from the abaxial side of leaves. The counting were replicated on three trees for each cultivar. The stomata were counted on transparent sheets which were placed on a glass slide by using a light microscope with a 40 x 10 magnification in 0.18 mm^2 vision field. The obtained values were calculated as stomata numbers per mm^2. Also, the size of stomata on three imprints was measured with an ocular scale under a 40 x 10 magnification with 3 replications.

Stomatal conductance was measured in the orchard with a portable porometer (Model AP-4 of Delta T, Cambridge, England). Conductance measurements were realized at noon time on 16 developed leaves near the tips of the shoots from two trees of each cultivar during summer of 2006 and 2007. Mean of maximum air temperatures in summer months were given in Table 1.

All data were subjected to analysis of variance with mean separation by Duncan's Multiple Range Test at 0.01.

RESULTS AND DISCUSSION

The stomata frequency varied in the apricot genotypes (Table 2). The highest number of stomata (349.0 m^2) was found in Orange Red, followed by Palstein (311.7 mm^2), and Katy, Roxana, Npeu, Hasanbey, Feriana and Harcott resulted in another statistical group with frequencies between 285.2 and 275.5. While, Thyrinthe, A. Errani, Goldrich, Beliana, B.de Mole, Sekerpare, Bebeco, H. Haliloğlu and Castelbrite, had lower stomatal frequencies between 260.5 and 226.7. The stomata frequencies were lowest in Soğancı, Priana and Cnef cultivars as 197.2, 194.7 and 188.2 respectively. Stomata size ranged from to 64.1 to 100.8 µm (Table 2). Orange Red had the highest stomata frequency (349/mm^2) and smaller stomatas (71.6 µm), while Cnef had the lowest stomata frequency (182.2/mm^2) and bigger stomatas (100.8 µm). Stoma size generally tended to decrease in genotypes with higher stomata frequencies.

Table 1. Mean of maximum temperature of summer months.

Month	Maximum air temperature	
	2006	2007
June	35.3	38.9
July	25.9	42.0
August	28.6	38.0

There was a significant variation in leaf stomata frequency in apricot genotypes. Similarly, Palasciano et al. (2005) reported significant differences in stomatal frequency and size among genotypes of wild and cultivated almonds. The leaf stomata frequency of the genotypes can be related to adaptation process of the trees. Because stomata frequency and size are considered to be significant both in plant genetics and ecology (Fregoni and Roversi, 1968). The number of stomata (per/mm^2) was found to be higher with increasing altitutes in walnuts (Caglar et al., 2004). Olmez et al. (2006) compared stomatal numbers of dry and fresh apricot cultivars in three different regions and demonstrated that the stomata numbers of the cultivars for drying process were found less than that for fresh consumption. Rana and Chadha (1990) found a correlation between growth of *Prunus* seedling and the number of stomata per unit area. Generally, there is an inverse relationship between the stoma number and size, characteristics which vary greatly among genotypes (Miller, 1938).

Stomatal conductance of apricot cultivars signifi-cantly varied within the genotypes and also between the experimental years (Table 2). In 2006 stomatal conductance was the lowest (84 mmol m^{-2} s^{-1}) in 'Roxana' and the highest (263 mmol m^{-2} s^{-1}) in 'Thyrinthe' with an average of 159.7 mmol m^{-2} s^{-1} for all genotypes. In 2007 the lowest stomatal conductance (143 mmol m^{-2} s^{-1}) was found in 'Hasanbey' and the highest (405 mmol m^{-2} s^{-1}) was in 'Cnef' with an average of 237 mmol m^{-2} s^{-1} for all genotypes. The higher conductance values of the second year were probably due to higher values of maximum air temperatures. Under irrigated conditions high stomatal conductance of trees can improve photosynthetic processes for the benefit of yield. In apples the stomatal behaviour of the leaves appears to be correlated with photosynthetic rate (Lakso, 1994). Several factors are known to control

Table 2. Leaf stomatal frequency, stomata size and stomatal conductance of apricot genotypes.

Apricot genotype	Stomata frequency (number/mm^2)	Stomata size (µm)	Stomatal conductance (mmol m^{-2} s^{-1})	
			2006	2007
Orange Red	349.0 a	71.6 abc	192 a-d	176 bc
Palstein	311.7 ab	76.6 abc	122 b-d	286 a-c
Katy	285.2 bc	81.6 abc	142 b-d	226 a-c
Roxana	283.0 bc	80 abc	84 d	191 bc
Npeu	281.5 bc	77.5 abc	102 b-d	189 bc
Hasanbey	278.5 bc	83.3 abc	106 b-d	143 c
Feriana	278.5 bc	64.1 c	183 a-d	338 ab
Harcott	275.5 bc	70.8 abc	165 a-d	339 ab
Thyrinthe	260.5 b-d	67.5 bc	263 a	262 a-c
A.Errani	257.7 b-d	83.3 abc	165 a-d	241 a-c
Goldrich	247.7 b-e	68.3 bc	211 ab	311 a-c
Beliana	246.5.b-e	77.5 abc	182 a-d	264 a-c
B. de Mole	246.5 b-e	100 a	143 b-d	292 a-c
Sekerpare	244.7 b-e	82.5 abc	91 cd	172 bc
Bebeco	235.0 c-e	85.8 abc	201 abc	218 a-c
H. Haliloglu	217.0 c-e	82.5 abc	171 a-d	285 a-c
Castelbrite	226.7 c-e	97.5 ab	135 b-d	237 a-c
Sogancı	197.2 de	90 abc	153 a-d	214 bc
Priana	194.7 de	95.8. ab	204 a-c	202 bc
Cnef	182.2 e	100.8 a	179 a-d	405 a
Mean	254.9	81.8	159.7 b	237 a

Values in same column followed by different letters indicate statistically significant differences between genotypes according to Duncans MRT 0.01 test

stomatal conductance, such as light, soil water potential, internal CO_2 concentration as well as sink strength in trees. But, genotypical differences in stomatal conductance were often neglected. The results of this study showed that stomatal conductance values of the apricot genotypes grown in the same conditions greatly varied. Also, a low stomatal sensitivity to drought in benefit of an increase in growth would probably be a more successful strategy under the competitive conditions during tree establishment (De Lucia et al., 1991). The stomatal conductance seems to be independent of stomatal frequency or stomata size, since there was no significant relation between them in all genotypes tested (data not shown).

Turkey is a leading apricot producer in the world and the production is mostly limited to dried apricots and to the cooler region of East Anatolia Region, mainly in the surroundings of Malatya Province. But fresh apricot growing is expanding to the warmer climates both for domestic and international trade (Kaska, 1997; Ercisli, 2004). For that reason fruit quality and yield of apricots under varm conditions can be maximized by selecting suitable varieties, matching correctly to the environment under which they are to be grown. The conductance values can be taken into consideration as possible selection criteria for apricot genotypes to regions with higher summer temperatures. The difference between the experimental years should be taken into consideration since in 2007 the maximum air temperatures were unusually high compared to previous years.

In cotton, high stomatal conductance might confer some adaptive advantage to genotypes that experience supra-optimum temperatures (Ulloa et al., 2000). However, unlike cotton, fruit trees are penrennial plants with more complex physiological features that are difficult to be related. Using shading nets in apricots resulted in higher leaf stomatal conductance values than in exposed plants (Nicolas et al., 2005). Thus, climatological differences should be taken into consideration when stomatal conductance values are to be discussed. The result of this study provided evidence that there are cultivar differences with respect to stomatal frequency and stomatal conductance. Therefore, this information is important in the development of adaptation studies, particularly concerning heat stress to which trees experience in summer. Further verification of this approach is needed, that is, correlation between tree yield and stomatal conductance of apricot genotypes.

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