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## FEATURES OF WATER EXCHANGE OF PISTACIA VERA L. ON APSHERON IN BOGARA CONDITIONS

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Pistachio (*Pistacia vera* L.) is a drought-resistant tree of subtropical deserts, that has developed the ability to satisfy its high moisture requirements due to an extremely developed “two-story” deep root system. This is a heat-loving and heat-resistant crop, the xeromorphic and heliophilic structure of its leaves creates an exceptionally high resistance of its assimilation apparatus to high air temperatures (up to 48<sup>0</sup>C). When the soil dries out from spring to autumn, the suction force of the pistachio roots increases with a simultaneous increase in this indicator (up to 87 atmospheres) and osmotic pressure in the cell sap (up to 70 atmospheres) in the leaves, which helps the tree find assimilable moisture in the soil when there is a pronounced deficiency of it, thereby ensuring high transpiration and optimal water content in the leaves to maintain their turgor and reduce heat.

**Keywords:** *drought resistance; water exchange; transpiration; water deficiency*

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### 1. Introduction

The orographic, climatic and soil conditions of the subtropical territories of Azerbaijan satisfy the requirements of true pistachio for heat, light, moisture conditions, soil fertility, absolute maximum and absolute minimum temperatures. Their lowland and foothill areas are distinguished by an abundance of warmth and light. These are the Absheron Peninsula, the Kura-Araks lowland, the Ganja-Kazakh inclined plain, the Alazan-Agrichay valley, where their influx is about 2500 hours, the annual value of total radiation is within 120134 kkal/cm<sup>2</sup>, and is necessary for normal growth and development and fruiting of trees, the sum of positive temperatures reaches 54-59<sup>0</sup> C. Based on the given thermal indicators of the growing season for plants in these climatic regions of the republic, the true pistachio, as a pronounced xerophyte, is a very promising species for the development of rainfed arid areas, where other tree fruits die due to lack of moisture [6, 7, 9].

K.Arzani et al. studied the epidermal anatomy of the leaves of four pistachio rootstocks under water stress conditions [11]. G.Memmi et al. became familiar with the influence of water stress, environment and rootstock on the daily behavior of stem water potential and conductivity of pistachio (*Pistacia vera* L.) leaves [12]. Azerbaijan has large empty land areas, the involvement of which in agricultural turnover will allow the creation of highly productive and long-lasting pistachio orchards and forest gardens in the

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foothills and mountainous areas in rain-fed areas [4]. In the northern part of the foothills (southern slopes of the Greater Caucasus Range), gardens can be planted without watering due to the heavy precipitation that falls a year for almost 10 months, and in the southern part (northern slopes of the Lesser Caucasus) - their entire almost treeless territory with The hot semi-desert climate is suitable for creating forest gardens in its lowest zone. Natural pistachios of Western and Central Asia are characterized in structure by sparse canopy and closed root systems, which is explained by their direct dependence on moisture conditions [3]. The less moisture in the soil, the longer the trees grow from each other, and their horizontal roots spread over considerable distances [1, 2]. Therefore, the question of the density of placement of true pistachio in rainfed conditions of the foothills, where the limiting factor for its satisfactory growth is soil moisture, is one of the most important agrotechnical methods for cultivating this species.

## 2. Material and methods

In order to identify the optimal density of pistachio plants in the rainfed conditions of Absheron, we conducted an experiment according to the following scheme: 1 – thickened plantings (1x1 m) – control; 2 – sparse plantings (6x6 m) with maintenance (annual tillage in the fall in order to increase the migration of moisture in the soil during natural moisture during the winter-spring period). The age of the plants is 18 years. Soil moisture and the degree of drought resistance of plants were studied based on the characteristics of the following indicators: water content of leaves (total water content was determined by drying in a thermostat to constant weight); transpiration intensity (by weight method according to L. Ivanov); water-holding capacity (based on water loss by leaf cuttings after 3- hour exposure to air); water deficiency (by immersing leaf cuttings in water until they are completely saturated). The test objects were mature leaves of the middle tier from shoots of last year's growth.

## 3. Results and Discussion

Under unfavorable environmental conditions, changes may occur in a plant organism at various levels, and even indicative characteristics can be identified [9]. Although the pistachio is true and has a deep root system, the bulk of its roots are usually concentrated in the top two-meter layer of soil. In sparse plantings of a crop, the lighting conditions of the plants change, the feeding area of each plant increases, which leads to an increase in the moisture supply of all soil horizons. So, by the time the natural moisture of the soil from precipitation ceased (May), the moisture reserve in the experimental plot with maintenance was 42.6% higher than in the control plot. Starting in June, in all areas there is intense drying out of the soil throughout the entire soil profile, especially in areas with dense plantings (Table 1).

**Table 1.** Dynamics of moisture reserves in different soil layers

Plot	Soil layer, cm	Moisture (mm) by month					
		IV	V	VI	VII	VIII	IX
Thickened plantings without maintenance (control)	0-50	58	64	38	31	28	30
	50-100	41	46	37	34	33	32
	100-150	43	45	38	36	36	35
Sparse plantings with care	0-50	82	104	62	55	43	38
	50-100	42	54	63	58	49	42
	100-150	55	63	64	78	69	60

Here, due to the large number of trees per unit area, the winter-spring moisture reserve in the soil is consumed faster: from June to August, its content in the meter layer decreased from 75 to 61 mm, which

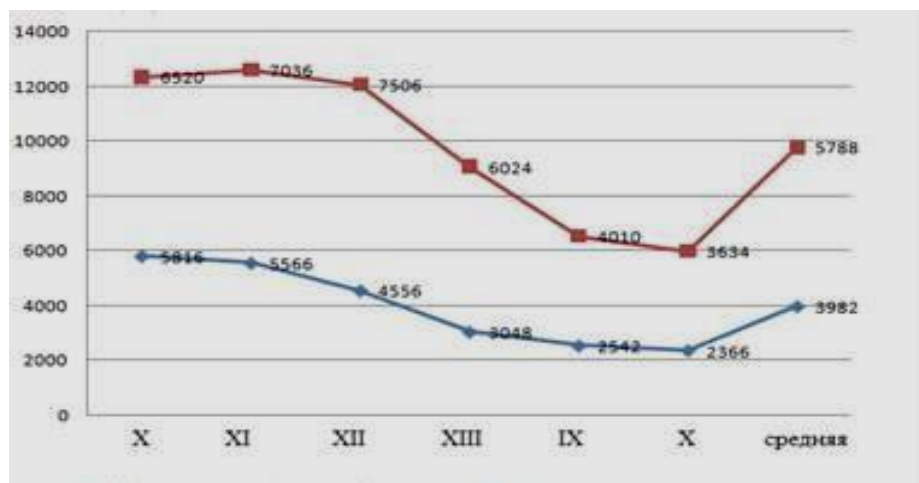
corresponds to 6-5% of the dry mass of the soil. And this is the lowest limit of soil moisture, at which the absorption of moisture by plants practically stops. In an area with a sparse distribution of plants, moisture reserves in the soil remained available to them even in August (92 mm). Different regimes for maintaining pistachio plants had a certain impact on the state of their water balance. The water content in leaves naturally decreases from their maximum values in the spring (63.2% in the first and 66.5% in the second variants) to the minimum by autumn (49.5 and 52.2%, respectively), which is a fairly significant difference between these extreme values (within 14%) (Table 2).

**Table 2.** Changes in water regime indicators in the leaves of pistachio plants in depending on the conditions of their detention

<b>Month</b>	<b>Options experience</b>	<b>Humidity, %</b>	<b>Water deficit (% of full saturation)</b>	<b>Water holding capacity (% of original weight)</b>
<b>May</b>	Thickened plantings	63,2	5,6	27,4
<b>June</b>	Thickened plantings	56,4	10,2	25,2
	Sparse landings	60,9	4,7	33,2
<b>July</b>	Thickened plantings	52,6	19,4	21,7
	Sparse landings	57,4	10,6	37,1
<b>August</b>	Thickened plantings	50,2	18,4	18,8
	Sparse landings	55,6	9,6	34,2
<b>September</b>	Thickened plantings	49,5	18,0	19,2
	Sparse landings	52,2	12,4	32,4

The highest water content of the leaves coincides with the phases of intensive growth and flowering, including the beginning of fruit formation. During this period, plants consume the greatest amount of water for new growth and synthesis processes actively occurring in their bodies.

During the hot summer period, the water content in the leaves drops sharply as a result of a decrease in soil moisture reserves. At the same time, the positive effect of the sparse content of plants in plantings in terms of their water content is clearly visible: the water content in the leaves of plants during this period was on average 4.9% higher compared to the leaves of plants in the control variant (in relative terms - higher by 9.2 %). In arid conditions, the transpiration process in the leaves of plants is directly dependent on soil moisture, organically related to the regulation of the balance of water supply and consumption: the more moisture in the soil, the more it is spent on evaporation by the leaves. Seasonal changes in the intensity the traspiration of pistachio leaves are presented in the drawing, which clearly shows that this process is strictly limited by the reserves of productive moisture in the soil (Fig. 1).



Thickened plantings without maintenance (control) (blue), Sparse plantings with care (red)

**Fig. 1.** Seasonal changes in pistachio transpiration rate

With the onset of atmospheric and soil drought, plants growing in areas with different moisture content experience a decrease in transpiration. Water consumption for evaporation is reduced in plants of the control variant already in June and continues to fall until the end of the growing season, having the following breakdown for each previous month: in June by 4.3, in July by 18.2, in August by another 33.2 %, etc., generally decreasing by almost half by the end of the growing season. In plants of the experimental variant, water loss from leaves through evaporation in general follows the course of the transpiration curve of the control variant, but the level of activity was much higher: in July more than 1.5 times, in August almost 2 times, maintaining a high gap until the end of the growing season. Such a high transpiration rate indicates the more efficient work of the leaves of these plants, and, consequently, their higher synthetic abilities.

Violation of the water regime of pistachio plants under the influence of atmospheric and soil droughts was also expressed in a change in their water-holding capacity and water deficiency. The highest water-holding capacity was observed in plants in compacted plantings: the amount of water lost by their leaves after 3 hours of experiment, with an increase in the intensity of the thermal factor and a decrease in the amount of absorbable moisture, in the soil decreased from May to June by 8%, from June to July - by more than 13.9%, etc. in experimental plants, on the contrary, this process follows the path of high moisture release from the leaves, which indicates a decrease in their water-holding capacity and more intense processes of evaporation from their surface.

High air and soil temperatures led to a sharp increase in the water deficit in leaves with a peak in July, which is almost 3.5 times higher than the initial value in May. Even a decrease in air temperature in September did not help stabilize the water deficit in the leaves - until the end of the growing season it remained at the level of 18%. The plant of the experimental variant showed the same reaction to high thermal influence - water deficiency in the lychids naturally increased throughout the growing season, but with a peak in September (12.4%), which exceeded the original level more than 5 times. The relatively low value of this indicator during the growing season, equal to an average of 7.9%, exceeded the control by 81.3%.

The magnitude of sublethal deficiency in water saturation of pistachio leaves is within 30%, with a range from 24.1 to 42.9% [10]. Taking this into account, it becomes clear why on the Absheron Peninsula pistachio plants in the most critical periods of their lives do not cross the threshold of the average critical value and their water balance always remains positive in rainfed conditions. This preserves their ability to carry out life processes at a satisfactory level both due to the development of a deep tap root, which ensures the supply of a sufficient amount of moisture to the small above-ground part, and, apparently, a certain genotype and the presence of a number of adaptive defense reactions, because drought stimulates the formation of specific proteins [5], and hormones [9] that regulate the activity of stomatal cells.

The deterioration of the growing conditions of true pistachio in rainfed areas appears primarily in the size of their above-ground parts and, as a consequence, in fruiting. The above-ground organs of the

pistachio grow very slowly and only at about 8-10 years of age do they begin the period of so-called great growth. However, in a dense culture, as a result of unfavorable lighting conditions, trees have thin stems elongated in height with small crowns. Subsequently, with increasing age, competition for soil moisture begins between plants as a result of the penetration of root systems into the areas they occupy, which entails the formation of a stable tendency to reduce both annual linear growth - on average four times - and productivity - 40 or more times (Table 3).

**Table 3.** The influence of growing conditions on the growth and fruiting of pistachio vera

Options experience	Average annual growth, cm	Increase		Average harvest kg wood	Increase	
		cm	%		kg	once
<b>Thickened plantings (control)</b>	2,5	-	-	0,2	-	-
<b>Sparse landings</b>	10,4	6,9	316,0	8,0	7,8	40

From the above it follows that the water regime of plants is a clear indicator of the growing conditions of the crop: the more favorable the conditions for providing the pistachio with real water, the more intense the physiological processes that occur in the cells of its tissues, promoting more intensive growth, development and fruiting. The high water content in the leaves allows the pistachio to spend more of it on evaporation processes, which allows plants to tolerate summer drought without significant disruption of physiological and biochemical processes and contributes to the normal course of water and gas exchange and assimilation processes. From an economic point of view, these features of the tree are so significant that in many areas of the republic that are unsuitable for agriculture, pistachio can be the only truly agricultural crop with serious chances for commercial success due to its high profitability. In this regard, all agricultural technology should be aimed at the correct placement of plantations in plantings and at the accumulation and careful consumption of moisture in the soil during the growing season in rain-fed conditions.

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