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WATER-CONTAINING ABILITY AND ADAPTATION FEATURES OF LEAVES OF SOME WOOD SPECIES IN THE CONDITIONS OF INDUSTRIAL ENVIRONMENT

Research article

Abstract

The article discusses the influence of the industrial environment on the functional and structural features and water-holding capacity of cut leaves of elm squat (Ulmus pumila L.) and Syrian ash (Fraxinus syriaca Boiss.). A relationship has been established between the water-holding capacity of leaves, the number of stomata per 1 mm2 of leaf surface, their size, the degree of openness during the day, and the degree of anthropogenic impact on plants. The differences in biometric indices of tree species from different ecological zones are revealed.

Keywords: ancient rocks, assimilation surface, water holding capacity, stability, growth, lamina, industrial emissions.

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ВОДОУДЕРЖИВАЮЩАЯ СПОСОБНОСТЬ И АДАПТАЦИОННЫЕ ОСОБЕННОСТИ ЛИСТЬЕВ НЕКОТОРЫХ ДРЕВЕСНЫХ ПОРОД В УСЛОВИЯХ ПРОМЫШЛЕННОЙ СРЕДЫ

Научная статья

Аннотация

В статье рассматривается влияние промышленной среды на функционально-структурные особенности и водоудерживающую способность срезанных листьев вяза приземистого (Ulmus pumila L.) и ясеня сирийского (Fraxinus syriaca Boiss.). Установлена зависимость между водоудерживающей способностью листьев, количеством устьиц на 1мм2 листовой поверхности, их размерами, степенью открытости в течение суток и степенью антропогенного воздействия на растения. Выявлены отличия в биометрических показателях у древесных пород из различных экологических зон.

Ключевые слова: древные породы, ассимиляционная поверхность, водоудерживающая способность, устойчивость, прирост, листовая пластинка, промышленные выбросы.

1. Introduction

The industrial - technogenic environment that has arisen around the large industrial centers, brought to life a new trend in botanical science - industrial botany, which is designed to optimize the environment with the help ofplants.

From this point of view, the priority is to identify the extent and nature of damage to woody species among the local and introduced dendroflora, and their widespread introduction into the practice of green building.

A number of studies [1–5] are devoted to studies on the gas resistance and water holding capacity of plants in industrial zones.

For the regions of the South of Uzbekistan, this issue has not been studied enough. Scientifically - based design of the relationship between the level of industrialization and wildlife is impossible without an understanding of the physiological mechanisms of plant resistance to industrial pollution. Therefore, the task of studying the mechanisms of gas stability and the selection of gas-resistant assortments of tree species on the basis of their water-holding capacity is particularly acute [6]. From this point of view, especially, the selection of a gas-resistant species assortment of plants for landscaping industrial zones is possible only after carrying out relevant studies on green trees, considering specific environmental and physical-geographical conditions.

The main air pollutants to which plants react sensitively in industrial areas are gaseous substances and aerosols emitted by industrial enterprises of various industries. Suspended particles entering the atmosphere most often consist of carbon oxides, sulfur and nitrogen, as well as solid particles, etc.

The level of air pollution in the industrial zones of the Kashkadarya region is characterized as “relatively high”. High average annual concentrations of carbon monoxide, sulfur dioxide, nitrogen dioxide, ammonia and suspended solids make the prevailing contribution to the level of atmospheric pollution in the zones of the Kashkadarya region. The total emission of industrial enterprises in the atmosphere exceeds the maximum permissible concentration (MPC).

The main sources of pollution are such enterprises as LLC Mubarek Gas Processing Plant (MGPP), LLC Shurtan Gas Chemical Complex (ShGCC). The ecological characteristics of the industrial zones studied are given in Table 1.

Bioecological studies were carried out in 2018 based on the economic agreement between Karshi State University and MGPP of February 14, 2018 for No. 063-us and Karshi State University and ShGCC of January 26, 2018 for No. 235/031.

The purpose of these studies was to study the influence of the industrial environment on some physiological and functional-structural features of various species of woody plants under the conditions of the above-mentioned industrial zones of the Kashkadarya region.

2. Materials and methods

Elm squat (Ulmus pumila L.), Syrian ash (Fraxinus syriaca Boiss.) Were studied as common objects.

Trial areas were selected in various industrial areas of the Kashkadarya region, characterized by varying degrees of environmental pollution: in the MGPZ (Experience-1), ShGHK (Experience-2) and the relatively clean sanitary zone of Karshi (Control). Depending on the nature and intensity of the anthropogenic impact sources, the test areas were characterized as “strong (Experience-1)”, “medium (Experience-2)” and “weak (Control)” degree of environmental pollution.

As can be seen from table No. 1, the degree of contamination of industrial areas is relatively high in relation to the sanitary zone.

Table 1 – Brief description of study areas (2018 year)

Study areas	Concentration SO^2 in the atmosphere, mg / m^3	Humus, mg / kg	Average annual air temperature, ^OC	Precipitation, mm	Vegetation period, days
Sanitary zone of Karshi	0,04±0,0015	0,9-1,6	14,9	240	301
Experience-1 (MGPP)	0,054±0,019	0,6-0,8	14,1	155	291
Experience-2 (SHGCC)	0,051±0,011	0,8-1,3	15,7	225	303
MPC (for tree species)	0,03	1,9-2,4	-	-	-

As indicators characterizing the state of the plants, leaf damage was used as a percentage of the total leaf surface area, photosynthesis intensity, leaves water-retaining capacity, stomata size per 1 mm2 leaf surface, stomatal openness dynamics and biometric method. As biometric indicators used: the length of the annual segments of the side shoots, the dry weight of the annual segments of the side shoots, the number of leaves on the annual segments of the side shoots, the average leaf area, the dry weight of the leaves.

In the process of adaptive evolution, plants developed properties that allow them to carry out normal activity in various adverse and sometimes extreme conditions of existence. They concern, first of all, the structure and function of the assimilation apparatus. The study of the structure and function of plants at the organ level is a necessary and important task of ecological phytophysiology. From this point of view, the study of the anatomical and morphological structure of leaves in plants growing under pollution conditions is very informative.

3. Result and discussion

Our physiological and anatomical and morphological studies of the assimilation apparatus in species growing under different environmental conditions revealed a relationship between the number of stomata per 1 mm2 of leaf surface and the degree of atmospheric gas pollution. In an ecologically unfavorable environment, an increase in the number of stomata and a decrease in their size were observed in all studied species of woody plants (Table 2).

Table 2 – Average values of morphometric parameters of the studied rocks

Breed name	Signs of study	Control	Experience-1	Experience-2
Elm squat	Sheet length, (cm)	6,2±0,71	5,8±0,65	6,1±0,67
	Sheet width, (cm)	4,3±0,92	4,1±0,71	4,2±0,086
	Specific surface density of the sheet, (g / cm^2)	0,024±0,0011	0,021±0,0018	0,023±0,0009
	Petiole length, (cm)	2,1±0,044	1,97±0,045	2,1±0,058
	Number of stomata, (cm^2)	467±35	529±43	498±46
	The size of stomata, (μm.)	64,12	51,26	57,14
	Rows of chloroplasts	4	6	5
Ash Syrian	Sheet length, (cm)	4,7±0,073	4,4±0,061	4,5±0,086
	Sheet width, (cm)	2,6±0,061	2,3±0,41	2,4±0,040
	Specific surface density of the sheet, (g / cm^2)	0,036±0,0012	0,031±0,0011	0,031±0,0031
	Petiole length, (cm)	5,6±0,11	5,2±0,088	5,3±0,12
	Number of stomata, (cm^2)	548±51	621±64	594±59
	The size of stomata, (μm.)	41,23	36,56	39,25

Under the conditions of "strong" anthropogenic impact, the number of stomata increased: in elm - by 1.14 times; in ash - by 1.08 times. In conditions of gas contamination, the size of the stomata of the studied species decreased: for elm - by 0.8 times; in ash - by 0.9 times. Analysis of the results of the study of stomatal sizes showed that as the atmosphere becomes more polluted, the stomata sizes of the studied rocks decrease, and the number of stomata increases (Table 2).

The regularity revealed by us characterizes the adaptive capabilities of plants to pollution conditions, and, the more stable the species, the greater the plasticity index.

Based on the anatomical studies of leaves given in Table 2, the above-mentioned species can be arranged in the following order according to the degree of decrease in resistance: the elm elum is more resistant than the Syrian ash.

The daily dynamics of stomata opening and the degree of stomatal apparatus sensitivity to changes in environmental factors are also of great importance for the gas resistance of plants. We have shown that the Syrian ash tree, the elm squat, stomatal apparatus during the day are open less long in time, and the degree of their discovery, determined by the Molish method and the imprint method [7, 8], almost did not depend on the growing conditions.

Their degree of openness showed inversely proportional dependence on the degree of pollution of the atmosphere. Based on this, it can be assumed that species with a large number of small stomata per mm2 are better able to regulate the degree of their opening, and hence gas exchange.

Therefore, among physiologists, the idea of an important role in the resistance of plants to water-holding forces and the ability to tolerate dehydration was strengthened.

And also we determined the rate of water loss by cutting the leaves of the studied plants. To determine the water retention capacity, the leaves were quickly weighed on torsion weights, then laid out on the table. Weighing was repeated after 1, 2, 3, 4 hours. Calculated the rate of loss of water leaves for the specified time intervals. In all cases, there was a lower rate of water loss by the leaves of individuals growing near industrial plants. Thus, the water-holding capacity of elm and ash increased by 1.3, 1.1 times, respectively, compared with the control, respectively. The greater the water-holding capacity of the leaves, the more resistant the species to environmental pollution. Thus, the indicators obtained by the method of withering characterize the ability of plants to regulate not only water loss, but also gas exchange, and, consequently, absorption of harmful gases by hiding stomata under unfavorable conditions (Table 3). The obtained data can be interpreted as a result of the ecological adaptation of plants to arid growing conditions in the industrial zone.

Any adverse conditions reduce the overall productivity of plants in plantations, therefore, a study of a number of biometric indicators of trees has been carried out (Table 3).

The results of the experiment showed that the industrial zone with relatively intense pollution is reduced: the accumulation of organic matter by shoots and leaves, the area of the leaf blade and the number of leaves on the shoot. Moreover, the degree of damage depends on the gas stability of the species (Table 3).

In a relatively unstable species - Syrian ash in conditions of intense pollution, the accumulation of organic matter in leaves decreased 1.5 times, and in a more stable species - elm squat, indicators decreased 1.3 times, respectively, compared to control trees.

The accumulation of organic matter by growing leaves of elm squat and Syrian ash, characterizing the intensity of photosynthetic processes, showed a relative lag of trees growing in gassed conditions.

Thus, the accumulation of organic matter by the leaves of an elm squat was 70% in experiment-1, and 74% of control in experiment-2. In Syrian ash, the accumulation of organic matter in leaves was in experience-1 87%, and in experiment-2 95% of control.

Table 3 – Biometric evaluation of the state of the studied rocks

Breed name	Signs of study	Control	Experience-1	Experience-2
Elm squat	Increase in annual escape, (cm)	58,4±1,51	47,5±1,92	51,4±1,87
	The number of leaves on the shoot, pieces	8,1±0,74	5,5±0,49	6,2±0,81
	Leaf blade area (cm^2)	32,1±1,30	27,1,8±1,22	29,2±0,97
	Dry weight of the annual shoot, (gr)	37,0±2,1	30,6±1,2	32,0±2,1
	Dry weight 10 leaves, (gr)	6,8±0,02	5,3±0,11	6,1±0,09
	Photosynthesis activity (mm2 / µg / 2h)	0,094±0,001	0,066±0,009	0,069±0,007
	Leaf damage, (%)	2,3	3,9	2,7
Ash Syrian	Increase in annual escape, (cm)	28,8±1,06	25,7±0,97	25,9±1,52
	The number of leaves on the shoot, pieces	7,3±0,29	5,9±0,21	6,1±0,34
	Leaf blade area (cm^2)	36,60±1,56	30,36±1,42	32,4±1,06
	Dry weight of the annual shoot, (gr)	48,6±1,2	38,1±2,0	45,3±1,8
	Dry weight 10 leaves, (gr)	5,7±0,03	5,0±0,09	5,2±0,07
	Photosynthesis activity (mm2 / µg / 2h)	0,064±0,004	0,056±0,003	0,061±0,008
	Leaf damage, (%)	1,2	2,1	1,7

4. Conclusion

Thus, the results of the conducted research allow us to draw a relative conclusion that the size and number of stomata per 1 mm2 leaf surface, the dynamics of their openness at different times of day, the water-holding capacity of cut leaves and the dynamics of organic matter accumulation by the vegetative organs of plants can serve as comparative indicators of gas resistance of the studied species of trees.

Experimental data on the adaptive ability of some species of woody plants belonging to the local and introduced flora used in landscaping industrial zones of the Kashkadarya region will allow them to become the basis for practical recommendations on greening large industrial zones in southern Uzbekistan.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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