ENVIRONMENTAL FEATURES AND RESISTANCE TO THE ANTHROPOGENIC LOAD OF CONIFEROUS INTRODUCENTS IN THE CENTRAL PART OF UKRAINE

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Abstract: The current state of coniferous introduced plants growing on the territory of Uman, Cherkasy region is analyzed. Such representatives are the multi-age trees Pinus nigra and Thuja plicata. The studies were aimed at determining their resistance to arid environmental conditions in summer and to adverse factors in the winter period with generally accepted methods. Studies were conducted during 2015–2017. P.nigra trees during the study period received high drought tolerance scores. In Th. plicata plants observed a partial loss of needles turgor during daylight hours. When evaluating the frost resistance, P. nigra trees of different ages did not have visible damage. Young plants Th. plicata were somewhat more vulnerable to the effects of low temperatures, while no damage was found in mature trees.
In general, both species have rather high rates of winter hardiness and drought resistance. This indicates their acclimatization to the given growing conditions. Also, the studied plants tolerate the adverse conditions of the city: dust, smoke, soil compaction. Therefore, it is advisable to use them for landscaping urban areas and personal plots. A feature of these species is that they retain a high decorative effect throughout the year and are good components for creating landscape compositions.
Comparing the conditions of the natural distribution range to the conditions of the cultural areas of the studied species, it is possible to state their successful cultivation, which indicates a high ecological plasticity and significant potential of these plants.
Keywords: environmental conditions, winter hardiness, drought resistance, plant habit, introduction, acclimatization, cryoprotectant proteins, turgor.

1. Introduction

Today, the reduction of negative anthropogenic impact, improvement of the quality and general condition of green spaces in all categories due to tree introductions, which most closely meet modern requirements for growth in the challenging conditions of the urban and technological environment, are of primary importance today. Particularly noteworthy are plants, the introduction of which into the culture in Ukraine enrich the biodiversity of the plant world of our state and contribute to the improvement of the environment [1, 2].

Selection of woody plants for landscaping city streets should ensure that they perform basic functions such as: creating comfortable microclimatic conditions, air purification, reducing noise, and enhancing the aesthetic qualities of the architectural environment. Changes in environmental conditions are influenced by the seasonal rhythm of plant development, the nature of the passage and the duration of individual phenological phases, as well as the external features – the general habit of plants – height, number and branching of the shoots. Therefore, when assessing the degree of adaptation, various research methods are used, one of which is the study of resistance to adverse environmental conditions [3].

Studies were conducted in the Uman, located in the central part of Ukraine. Coniferous greenery of the city is represented by trees, bushes, grass and flower vegetation. Trees grow mainly in groups. From aboriginal wood plants are presented: chestnut ordinary (*Aesculus hippocastanum L.*), heart-leaved linden (*Tilia cordata L.*), Norway maple (*Acer platanoides L.*), oak (*Quercus robur L.*), witch elm (*Ulmus glabra Huds.*), European spruce (*Picea abies (L.) Karsten*). Among this variety of species, introduced conifers – *Pinus nigra* and *Thuja plicata*, which are often used for landscaping in central Ukraine, grow. However, there is no information in the literature regarding the resistance of the species against the complex of adverse environmental factors in the region.

2. Methods

A visual assessment of the drought resistance of *Pinus nigra* and *Thuja plicata* was done using S. Piatnitsky 6-point scale [1] method of taking into account damage to needles and shoots: 0 – the plant dies from drought; 1 – the needles disappear, the ends of the shoots dry out; 2 – most of the needles and some shoots dries; 3 – less than half of needles are affected; 4 – in the daytime, the needles lose their turgor, wither, but restore it during the night; 5 – plants do not respond to drought.

Determination of winter hardiness was visually carried out using S. Sokolov 8 – point scale [2]: 1 – the plant is completely winter-hardy; 2 – frost the tops of annual shoots; 3 – annual shoots frost over the entire length; 4 – two-year branches are covered with ice; 5 – three-year branches are covered with ice; 6 – the plant is frozen to the level of snow cover; 7 – the plant is frozen to the root of the neck, but grows; 8 – the plant dies during the wintering period.

3. Research results

One of the most common methods for determining drought tolerance is the field method, when the behavior of plants is observed during the dry season under natural conditions. This takes into account the magnitude of growth, color of leaves, fruit fall. The assessment was carried out in the dry period, when there was no precipitation for 10 days, and the air temperature reached its annual maximum. The data obtained indicate a high field drought tolerance of the species studied (**Table 1**).

According to the results given in **Table 1**, *P. nigra* trees of different ages show high drought tolerance scores for all the years of research. *Th. plicata* plants during 2015–2016, observed only loss of needles turgor during daylight hours, but during the night it completely restored it. In 2017, due to insufficient humidity and high air temperatures, the needles turgor loss of the studied *Th. plicata* plants observed.

Table 1
Drought tolerance of *P. nigra* and *Th. plicata* of different age periods (in points)

Age of trees	Years of research			Average
	2015	2016	2017	
P. nigra				
50	5	5	5	5,0
10	5	5	5	5,0
Th. plicata				
8	4	4	3	3,7
54	4	4	4	4,0

The dry periods in summer do not limit the cultivation of introduced conifers in the Forest-Steppe of Ukraine. However, water balance disturbances in plant tissues as a result of moisture deficiency quite often negatively affect their vegetation, their growth and development are inhibited.

Frost resistance is only a part of the complex of mechanisms to withstand winter damage. In addition to the long-term effects of low temperatures, perennial plants are also affected by alternating thaws and frosts, sunburn, icing, and the like. Therefore, the assessment of winter hardiness was carried out by a visual method. Signs of damage to the needles of annual shoots and buds were revealed (**Table 2**).

Table 2

Evaluation of winter tolerance of *P. nigra* and *Th. plicata* of different age periods (in points)

Age of trees	Years of research			Average
	2015	2016	2017	
P. nigra				
50	1	1	1	1,0
10	1	1	1	1,0
Th. plicata				
8	1	1	2	1,3
54	1	1	1	1,0

Research results shows that *P. nigra* trees of different ages had no visible damage. Young plants *Th. plicata* were somewhat more vulnerable to the effects of low temperatures. In 8-year-old plants, damage was found only in 2017. In mature trees, damage after the winter period was not found at all, indicating their high winter hardiness.

4. Discussion of results

Determination of indicators of the water regime of needles *P. nigra* and *Th. plicata* is an important task for assessing their prospects in terms of introduction. As is well known, in drought tolerance, plants understand the ability of plants to withstand long dry periods, water deficiency, dehydration and overheating of cells, tissues and organs with the least decrease in productivity. Drought tolerance is due to genetically determined adaptability of plants to the growing conditions, as well as adaptation to water scarcity [4]. According to the research results, the introduction shows high resistance to dry periods in the summer, which made their cultivation in the study area optimal. The lack of water in the examined plants, given the rather high daily temperatures during the research, is insignificant and does not pose a threat to the studied plants. When the rainy season comes the needles of *Th. plicata* are quickly restores turgor.

One of the most important factors for the success of acclimatization of woody plants in the conditions of introduction is their ability to withstand low winter temperatures [3]. It is known that various coniferous plants, in order to achieve resistance to low temperatures, implement the processes of biochemical adaptation in various directions. This is primarily associated with the synthesis of cryoprotectant proteins [5].

Th. plicata is a frost-resistant tree species. According to its high frost resistance, many well-known researchers point out. In the arboretum "Trostianets" *Th. plicata* successfully survived the harsh winter of 1941–1942 [6, 7]. In the cultures of the Kaliningrad region *Th. plicata* in the harsh winters of 1878–1979 a slight yellowing of the needles was found on young specimens of its undergrowth, which later did not affect their growth and development. *Th. plicata* has coastal and mountainous forms, the latter of which withstands continental conditions with cold winters [8].

P. nigra species is also considered to be quite winter-hardy. It is able to withstand temperatures down to – 40 °C [9].

As a result of our observations, no signs of freezing of annual and two-year shoots are also found. That is, the low winter temperatures characteristic of the region do not have a significant effect on these introductions. Due to this, plants form a normally developed crown. Although a single freeze-up of renewal of buds was observed, the tree as a whole was in good condition after wintering.

Separate characteristics require a bud. In the bud of plants of the *Pinus L.* genus there is no the cavity and the core tissue is a continuation of the core of the shoot and is directly related to the meristematic tissue [10]. According to the *Thuja L.* genus, it can be assumed that there is a hereditary mechanism of cryoresistance in the meristematic tissues of its buds, which is implemented in a state of deep dormancy, regardless of whether the tree is under low temperature stress or not.

Coniferous plants create favorable living and working conditions for residents throughout the year. *P. nigra* and *Th. plicata* close to native conifers has not only a decorative value, but also has a positive effect on the environment, cleaning the air and reducing the heating of the surface covered with asphalt or concrete.

Information about the use of *P. nigra* in foreign countries has been found for a long time. For example, in the United States, because of its greater salt tolerance than in local pines, it has been used since the 70s to create protective forest belts and windbreaker lines along highways that are sprinkled with salt in the winter [11]. In Ukraine, in the Rivne region, *P. nigra* can significantly improve the ecological state in the conditions of technogenic pollution by industrial plants for the production of cement [12].

However, *P. nigra* is suitable not only for afforestation of industrial heaps, but also for landscaping settlements. For example, in Uman one specimen is located in a completely asphalted area, while it has a fairly satisfactory appearance, which confirms the stability of this species under extreme conditions (**Fig. 1**).

Fig. 1. Th. plicata and P. nigra in urban areas

It is known that *Th. plicata* belongs to the North-West American floristic area [13]. Conifers of this area are characterized by resistance to adverse environmental conditions. In vivo *Th. plicata* grows on heavy, wetted soils and shaded slopes of ravines and gorges [14]. Experience breeding *Th. plicata* in Ukraine confirms its high resistance to various growing conditions. It can normally grow and develop on a wide range of soils, including those with low nutrient content. To climatic factors that adversely affect the growth and development of *Th. plicata* include: early autumn and especially late spring frosts, high temperature amplitudes, dry southeast winds. But in general, the plants have successfully acclimatized, as evidenced by their active growth, development, frost and drought resistance, resistance to adverse conditions of the city. The wide range of distribution of the species in natural and cultural areas is evidenced by the plasticity of *Th. plicata* regarding growth conditions. This increases the prospects of its cultivation in the conditions of the Right-Bank Forest-Steppe of Ukraine, where it can be used for landscaping populated areas.

So, on the basis of the conducted research, it can be concluded about acclimatization of *Th. plicata* and *P. nigra* to the conditions of this region. Despite the dry summer periods and temperature differences characteristic of the climatic conditions of the study area, cooling and warming during the winter period, the plants successfully go through all phases of their growing season.

Comparing the conditions of the natural distribution range to the conditions of the cultural areas of the studied species, it is possible to state their successful cultivation, which indicates a high ecological plasticity and significant potential of these plants.

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