# Trends in Landscape, Agriculture, Forest and Natural Science

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Edited by

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Cambridge Scholars Publishing

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This book first published 2020

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library



ISBN (10): 1-5275-4300-5
ISBN (13): 978-1-5275-4300-3

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# PREFACE

The history of science is the history of humanity, the history of civilization, and the history of development. To establish a connection between what came first and what followed is necessary to build our today and our tomorrow.

If we want to talk about today's trends, we have to connect our past knowledge to today's research and findings. Indeed, setting trends—particularly in science—requires lots of dedication. Just using a technical perspective is not enough, and researchers have to remain in possession of every aspect of life and every level of thinking. The trends in landscape, agriculture, forestry, and natural science center on responsibility because these topics are directly involved in human life and our future.

Our fifty contributors are not only experts in their fields, but also they have experience of working in a multidisciplinary manner. This multidisciplinary view is essential to building our future, both safely and sustainably. For a sustainable world, landscape, agriculture, forestry and environmental sciences play a significant role. However, the preservation of our planet is not enough in this era. We have to heal and improve it for our future followers. As described in an Indian proverb, “we borrowed this World from them”.

In this book, as an editor, I have tried to collect different data sets in various disciplines. We hope that we can achieve a holistic approach to our studies in landscape, agriculture, forestry, and natural sciences. *Trends in Landscape, Agriculture, Forestry, and Natural Science* is not only for the experts in these fields, but it also provides a good source for people who want to learn about these topics. This book includes research, studies, and current trends in all of these areas. Our book includes twenty-five chapters prepared by fifty different contributors. We are grateful to them for their invaluable help and expertise. Without them, this book would not have reached its purpose.

THE EDITOR

# CHAPTER ONE

# ECOLOGICAL TOLERANCE AND WOODY LANDSCAPE PLANTS

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NILUFER SEYIDOGLU AKDENIZ
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## Introduction

In today's world, the differentiation of the needs of human beings, the advancement of technology, and the intensive use of all kinds of resources have caused the deterioration of natural balance. This change in equilibrium has emerged as a questioning factor in our way of life and has brought many problems, such as the change of ecosystems, the decrease of biodiversity, and the increase in natural disasters (Zeybek, 2015; Goksen et al., 2017). In this context, it is essential to make designs that consider ecological principles and to provide new planning approaches in the perspective of sustainability by bringing solutions that are compatible with natural processes to encourage self-sufficient ecosystems (Pirselimoglu and Demirel, 2012; Pirselimoglu Batman and Demirel, 2015; Onur and Demiroglu, 2016; Tosun, 2017). Many factors, such as drought, salinity, extreme temperatures, radiation, and oxidative stress affect environmental degradation. Changes in these abiotic factors particularly affect plant life cycles and processes, as well as damaging plant growth. Plants responses to stress factors are realized in a dynamic process, but the formation of tolerance is a complex structure at the organism and cellular level. Depending on the degree and duration of stress factors on plants, they can have different tolerances in various degrees and adjust their metabolism according to their environment (Ashraf and Foolad, 2007; Korkmaz and Durmaz, 2017; Imal, 2015).

Ecological tolerance means something can withstand the extreme effects of environmental factors (Sahin, 2018). In other words, tolerance is a concept that has a physiological basis and provides an understanding of the structure and dynamics of terrestrial ecosystems (Niinements and Valladares, 2006). Although ecological tolerance depends on a plant's genetic code, many species show various levels of tolerance in different habitats. Knowing a plant's ecological tolerance is an important aspect to consider in holistic design approaches. Some plants are very tolerant of environmental factors and others less so. The plants to be used should be highly tolerant of ecological conditions (heat, cold, drought, etc.). Plants with high ecological tolerance adapt to different habitats and are a part of natural flora. It is clear that plants with a low tolerance will lose their vitality because of changes in environmental conditions (Zencirkiran and Akdeniz, 2017; Sahin, 2018).

Woody plants (trees and shrubs) play an important role in climate change and improve the urban ecosystem. To maintain the existence of woody plants that will be used in the urban landscape, it is necessary to know their ecological tolerances as well as their aesthetic beauty (Akdeniz et al. 2017; Ender and Zencirkiran, 2017). In this context, the ecological tolerance of some woody plant species used in landscape designs were evaluated, and recommendations have been made.

## Ecological Tolerances

### Cold Tolerance

Each plant species has its maximum, minimum, and optimum temperature (Korkmaz and Durmaz, 2017). Minimum survival temperatures vary according to their habitats, growth, and development (Sakai, 1966; Strimbeck et al. 2015; İmal, 2015). A decrease or changes in the balance of temperature required affect a plant's metabolic activities dependent on its duration and density; it also blocks their vital actions. They also limit their geographical distribution and efficiency. A plant's ability to survive at temperatures below 0 °C is called cold tolerance. Cold tolerance causes cell shrinkage and water loss during freezing and is created by mechanisms to eliminate, reduce, or remove the effects of stress factors (Einset, 1985; Strimbeck et al. 2015; Imal, 2015; Peskircioglu et al., 2016; Korkmaz and Durmaz 2017).

Plants' cold tolerance involves a complex structure that contains cell components. The three elements of cold tolerance are cold acclimation, ultimate or maximum mid-winter hardiness, and acclimatization. A lack of these components may limit their survival (Linden, 2002; Sanghera et al. 2011 Hummel and Ophardt, 2016.). Avoiding damage from cold winter weather is dependent on many factors, such as their genetic structure, seasonal phenological development, and the cultural processes applied. In particular, their dormancy periods are closely related to cold tolerance; during the deep sleep period, their cold tolerance will be high (Imal, 2005; Peskircioglu et al., 2016).

Plants' cold tolerance is categorized according to the land conditions or minimum degrees in which they can survive. USDA plant hardiness zone maps, which are prepared by the US Department of Agriculture, are used to determine their cold tolerance. The map is divided into zones of 10 °F based on the yearly average winter temperatures. According to this, there are 13 different zones of tolerance divided into two sub-regions of 5 °F (a and b). The lowest temperature zone is the 1a zone (-55, -60 °F or -48.3, -51.1 °C) and the hottest temperature zone is the 13b zone (65–70 °F or 18.3–21.1 °C). In Turkey, the General Directorate of Meteorology's cold tolerance map is used, which is revised according to 1971–2010 data, and the tolerance zones are between 2a and 10b.

## Heat Tolerance

The high temperature in plants is one of the abiotic stress conditions that limits growth and development when there is an increase of 1,5–6 °C in the optimum growth temperature. Each plant has an optimum temperature range and, if it is outside this range, cell metabolism will be affected negatively, and it also causes morphological, anatomical, physiological, and biochemical changes. High temperatures cause damage in particular intermolecular interactions and also harm photosynthetic reactions (Wahid et al., 2007; Yildiz and Terzi, 2007; Bita and Gerats, 2013; Korkmaz and Durmaz, 2017).

Plants tolerance to high temperatures is called heat tolerance or thermal tolerance (Yildiz and Terzi, 2007). In other words, heat tolerance is generally a plant's ability to develop in a high temperature and to produce economic yield. Drought and high temperatures are related. In a region with a regular summer drought, the vegetation will be inactive due to lack of water, although, in a wet zone, heat is only important as a stress factor in short drought periods (Mancuso and Azzarelo, 2002). A plant's continuity at high temperatures is associated with the severity and duration of the stress imposed, as well as the type of plant and its developmental stage (Yildiz and Terzi, 2007).

The American Horticultural Society created the AHS Heat Zone Map using data from 1990–2012 (URL 7). This heat tolerance map compiles the average number of days when the maximum air temperature was above 30 °C from 12 different zones. The first region is the warmest area, where the average annual number of days above 30 °C was less than 1, and the twelfth region is the warmest area where the average annual number of days above 30 °C was greater than 210. Turkey has its own Plant Heat Tolerance Map, which uses data from 1971–2010 (URL 2).

## Drought Tolerance

Water is one of the most critical issues with regard to the sustainability of open green areas. As a result of the rapid population growth in cities, the balance between water presence and water consumption has changed considerably (Hilaire et al., 2008). Drought acts as an environmental restraint for plants; if adequate measures are not taken, the risk of drought could become severe in the coming years. Drought means a reduced or very low availability of water for a prolonged period, thereby disturbing plant growth, development, water relations, and efficiency in many terrestrial plants. Plants acclimatize to different sophisticated biochemical, physiological, and morphological changes to overcome drought conditions (Butt et al., 2018). Water, which is crucial to landscape architecture applications, is essential for ornamental plants. The amount of water consumption that used in open urban areas needs to be significantly reduced (Baris, 2007).

The concept of xeriscape was first created in 1981 to reduce water use. Xeriscape comes from the Greek, "xeros", and the English word, "landscape" (Tulek, 2008). The primary purpose of xeriscape landscaping is to minimize water consumption and to protect water resources by using plants with less water needs (Yazıcı et al., 2014). Using drought-tolerant plants helps to cut down on summertime water use, thereby saving time, money, and frustration.

## Salinity Tolerance

Salinity is a problem, especially in arid and semi-arid climatic zones; this is caused by groundwater redistributing salts and the accumulation of salt on and near the soil's surface (Ergene, 1982; Kwiatowsky, 1998; Kara, 2002). Salinity is one of the world's major problems. The improper cultivation of agricultural or landscape irrigation can lead to salinity problems in arid and semi-arid areas, especially where natural drainage conditions are poor (Emekci et al. 2005).

Plants' tolerance to the effects of saltiness has a great importance, especially in cities where there are lots of coastal areas. The coastal regions are one of the most challenging landscaping areas with salty water effects coming from the sea and the filler soil, strong wind and moisture, and a limited environment due to filler soil (Korkut, 1992). Substantial increases in soil salinity could affect the long-term health, productivity, or survival of plants (Jackson, 2009). Salt-affected dwarf plants sometimes have dark green leaves, which can be thicker and more succulent than usual. In woody species, high soil salinity may cause leaf burn and defoliation (Amacher et al. 2000).

Salinity tolerance is influenced by many plant, soil, and environmental factors and their interrelationships. Generally, fruits, vegetables, and ornamentals are more salt sensitive than field crops and certain varieties or cultivars may tolerate higher salt levels than others. Plants are more sensitive to high salinity during seedling stages, immediately after transplanting, and when subject to other stresses, such as a disease, insect, or nutrients. Climate and irrigation also influences salinity tolerance (Amacher et al. 2000). Often the best species are salt-tolerant native species that occur in the area. Native species support biodiversity, grow in local conditions, and do not create weed problems (Jackson, 2009).

## Air Pollution Tolerance

Air pollution is caused by deterioration in the air's natural composition due to human, industrial, and domestic combustion events (Yildirim et al. 1991). The primary sources of air pollution are industrial organizations, public organizations, and vehicles (Elkoca, 2003). Sometimes the effects of pollution are not visible, but plants may grow proportionally, provide fewer products, and have a faster lifecycle in terms of flowering and maintaining their fruit. Other prominent features are sunburn in woody plants, a reduction in development, dry roots, and a quicker death. However, these effects are closely related to pollution rate, as well as the plant's genus and type (Guclu, 1978). Air pollution causes adverse or lethal effects on leaves, roots, fruits, trunks, and cells (Kantarci, 1996). Pollution causes necrosis on leaves and decreases chlorophyll content, causing regression of photosynthetic activity and, consequently, an increase in diameter, which negatively affects various growth parameters, such as height and leaf area (Pandey and Agrawal, 1994). As a result of the adverse effects of air pollution on tree development, significant decreases in the competitiveness of genetically susceptible species occur (Karnosky et al. 1992). However, tolerance to air-affected trees is reduced if there is also drought, frost, harmful insects, or fungi present. As a result of all these negative impacts, tree and forest deaths are inevitable (Elkoca, 2003).

## Wind Tolerance

Wind is an air movement. In other words, it is the environmental variable that shows differences in direction and frequency between habitats. Air movement is a necessary environmental factor for plants. It plays an important role in their pollination, in the propagation of seeds, in the intensity of transpiration, and also in their morphology. It provides more light to the soil by providing branch and leaf movement and reduces the effects of diseases and damage caused by humid conditions (Cepel, 1988; Jia et al., 2012; Tilley, 2014; Affled, 2018). Wind has mechanical and physiological effects on plant tissues. The most crucial physiological effect is the increase in transpiration due to its speed, as well as the increase of water loss and drying in plants (Ors, 2007; Affled, 2018). Severe winds have mechanical effects, such as the excessive shaking of plants, pulling them towards their roots, breaking their shoots and leaves, and blocking their development (Cepel, 1988; Tilley, 2014).

For protection purposes, in windy areas screen plantings or bumpers can be used to prevent wind damage by creating a different climate. For this purpose, trees are generally used and placed in a specific order (Cepel, 1988; Wilkinson and Elevitch, 2000; Sanderson, 2018). Wind tolerant plants have flexible bodies that allow them to bend without breaking, and are usually small and narrow-leaved (Tilley, 2014). An effective windscreen should protect the area from the dominant wind and limit storm damage of winds (Wilkinson and Elevitch, 2000).

## The Ecological Tolerances of Woody Plants Used in Urban Landscapes

Woody species used in urban landscapes have been evaluated in terms of frost, heat, drought, salinity, air pollution, and wind tolerances and these are categorized as low tolerant (L), moderately tolerant (M), and high tolerant (H) (Table 1; Table 2) (Amacher et al., 2000; Baris, 2007; Mickelbart and Jenks, 2010; Zencirkiran, 2013; Akdeniz et al., 2017; Zencirkiran and Akdeniz, 2017; URL 3; URL 4; URL 5; URL 6).

**Table 1:** The Ecological Tolerance of Conifers

| Conifers | Cold | | | Heat | | | Drought | | | Salt | | | Air-pollution | | | Wind | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H |
| *Abies alba* | | | * | | | * | * | | | * | | | * | | | * | | |
| *Abies bornmulleriana* | | | * | * | | | * | | | * | | | * | | | | | * |
| *Abies concolor* | | | * | | | * | | | * | * | | | | | * | | * | |
| *Abies nordmanniana* | | | * | * | | | * | | | * | | | * | | | | | * |
| *Calocedrus decurrens* | | * | | | | * | | | * | | | * | | | * | | | * |
| *Cedrus atlantica* | | | * | * | | | | | * | * | | | | | * | | * | |
| *Cedrus deodora* | | * | | * | | | | | * | | * | | * | | | | * | |
| *Cedrus libani* | | * | | * | | | | | * | * | | | | | * | | * | |
| *Chamaecyparis obtusa* | | | * | * | | | | | * | * | | | | * | | | | * |
| *Cryptomeria japonica* | * | | | * | | | | | * | * | | | | | * | | * | |
| *Cupressocyparis leylandii* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Cupressus arizonica* | | | * | * | | | | | * | | * | | | | * | | | * |
| *Cupressus sempervirens* | | | * | | | * | | | * | | * | | | | * | | | * |
| *Ginkgo biloba* | | | * | * | | | | | * | | | * | | | * | | | * |
| *Juniperus* sp. | | | * | | | * | | | * | | | * | | | * | | | * |
| *Metasequoia glyptostroboides* | | | * | | | * | | * | | * | | | | | * | | | * |
| *Picea abies* | | | * | | | * | | * | | | * | | * | | | | * | |
| *Picea glauca* | | | * | | | * | | | * | * | | | * | | | | | * |
| *Picea orientalis* | | | * | | | * | | * | | | * | | * | | | * | | |

| Conifers | Cold | | | Heat | | | Drought | | | Salt | | | Air-pollution | | | Wind | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H |
| *Picea pungens* | | | * | * | | | | | * | | * | | | | * | | | * |
| *Pinus griffithii* | | * | | | | * | | | * | | * | | | | * | | * | |
| *Pinus nigra* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Pinus pinea* | | * | | | | * | | | * | | | * | | | * | | | * |
| *Pinus strobus* | | | * | | * | | | * | | * | | | * | | | * | | |
| *Pinus sylvestris* | | | * | | * | | | | * | | * | | | | * | | | * |
| *Taxus baccata* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Thuja orientalis* | | | * | * | | | * | | | * | | | | | * | | * | |

**Table 2:** The Ecological Tolerances of Deciduous Plants

| Deciduous Plants | Cold | | | Heat | | | Drought | | | Salt | | | Air-pollution | | | Wind | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H |
| *Abelia x grandiflora* | | | * | * | | | * | | | * | | | | | * | | | * |
| *Acacia dealbata* | * | | | * | | | | | * | * | | | | * | | * | | |
| *Acer campestre* | | | * | * | | | | | * | | * | | | | * | | | * |
| *Acer ginnala* | | | * | * | | | * | | | * | | | | | * | | | * |
| *Acer negundo* | | | * | * | | | | | * | * | | | | * | | * | | |
| *Acer platanoides* | | | * | * | | | | | * | | * | | | | * | | | * |
| *Acer pseudoplatanus* | | | * | * | | | * | | | * | | | | | * | | | * |
| *Acer rubrum* | | | * | * | | | | | * | | * | | | | * | * | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Acer saccharinum* | | | * | * | | | | | * | | | * | | | * | | | * |
| *Aesculus x carnea* | | | * | * | | | | | * | | | * | | | * | | | * |
| *Aesculus hippocastaneum* | | | * | | | * | * | | | * | | | | * | | * | | |
| *Ailanthus altissima* | | | * | | | * | | | * | | * | | | | * | * | | |
| *Albizia julibrissin* | * | | | | | * | | | * | | * | | | * | | | * | |
| *Alnus glutinosa* | | | * | * | | | | | * | | * | | | | * | | | * |
| *Arbutus unedo* | * | | | * | | | | | * | | | * | | | * | * | | |
| *Aucuba japonica* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Berberis thunbergii* “*Atropurpurea*” | | | * | * | | | * | | | * | | | | | * | | | * |
| *Betula pendula* | | | * | | * | | | * | | | * | | | | * | | | * |
| *Broussonetia papyrifera* | * | | | * | | | | | * | | * | | | | * | * | | |
| *Buddleja davidii* | | | * | * | | | * | | | | * | | | | * | * | | |

| Deciduous Plants | Cold | | | Heat | | | Drought | | | Salt | | | Air-pollution | | | Wind | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H |
| *Buxus microphylla* | | | * | | | * | * | | | | * | | | | * | | | * |
| *Buxus sempervirens* | | | * | | | * | * | | | | * | | | | * | | | * |
| *Camellia japonica* | * | | | * | | | * | | | * | | | * | | | * | | |
| *Carpinus betulus* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Castanea sativa* | | | * | * | | | | | * | | * | | | * | | | | * |
| *Catalpa bignonoides* | | | * | * | | | * | | | * | | | | | * | * | | |
| *Celtis australis* | | | * | | | * | | | * | | * | | | | * | | | * |
| *Cercis siliquastrum* | | | * | | | * | | | * | * | | | * | | | | * | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Chamaerops excelsa* | | | * | | | * | | * | | | * | | | | * | | | * |
| *Chaenomeles japonica* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Cornus alba* | | | * | * | | | * | | | * | | | | | * | | | * |
| *Cornus mas* | | | * | * | | | * | | | * | | | | | * | | | * |
| *Cornus stolonifera* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Corylus maxima* | | | * | * | | | * | | | | * | | | | * | | | * |
| *Corylus avellana* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Cotinus coggygria* | | | * | * | | | | | * | | * | | | | * | | | * |
| *Cotoneaster cooperi Cornubia* | | | * | * | | | | | * | | | * | | | * | | | * |
| *Cotoneaster horizontalis* | | | * | * | | | * | | | | * | | | | * | | | * |
| *Crataegus oxyacantha* | | | * | * | | | | * | | * | | | | | * | | | * |
| *Cydonia oblonga* | | | * | * | | | | | * | * | | | | | * | | | * |

| **Deciduous Plants** | **Cold** | | | **Heat** | | | **Drought** | | | **Salt** | | | **Air-pollution** | | | **Wind** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** |
| *Deutzia gracilis* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Diospyros kaki* | | | * | * | | | * | | | * | | | | | * | * | | |
| *Eleagnus angustifolia* | | | * | * | | | | | * | | | * | | | * | | | * |
| *Eleagnus x ebbingei* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Eleagnus pungens* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Fagus sylvatica* | | | * | * | | | | | * | * | | | * | | | | * | |
| *Ficus carica* | * | | | | | * | | | * | | | * | | | * | | * | |
| *Forsythia intermedia* | | | * | * | | | | | * | * | | | | | * | * | | |
| *Fraxinus excelsior* | | | * | | | * | | | * | | * | | | | * | | * | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Fraxinus angustifolia* | | | * | | | * | | * | | | * | | | | * | | | * |
| *Gleditsia triacanthos* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Hibiscus syriacus* | | | * | * | | | | | * | * | | | | | * | * | | |
| *Ilex aquifolium* | | | * | | | * | * | | | | | * | | | * | * | | |
| *Juglans nigra* | | | * | * | | | | | * | | * | | | | * | | | * |
| *Juglans regia* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Kerria japonica* | | | * | | | * | | * | | | | * | | | * | | | * |
| *Koelreuteria paniculata* | | | * | * | | | | | * | | * | | | | * | | * | |
| *Laburnum x watereri* | | | * | * | | | | | * | | * | | | | * | * | | |
| *Lagerstroemia indica* | | | * | * | | | | | * | * | | | | | * | * | | |
| *Laurus nobilis* | | | * | | | * | | | * | | * | | | | * | * | | |
| *Lavandula angustifolia* | | | * | | | * | | | * | | * | | | | * | | | * |

| **Deciduous Plants** | **Cold** | | | **Heat** | | | **Drought** | | | **Salt** | | | **Air-pollution** | | | **Wind** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** |
| *Ligustrum jonandrum* | | | * | | * | | | | * | | | * | | | * | | | * |
| *Ligustrum ovalifolium* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Ligustrum vulgare* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Liquidambar styraciflua* | | | * | * | | | * | | | | * | | | | * | | * | |
| *Liriodendron tulipifera* | | | * | * | | | * | | | * | | | | | * | | | * |
| *Lonicera nitida* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Lonicera pileata* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Magnolia grandiflora* | | * | | | | * | * | | | | | * | | | * | | | * |
| *Magnolia liliiflora* | | | * | | | * | | | * | | | * | | | * | | | * |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Magnolia soulangeana* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Magnolia stellata* | | | * | | | * | | | * | | * | | | | * | | | * |
| *Mahonia aquifolium* | | | * | * | | | | | * | * | | | | | * | | | * |
| *Malus floribunda* | | | * | * | | | | * | | * | | | | | * | | * | |
| *Melia azaderach* | | | * | | | * | | | * | | | * | | | * | | * | |
| *Mespilus germenica* | | | * | | * | | | * | | * | | | | | * | | | * |
| *Morus alba* | | | * | | | * | | | * | | | * | | | * | * | | |
| *Morus nigra* | | | * | | | * | | | * | | | * | | | * | * | | |
| *Nandina domestica* | | | * | * | | | * | | | * | | | | | * | | | * |
| *Nerium oleander* | | | * | | | * | | | * | | * | | | | * | | | * |
| *Olea europaea* | | | * | | | * | | | * | | * | | | | * | * | | |

| **Deciduous Plants** | **Cold** | | | **Heat** | | | **Drought** | | | **Salt** | | | **Air-pollution** | | | **Wind** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** |
| *Osmanthus aquifolium* | | | * | | | * | | | * | * | | | | | * | | | * |
| *Photinia serrulata* | | | * | | * | | | | * | * | | | | | * | | | * |
| *Pittosporum tobira* | | | * | | | * | | | * | | * | | | | * | | | * |
| *Platanus x acerifolia* | | | * | | | * | | | * | | | * | | | * | | * | |
| *Platanus orientalis* | | | * | | | * | | | * | | | * | | | * | | * | |
| *Populus alba* | | | * | * | | | * | | | | | * | | | * | | | * |
| *Prunus amygdalus* | * | | | | | * | | | * | * | | | | | * | * | | |
| *Prunus armeniaca* | | | * | * | | | | | * | * | | | | | * | * | | |
| *Prunus avium* | | | * | * | | | * | | | * | | | | | * | * | | |
| *Prunus cerasifera pissardii nigra* | | * | | | | * | | * | | | * | | | * | | | * | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Prunus cerasus* | | | * | | * | | | * | | | * | | * | | | * | | |
| *Prunus laurocerasus* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Prunus persica* | | | * | * | | | * | | | * | | | * | | | * | | |
| *Punica granatum* | | | * | | | * | | | * | | | * | * | | | * | | |
| *Pyracantha coccinea* | | | * | | | * | | | * | | * | | | | * | | | * |
| *Quercus ilex* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Quercus palustris* | | | * | | * | | | * | | * | | | | | * | | | * |
| *Quercus robur* | | | * | * | | | | | * | | | * | | | * | | | * |
| *Quercus rubra* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Rhododendron sp* | | | * | | | * | | | * | | * | | | | * | | | * |

| **Deciduous Plants** | **Cold** | | | **Heat** | | | **Drought** | | | **Salt** | | | **Air-pollution** | | | **Wind** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** |
| *Robinia pseudoacacia* | * | | | * | | | | | * | | * | | | | * | | * | |
| *Rosa sp* | | | * | | | * | * | | | * | | | | | * | | | * |
| *Rosmarinus officinalis* | | | * | | | * | * | | | | * | | | | * | | | * |
| *Salix babylonica* | | | * | * | | | * | | | | * | | | | * | | | * |
| *Salix caprea* | | | * | * | | | * | | | * | | | | | * | | | * |
| *Salix matsudana* | | | * | | | * | * | | | | | * | | | * | | | * |
| *Sambucus nigra* | | | * | | | * | * | | | | | * | | | * | | | * |
| *Sophora japonica* | | | * | * | | | | | * | * | | | | | * | * | | |
| *Sorbus aucuparia* | | | * | | | * | * | | | * | | | | | * | | | * |
| *Spirea bumalda* | | | * | | | * | | | * | | | * | | | * | | | * |
| *Spirea vanhoutteii* | | | * | | | * | | * | | | | * | | | * | | | * |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Syringa vulgaris* | * | * | | * | | * | | | * | | * |
| *Tamarix gallica* | * | | * | | * | | * | | * | | * |
| *Tamarix hispida* | * | | * | | * | | | * | * | | * |
| *Tilia tomentosa* | * | * | | * | | * | | | * | | * |
| *Ulmus glabra* | * | | * | | * | | | * | * | | * |
| *Viburnum fragrans* | * | * | | * | | * | | | * | | * |
| *Viburnum opulus* | * | * | | * | | * | | | * | * | |
| *Viburnum tinus* | * | * | | * | | * | | | * | | * |
| *Weigelia florida* | * | | * | | * | * | | | * | | * |
| *Wisteria sinensis* | * | | * | | * | * | | | * | | * |

## Conclusion

The limits of the environmental factors that plants can survive give us their ecological tolerance value. Their degree of tolerance affects their competitiveness and ecological success. Plants can adapt to environmental factors by giving various responses in order to survive. Providing sustainability in an ecological sense is essential for society. Sustainability in urban areas can only be achieved by reducing the consumption of natural resources and, from a landscape architect's perspective, this can be obtained by creating designs that minimize waste and overuse. Designs that are suitable for the environment and climate should be considered. The protection of the existing vegetation, as well as using plant species with a high tolerance to environmental conditions, is essential. For this purpose, native plant species should be preferred due to their lower water consumption and fewer maintenance demands. Using plants with high ecological tolerance in urban green areas is one of the most critical ways to ensure sustainability.

In this study, the ecological tolerance values (frost, heat, drought, salinity, air pollution, and wind tolerance) of woody plants that are commonly used in urban landscaping areas were investigated and listed in a table. The data obtained from this study encourages the use of plants with high ecological tolerance in landscape designs. The most suitable plant species for different extreme conditions, such as mining areas, landfill sites, coastal areas with high saline effects, windy areas, places where air pollution is dominant, and arid areas, has been listed in this study.

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