Community Trees

Community Tree Steward Program

Requirements for Plant Growth

Jeff Iles
Department of Horticulture
Iowa State University

The quantity and quality of growth made by landscape plants is dependent on interactions between their genetic potential and the above- and below-ground environment in which they are growing. The principal environmental requirements for plant growth include adequate space for root and canopy development, sufficient light, water, oxygen, carbon dioxide, and mineral elements, and temperature suitable for essential physiologic processes.

Adequate space

Adequate space for crown (canopy) development is a basic requirement for trees and large shrubs. Space for lateral and overhead clearance as well as clearance for pedestrians and vehicular traffic must be provided. Equally important is adequate space for root growth. Many of the problems associated with declining plants in urban and suburban environments can be attributed to restricted root growth because of inadequate soil volumes. Roots are responsible for water and mineral element uptake, energy storage, synthesizing important organic compounds, and plant anchorage. If root growth is restricted, these important processes and functions are slowed or impeded and plant health will be jeopardized. It has been estimated that 300 to 400 cubic feet of soil is required to support a medium-sized shade tree, yet in many urban sites, trees are routinely confined to tree pits that provide a paltry 40 to 50 cubic feet of soil for root growth. Trees whose roots have fully exploited the volume of soil available to them are increasingly vulnerable to environmental stresses (drought, for example), insect attack, diseases, and various forms of people pressure, and eventually decline and die.

Sufficient light

Plant growth requires energy, and through the process of ***photosynthesis***, leaves of trees and shrubs capture light energy from the sun and convert it to soluble carbohydrates (starch and sugar). In turn, these soluble carbohydrates are transported to all parts of the plant to satisfy energy needs. Leaves of different plant species vary in how energy efficient they are in capturing the sun's energy. Shade-tolerant trees such as

April, 2001

IOWA STATE UNIVERSITY
University Extension

Ames, Iowa

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Stanley R. Johnson, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.

dogwood, redbud, beech, and linden are able to use the energy available in subdued or filtered light. Shade-intolerant species like pine, oak, cottonwood, and juniper require full sunlight for best growth. Plants should be carefully matched to sites to accommodate their specific light requirements.

Sufficient water

An adequate amount of water is essential for plant growth and maintenance of essential plant processes. In fact, no organic process occurs in the absence of water. But plants probably suffer more from moisture-related problems than from any other cause. Either inadequate amounts of water or too much water is considered by many to be the primary cause of death for newly-planted trees and shrubs. The problem of excess water is often compounded if turfgrass and woody plants are installed coincidentally, since turf installation techniques (seeding or sodding) require large amounts of water for successful establishment. In many landscapes, about 1 inch of water every 7 to 10 days is sufficient to support tree and shrub growth. And because many soils will not allow penetration of this amount of water all at once, it is more efficiently applied in two or three applications.

Atmospheric factors

The atmosphere surrounding both above- and below-ground parts of woody plants if often taken for granted. But growth cannot occur without oxygen which is essential for ***respiration*** (the plant process that releases the energy of stored sugars to fuel growth), and carbon dioxide which is required for photosynthesis. Compacted urban soils frequently are oxygen deficient. In extreme cases, trees and shrubs can die suddenly from lack of soil oxygen. More commonly, poorly aerated soils gradually weaken plants and predispose them to other problems. In areas where soils are poorly-drained or compacted, landscape plants benefit when they can be planted a few inches above grade.

Growth-inhibiting substances that contaminate the air also can limit plant growth. The best way to prevent injury from atmospheric contaminants is to use pollution-resistant plants in areas where known potential pollution problems exist.

Mineral elements and soil reaction

Following absorption by the roots, mineral elements are translocated to various parts of the plant for utilization in important biological functions. There are 16 mineral elements essential for normal plant growth classified as either ***macronutrients*** (hydrogen, carbon, oxygen, nitrogen, potassium, calcium, magnesium, phosphorus, and sulfur) or ***micronutrients*** (molybdenum, copper, zinc, manganese, iron, boron, and chlorine), according to their relative concentration in plant tissue. Throughout a plant's life, mineral elements are required for growth and maintenance, however, all plants do not have the same requirements. For example, a beech tree requires more calcium, potassium, and phosphorus than most pines.

Adding mineral elements through fertilization is an important cultural practice that contributes to plant health and vigor. But applying fertilizer to "be safe" without knowing if elements are deficient, wastes time and money, can lead to salt build-up in the soil, and pollution of ground and surface water supplies. When a mineral element is deficient (frequently nitrogen), the appropriate fertilizer should be applied at recommended rates and at a time when it will be most readily available for plant uptake.

Soil reaction (expressed as pH) refers to the acidity or alkalinity, in other words, the relative proportion of hydrogen (acid) and hydroxide (basic) ions. Equal concentrations of the two produce a neutral reaction (pH 7.0). As a soil becomes more acidic, its pH decreases; as it becomes more alkaline, its pH increases.

Availability of a number of mineral elements, particularly phosphorus and the micronutrients, is significantly influenced by soil pH. For example, certain woody plants (pin oak, red maple, river birch, etc.) growing on high pH soils, frequently show iron or manganese deficiency symptoms. Most plants will tolerate a wide range in pH (5.5 to 8.3), particularly if the soil is well-drained, but a soil pH between 6.0 and 6.5 is considered optimal for good plant growth. Soils having pH levels well above 7.0 (a common occurrence in the

Midwest) can be treated with elemental sulfur (96%) in an attempt to lower soil pH, however, the better solution would be to use plants that are naturally found growing on alkaline soils. Trees like hackberry (*Celtis occidentalis*), sycamore (*Platanus occidentalis*), catalpa (*Catalpa speciosa*), honeylocust (*Gleditsia triacanthos*), blue ash (*Fraxinus quadrangulata*), Kentucky coffeetree (*Gymnocladus dioicus*), bur oak (*Quercus macrocarpa*), and chinkapin oak (*Quercus muehlenbergii*) are know to tolerate soils having pH 8.0 or higher.

<u>Appropriate temperatures</u>

Woody plant species in North America differ considerably in their response to temperature, however, most require a broad range of temperatures to complete their life cycles. For example, many trees and shrubs require a relatively long exposure to temperatures near 40∞F during winter before they can overcome dormancy, yet much higher temperatures are needed for optimal growth and development. But temperature extremes, both high and low, can result in injury or even death.

High temperatures are unfavorable for growth of many landscape plants because their rate of photosynthesis begins to decline rapidly after a critical high temperature is reached. It is difficult to define one critical high temperature for plants because it varies with species, however, temperatures in the 90∞ to 100∞F range undoubtedly slow this important food-making process. Unfortunately for trees and shrubs, respiration is not quite as sensitive to high temperatures, and continues day and night, further depleting food reserves. Finally, high temperatures may simply cause injurious water loss when ***transpiration*** (the process by which leaves release water vapor to the atmosphere) exceeds moisture absorption by the roots.

High temperatures also can injure roots. Optimum temperatures for root growth range from 60∞ to 80∞F, but when landscape plants are grown in above-ground containers or in urban environments, their roots may experience unusually high temperatures. Temperatures 95∞F and higher can be lethal to the roots of many plants.

Low temperatures also present problems for woody landscape plants. Most of our trees and shrubs tolerate a certain amount of freezing in stems, branches, trunks, and in some cases leaves, after undergoing a seasonal change in metabolism known as ***acclimation***. Cold hardy plants that have entered this quiescent or dormant state are generally capable of tolerating severe cold. But low temperature injury may occur when, (1) temperatures fall below a plant's maximum cold hardiness limit, even after normal acclimation has occurred, (2) premature freezing occurs before a plant has acclimated in the fall, (3) unusually late freezes occur in the spring after a plant has deacclimated, and (4) when there are dramatic swings in temperature during the winter that cause a plant to deacclimate before the threat of severe freezing is over.

In any discussion of cold hardiness it is important to remember that plants are made up of many different organs and there can be significant differences in hardiness among them. Roots, for example, are much less cold hardy than stems and branches (temperatures below 24∞F can be lethal to roots). But there also can be differences in hardiness among above-ground parts of the plant. For example, flower buds are usually much less cold hardy than vegetative buds. Therefore, a plant's ability to tolerate both high and low temperatures must be taken into account when considering it for a given landscape situation.

<u>Other considerations</u>

In order for landscape plants to have long and functional lives, they must be afforded protection from all forms of "people pressure." Roots can be injured and plant health compromised when soil is compacted around trees and shrubs. And wounds to trunks and branches administered by vehicles, bicycles, hot charcoal, lawn mowers, and string-trimmers can injure plants directly, and/or predispose them to secondary attack by insects and disease-causing pathogens.

A thoughtfully designed landscape populated by appropriate and well-adapted plant species should provide many years of functional utility and beauty. But without a comprehensive plan for follow-up maintenance, and qualified personnel to execute the required tasks, a landscape has little chance of fulfilling its intended purpose. Developing a landscape maintenance schedule that provides for timely pruning, watering, mulching, pest control, and fertilizing when necessary, will promote individual plant health and ultimately protect and enhance the entire landscape.

Revised April, 2001