Predicting and Reducing Drought-Related Plant Problems

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DROUGHT AND PLANTS

In August 1987, the Arboretum experienced extremely heavy rains, which resulted in flooding reaching 100-year levels twice within a two-week period. The summer of the following year goes on record as one of severe drought. Other recent drought years include 1983 and 1985. Such extreme variations in rainfall are not only sensed by people, but also by plants. Since water is so essential to plants, we need to be aware of its availability and methods for conservation.

THE ROLE OF WATER IN PLANTS

The woody structure of trees and shrubs serves as a framework and conduit for a water continuum which permeates the entire plant, connecting all parts from the farthest root hair in the soil to the topmost leaf. This continuous liquid environment, found largely within cells, is the site for all the complex chemical and physical processes which characterize life. It transports life-giving substances throughout the plant.

Hydrostatic pressure helps to maintain the turgid shape of non-woody parts, such as leaves, flowers, and fruit. Water pressure in leaves maintains turgidity of guard cells, which allow minute pores on the leaf surfaces called stomata to open and release water vapor (transpiration) and at the same time take in carbon dioxide. Only a small amount of the water passing through green leaves is utilized directly in the process of photosynthesis. Most water taken in by plants is released to the air through transpiration.

Each cell of the plant is made up primarily of water. Water moves from cell to cell by osmotic action. Rapidly growing shoots, young succulent leaves, and root tips are composed of 90-95% water. The woodier parts of plants comprised mainly of dead cells may be as much as 50% water.

THE WATER CYCLE

The water cycle can be said to begin with precipitation, rain or snow, which soaks into the soil, where it may be absorbed by plant roots. The amount of soil moisture available to roots is affected by the amount of precipitation, soil composition, exposure of site to sun and wind, the slope of the site, and the genetics and structure of the plant itself.

Water that moves downward through a moist soil is called gravitational water. Depending upon the structure of the soil, it can percolate below the reach of roots in a few days, except when showers follow one another in rapid succession. Soils vary greatly in composition from coarse sand and gravel to fine clay. Loam contains a mixture of soil particle sizes. Water passes quickly through sand and gravel, rapidly becoming unavailable to plants. On the other hand, clay particles bind water so tightly that little of it is available to plants. Of the soil types, loam holds water more readily in a state where it is available to plants.

Some water is held as a film around the soil particles and in the pore spaces between them. This is known as capillary water. As long as it is present, the soil atmosphere is almost saturated with water vapor. Roots grow into these pore spaces and absorb the water for plant growth. When capillary water is depleted, the water that remains is held so tightly against soil particle surfaces (hygroscopic water) that it is largely unavailable to plants.

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Adding organic matter, such as decayed manure or compost, will increase the water-holding capacity of sandy soils and the available water in clay soils. (See *The Morton Arboretum Plant Information Bulletin* Number 35, Autumn 1987, for a more comprehensive discussion of soils.)

A water deficit impacts on the entire plant, leaves become less turgid and wilt, stomata close, and vital plant processes dependent on water and gas exchange slow down. The closed stomata cut off the supply of carbon dioxide, which reduces photosynthesis and the amount of carbohydrates and other substances available for growth and storage. The plant lacks both water and carbohydrates which are no longer being produced. Respiration, the process which releases the energy of stored foods to fuel growth, is not quite as sensitive to water shortage and continues day and night, further depleting the food reserves of the plant. Indeed, high temperature accelerates the rate of respiration and depletion of food reserves in the plant.

When a plant is subjected to prolonged drought stress, these changes often make the plant more susceptible to certain kinds of insects and diseases. A weakened plant possesses less natural resistance to these potentially harmful organisms than does a healthily growing plant, which can more likely withstand insect and disease attacks. This situation is analogous to an elderly person who falls and, breaking his pelvis, becomes prone to serious respiratory infection.

STRATEGIES USEFUL IN REDUCING THE EFFECTS OF DROUGHT

PROPER PLANT SELECTION AND USE

Planting well-adapted landscape plants is the most effective way to reduce the direct and indirect effects of drought. Plants proven to be susceptible to chronic stress-related insect or disease problems in our region should not be used without providing specialized care in siting, planting, and maintenance. Consideration should be given to: supplemental irrigation, special soil modifications, and careful siting of plants. The continued use of canoe or paper birch *(Betula papyrifera)* is a good example of improper plant selection. Locally, this species occurs spontaneously only on north-facing ravine slopes along the shore of Lake Michigan north of Chicago, and in sand barrens around Gary, Indiana. The soil in these locations typically remains moist and has excellent drainage. Under these conditions, paper birch grows well and is naturally quite resistant to bronze birch borer. Under more typical landscape conditions in the Chicago area, plants are subjected to higher soil temperatures and reduced soil moisture and aeration. This situation predisposes paper birches to borer attack. Several other commonly planted trees and shrubs have proven sensitive to drought and should not be used unless special care is taken. These include:

Japanese maple	*Acer palmatum*
Red maple	*Acer rubrum*
Sugar maple	*Acer saccharum*
Alders	*Alnus* spp.
Birches	*Betula* (most species)
Katsura tree	*Cercidiphyllum japonicum*
Pagoda dogwood	*Cornus alternifolia*
Flowering dogwood	*Cornus florida*
Winged Euonymus	*Euonymus alatus* and cultivars

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Carolina silverbell	*Halesia carolina*
Larches	*Larix* spp.
Shrubby cinquefoil	*Potentilla fruticosa*
Douglas fir	*Pseudotsuga menziesii*
Pin oak	*Quercus palustris*
Currants	*Ribes* spp.
Rhododendron	*Rhododendron* (various hybrids and cultivars)
Willows	*Salix* spp.
Mountain ash	*Sorbus aucuparia*
Cut-leaved Stephanandra	*Stephanandra incisa* and cultivars
Arborvitae or White cedar	*Thuja occidentalis* and cultivars
Canadian hemlock	*Tsuga canadensis*

For these plants to survive during a drought, they need special care. Irrigation equipment such as sprinklers or drip irrigation should be installed at the construction and/or planting phase of the landscape project. For some of these plants, modification of the existing soil may be necessary. Through the addition of soil amendments such as compost, peat moss, sand, Perlite, and others, the plants may become established more readily and be more drought tolerant. A word of caution — incorporating these materials often increases the drainage and aeration of soil, making the use of supplmental irrigation even more important.

Carefully siting plants in protected locations is perhaps the simplest, least expensive method of drought protection. For example, siting a plant on the north or east side of a building so that the root zone is shaded during the hottest part of the day reduces the plant's need for water. Simarily, siting a plant where it is protected from sweeping, dry winds reduces the need for water by reducing the rate of transpiration.

Many plants that have proven to be more tolerant of drought have been selected from native habitats where sparse or erratic rainfall is common. These plants have evolved to be more dorught tolerant. The Black Hills white spruce (*Picea glauca* var. *densata)* is a good example. This white spruce selection occurs spontaneously in the Black Hills region of South Dakota and possesses greater drought and heat tolerance than plants from more easterly and northerly regions where the precipitation is more evenly distributed. Other plants that have proven to possess good drought tolerance include:

Amur maple	*Acer ginnala*
Black maple	*Acer nigrum* and cultivars
Silver maple	*Acer saccharinum* and cultivars
Legacy sugar maple	*Acer saccharium* 'Legacy'
Tatarian maple	*Acer tataricum*
Whitespire birch	*Betula platyphylla* var. *japonica* 'Whitespire'
Common hackberry	*Celtis occidentalis*
Gray dogwood	*Cornus racemosa*
Drummond's dogwood	*Cornus drummondii*
American smoketree	*Continus obovatus*
Green ash	*Fraxinus pennsylvanica* and cultivars
Thornless honey locust	*Gleditsia triacanthos* f. inermis and cultivars
Junipers	*Juniperus* spp.

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Amus maackia	*Maackia amurensis*
Northern bayberry	*Myrica pennsylvanica*
Pines	*Pinus* (two-needled spp.)
White poplar	*Populus alba*
Callery pear	*Pyrus calleryana* and cultivars
Hill's Oak	*Quercus ellipsoidalis*
Bur oak	*Quercus macrocarpa*
Chinquipin oak	*Quercus muehlenbergii*
Fragrant sumac	*Rhus aromatica*
Smooth sumac	*Rhus glabra*
Staghorn sumac	*Rhus typhina*
Tamarisk	*Tamarix* spp.
Redmond linden	*Tilia americana* 'Redmond'

Information regarding these and other plants that have proven to possess improved drought tolerance is available from several sources, including: The Morton Arboretum Plant Clinic, the University of Illinois Cooperative Extension Service, a qualified and knowledgeable nurseryman or garden center manager, and various horticultural textbooks contained in the Arboretum's library.

Credit — The Morton Arboretum
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(The continuation of this article will be in the May issue.)

Illinois Turfgrass Selects New Officers

The Illinois Turfgrass Foundation has elected new officers for 1990. Michael D. Vogt, Superintendent Illini Country Club, President; Kerry G. Anderson, Sales Representative Rhone-Poulenc Agriculture Company as Vice-President. Robert W. Graunke, Superintendent Eagle Ridge Resort, will serve a second term as Secretary-Treasurer. John Turner, Sales Representative NOR-AM Chemical Company continues to serve on the board as Immediate Past President.

Directors for 1990 are: Jim Ashby, Superintendent Rend Lake Conservancy District; Robert J. Dore, President of Green Scene Lawn Care, Inc.; Philip H. Hall, Superintendent Rock River Country Club; Michael A. Rafacz, Owner Greener Garders Sod Farm; Warren C. Shafer, General Manager Tyler Enterprises Inc.; Conrad J. Stynchula, Superintendent University of Illinois Golf Course; David Ward, Superintendent Ravisloe Country Club.

Serving the board in an advisory capacity are: Dr. Ken Diesburg, Southern Illinois University; Dr. Randall T. Kane, Chicago District Golf Association; Dr. Thomas W. Fermanian, Tom Voigt, Dr. David J. Wehner, Dr. Henry T. Wilkinson, all of University of Illinois.

ITF was formed in 1959 with the goal of raising and distributing funds in support of turfgrass research and educational programs in the State of Illinois. Serving as a liaison between the turfgrass industry and the academic community, the motto of ITF is ''Better Turf Through Research''. Since its inception the Illinois Turfgrass Foundation has provided almost $500,000.00 in financial support for turfgrass research projects at the University of Illinois and Southern Illinois University.