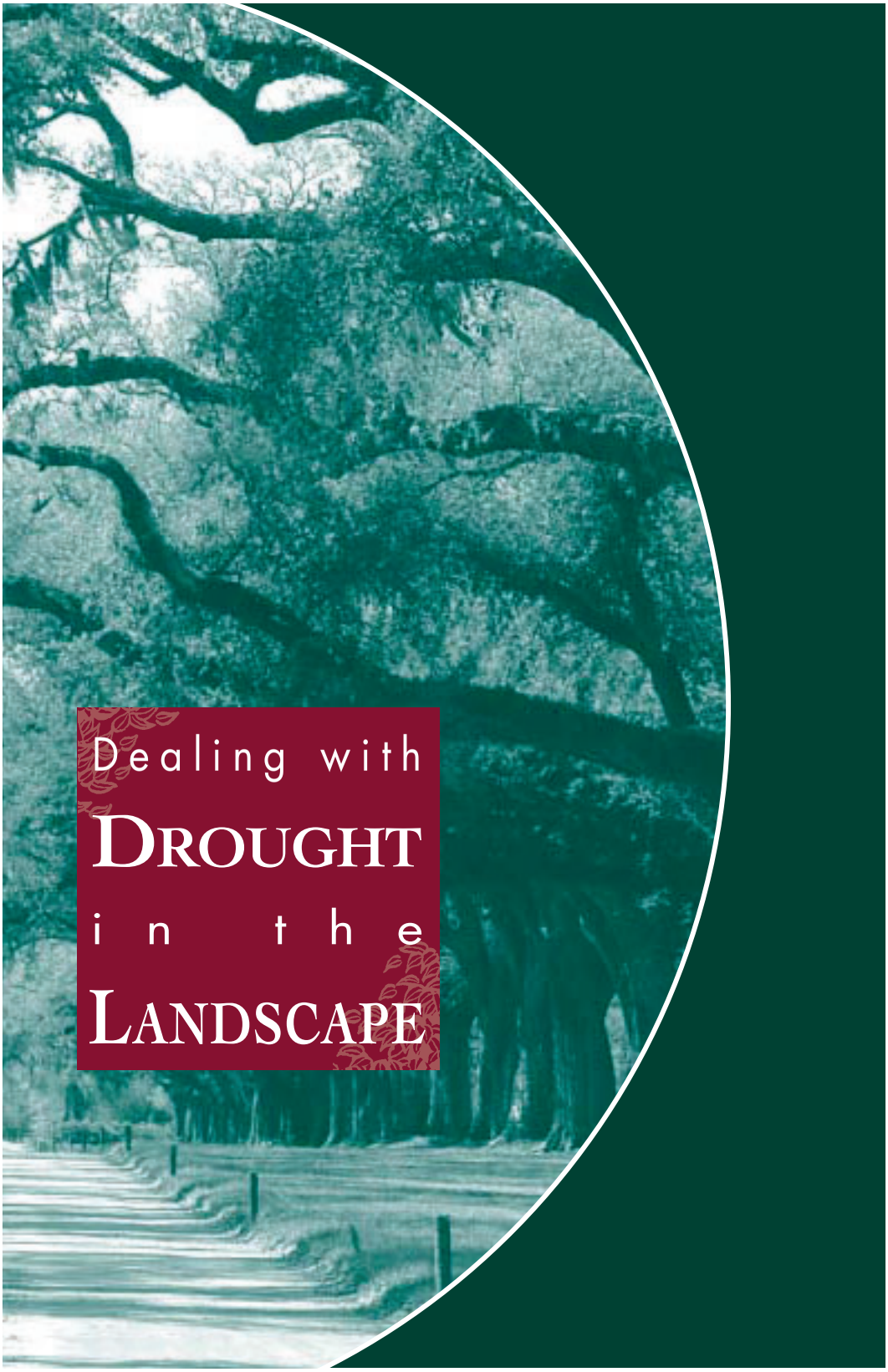


Dealing with DROUGHT in the LANDSCAPE

Benefits of the thriving landscape

Research has shown that trees are important to the quality of residential streets and to the perceptions people have about their neighborhoods. People prefer landscapes with trees, especially large ones. Shrubs provide the framework for the garden, annuals and perennials provide colorful accents, and the lawn is the carpet that unifies the composition. All components are required to gain the economic and social benefits associated with an attractive landscape, which include increased property value (12 to 15 percent), increased occupancy for apartments and hotels, greater productivity in business establishments, improved social communities in housing complexes, and enhanced recovery in hospitals. Landscape plants are important to our social well being.

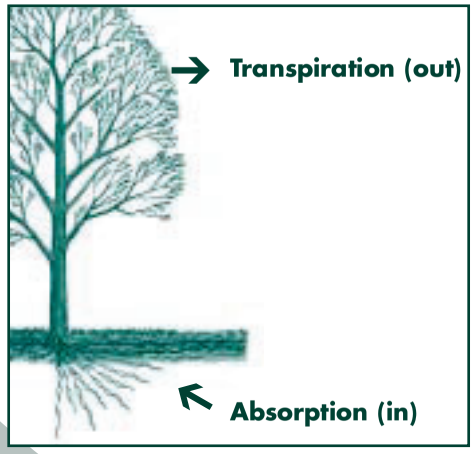
Landscape plants also play an important environmental role. Through photosynthesis, they use CO_2 (carbon dioxide) and release O_2 (oxygen). Plants provide shade and cool the environment by water evaporation from leaves. They also reduce wind speed and remove dust and pollutants from the air.

It is less expensive economically and environmentally to maintain landscape plants during a drought with minimal watering than to allow landscape plants to die and lose the benefits they provide. When landscape plants are replaced, they will require much more water to reestablish than would have been required to maintain them.

Plant water needs

Water enters a plant primarily through its root system. Most of the water entering the plant—85 percent—escapes from the leaves through pores (stomates) as water vapor, a process termed transpiration. Only 15 percent of the absorbed water stays in the plant to support physiological activities and growth. If more water leaves the plant than enters it, then the plant has water deficit (stress). Mild water deficit is normal and occurs during daylight hours when stomates are open, with maximum water stress occurring in the early afternoon. Plants close their stomates in the evening and night, and yet continue to absorb water, so the plant fills up with water thereby recovering from the water stress that developed during the previous day.

During drought, the soil becomes progressively drier. The plant becomes increasingly less able to extract water from the soil. Each day leads to a progressive increase in plant water stress. Eventually the stress is so great that injury . . . and perhaps death . . . may occur.



Plant responses to drought

Plants are wonderfully varied in their responses to drought. Over millions of years plants have evolved to certain environments (habitats). Most plant species in our region are termed mesophytic ("middle plants") in that they are adapted to neither too wet nor too dry soil conditions. But in our region, both xerophytes ("dry plants") and hydrophytes ("water plants") can thrive. Within the mesophyte group, there is a wide range of drought tolerance.

Certain plant species are inherently (genetically) more drought-tolerant than others. Species that ensure greater water absorption by having deep or extensive root systems are more drought-tolerant since their roots can extract water from a greater volume of soil, particularly water deep within the soil, which is usually more plentiful than water near the surface during drought. To reduce transpiration, most plants close their stomates under water stress. Wilting is a protective mechanism that results in closed stomates. Some species curl or roll their leaves to reduce water loss from transpiration.

Drought-tolerant species may have low transpiration rates because they have waxy, hairy, or light-colored (silver or gray) leaves with stomates that are "sunken" below the leaf surface. These are just a few reasons why some plant species are more drought-tolerant than others.

Drought-induced water stress symptoms include:

Leaf scorch

Leaf tissue away from the main veins browns and dies (necrosis). Distinguish this injury from anthracnose disease because moisture-stress-induced necrosis rarely crosses over leaf veins of the inner section of the leaf area. Leaf scorch tends to be most severe in the upper branches of trees or shrubs in contrast to anthracnose, which is evident in the lower branches. Maples and dogwood readily show leaf scorch symptoms. Needle tip die back is a common symptom of water stress in conifers.

Interveinal necrosis

The leaf tissue surrounding major veins remains green but the tissues between the veins turn yellow or brown.

Midsummer defoliation (leaf drop)

This is commonly preceded by leaf scorch. Defoliation will begin at the top of the tree and move downward.

Dead leaves remaining on the tree or shrub

Oaks and other deciduous trees or shrubs may show complete browning of foliage and yet the leaves may remain attached.

Extended drought stress can result in **crown decline** characterized by twig and small branch **die back** in the upper crown. Progressively larger branches can succumb, which then are vulnerable to breakage in strong winds. **Suckering** may occur on the trunk and upper branches of heavily stressed trees. Extended water stress can result in heavy seed loads in the year following the drought.

Symptoms of drought stress are delayed often until the spring following a drought year. Water deficiency may cause extensive root injury in the late summer and fall, but the current year's foliage may show no symptoms. By the time most conifers express symptoms of stress, the plant may be in dangerously poor health.

Ways of conserving water in the landscape

• *Stimulate deep and extensive root systems*

Surface soil fluctuates more in water content than deeper soil, so it is important to manage the soil to stimulate deep roots where the water supply is more constant. Having an appropriate pH level (usually 6 to 7, slightly acid to neutral) and nutrients will stimulate root growth. Test your soil (testing available through the University of Delaware Soil Laboratory, call (302) 831-2506 or 831-1392). This test will provide recommendations for the amount of limestone or fertilizer(s) that your soil needs.

In addition to these chemical aspects of the soil, physical aspects are important. Chemical properties are associated with soil solids (sand, silt, clay, and organic matter), whereas the physical properties of the soil are associated with the pore space. An "average" soil should have 50 percent pore space, but there should be a balance of small and large pores. The large pores drain readily, allowing air into the soil, which is needed by plant roots and microorganisms. The small pores retain water. Light (sandy) soils can have excess large pores so they drain too readily and tend to be dry. Heavy (high clay) soils can be poorly drained, and tend to have inadequate aeration. Adding organic matter will help the physical properties of your soil. Spent mushroom compost, leaf mold, and garden compost will "loosen" a heavy soil and increase the small pore content of a sandy soil. Apply as much organic matter as possible, then incorporate it as deeply as possible.

• *Apply mulch*

Mulch is a covering over soil that provides several benefits: a physical barrier to water vapor loss by evaporation from the soil, insulation of the soil from temperature extremes, and suppression of weed growth that otherwise would compete with trees, shrubs, and herbaceous plants for water and nutrients.

Many types of mulch are available. Preferred mulches are natural, organic ones such as chipped wood (available from arborists), bark, or leaf mold (from city supplies or from you own compost). Spread the mulch 2 to 3 inches deep. Lawn clippings (from lawns not treated with herbicides) are an effective mulch especially in flower beds when spread to a depth of one inch or less.

• *Decrease your lawn area*

Lawns can require large amounts of water to remain green during a drought. You may wish to reduce the size of your lawn, thereby increasing the size of your tree, shrub, or flower areas. Outline the new and reduced boundary of your lawn with a hose or a stream of limestone. Spray the area outside this boundary with a non-selective, systemic herbicide. Cover the area with 3 to 4 inches of mulch. You can plant in this area at your leisure.

- *Use the microenvironments of your landscapes*

Since the north and east sides of buildings receive less sun (heat) than the south and west sides, the soil in these more shaded areas tends to remain more moist. As a general rule, plant less drought-tolerant and more shade-tolerant plants in these areas. In areas of your landscape that receive much sun and tend to be dry (south and west of buildings, steep slopes, sandy soil), plant species that are drought-tolerant (see list below). Group plants with similar water requirements in the same microclimate.

Watering Practices

Suggestions for watering various components of your landscape are described below.

- *Lawns*

Newly planted seed — water daily, preferably around mid-day, to moisten surface.

Newly planted sod — water daily to wet the underlying soil.

Established lawn (to keep lawn green) — 1.5 inches every 10 to 12 days, from rain or irrigation. You may spot-irrigate only those areas that need water. Realize that 940 gallons are required to apply 1.5 inches to 1,000 square feet (32 by 32 feet) of lawn. During a 6-week drought, 197,000 to 233,000 gallons of water would be required on the average (0.8 acre) Delaware lawn. Such water usage ***may*** be considered socially irresponsible.

Established lawn (allowed to go "summer dormant") — no water required. The grass will turn purplish-green or perhaps brown, but will regrow with the return of rain if the drought was insufficiently severe to cause death of the roots and crowns.

- *Shade Trees*

Deciduous, newly planted — water once per week.

Deciduous, established — water twice a month in summer and fall.

Evergreens, newly planted — water weekly, especially into fall and winter.

Evergreens, established — water twice a month all year.

- *Shrubs*

Newly planted — water twice per week.

Established (3 to 5 years old) — water weekly during the summer and twice a month in fall and spring.

- *Flowers*

Newly planted — water three times per week.

Established — water weekly during the growing season. All flowers, annuals (petunias, impatiens); biennials (sweet William, foxglove) and perennials (coneflowers, asters) need frequent irrigation during establishment. However, biennials and perennials frequently are more drought-tolerant than annuals because they have deeper, more extensive roots. Limit the amount of annual flowers in the landscape, and put them only in high visual impact areas.

- *Vegetables*

  After planting seeds — water every other day until seedlings emerge.

  Established — water weekly during the growing season.

WATERING TIPS

Deep, infrequent soakings are the most efficient way to water. When water is applied to the top few inches from frequent shallow watering, most of the applied water is lost to evaporation. Roots may tend to concentrate in this moist surface soil. As the soil dries, especially during drought, these roots will succumb.

The amount required for soaking is dependent on the soil type. The following chart gives approximate infiltration rates (rate of water entry into the soil) and water requirements by soil type.

Soil Type	Avg. Infiltration Rate	Water Needed to Supply One Foot Depth of Soil
Light sandy soil	1.5–2 in./hour	0.75 in.
Average loam soil	0.5–0.75 in./hour	1.5–2.0 in.
Heavy clay soil	0.25–0.5 in./hour	2.5 in.

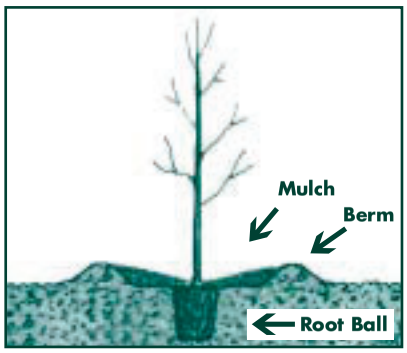
These infiltration rates are for level soils. The values decrease progressively as slopes increase. Applying water at rates higher than the infiltration rate will result in wasted runoff. In this case, apply water and allow it to sink in, then water again. The amount of water to supply one foot applies to soils that are dry (0 percent available water).

One way to determine the depth of soil that is wet is to probe the soil with a long screwdriver. If the screwdriver easily penetrates the soil, then the soil is sufficiently moist.

It is best to water in the early morning or late afternoon when it is cool and less windy because loss of water by evaporation or drift will be less than occurs at mid-day.

If at all possible, avoid overhead sprinklers. Overhead sprinklers can lose as much as 50 percent water to evaporation before the water reaches the soil. Sprinkler efficiency is greatly increased by early-morning or late-afternoon applications. Never use overhead sprinklers on windy days, and place them to avoid wetting driveways, sidewalks and roads.

Where possible, apply water by soaking. Use an open hose (no nozzle) at the base of small or newly planted shrubs and trees. Allow water to trickle into the soil gradually. For larger trees, spread a soaker hose over an area under the tree about as wide as the tree is tall. Soaker hoses emit water along their entire length. Put hoses on timers to avoid waste. Soaker hoses and timers are readily found in nursery/garden centers. Soaker hoses are an excellent choice for shrub and flowerbeds.



At the time of planting, it is a good idea to create a watering basin around trees and shrubs. This is a raised circular berm, about 3 inches tall and with a diameter perhaps 3 or 4 times that of the rootball. This allows applied water to be concentrated in the area of the small root balls. The area within the berm can be filled with mulch tapering down to the base of the trunk. Attention to watering is required under drought conditions for at least two years following planting.

Do not try to water the entire landscape at one time. Divide the landscape into sections and concentrate on one area, watering it thoroughly. Move on to the next area. Do not water again until an area is dry. Over-watering can be more harmful to plant growth than lack of water. If the soil remains soaked for long periods, oxygen is excluded and plant roots die. This often results in wilting and confuses homeowners who think the plant needs more water!

Reduce Water Requirements

The best way to reduce the water requirements of a landscape is to maintain healthy, vigorous plants that can bounce back from a summer drought with few, if any, problems.

For lawns this means:

- Seed in the fall when the soil is warm for good germination and the air is cool for good growth. Avoid spring seeding when there is greater weed competition, less rainfall, and more heat to stress tender cool-season grass seedlings.
- Maintain the soil pH between 6.0 and 7.0 by adding limestone as needed based on soil test results.
- Apply fertilizer during the fall to promote root growth. Avoid late spring fertilization, which leads to succulent top growth that becomes stressed during hot, dry weather of summer.
- Tall-fescue seed mixtures are recommended for drought tolerance in our area, in part because these lawns have deep (4 to 6 feet) root systems. Zoysia and bermudagrass lawns are very drought tolerant but undergo winter dormancy and become straw-colored.
- In times of water or heat stress, turfgrass benefits from a greater mowing height. Cut the lawn to a height of 2.5 to 3.5 inches to enhance turf root growth and to increase shade at the soil surface, which reduces evaporation, weed seed germination, and seedling growth.
- Aerify the lawn periodically to increase water infiltration and decrease soil compaction.

For landscape plants this means:

- Plant in early spring or late fall to take advantage of rainfall so plants are better established during the hot, dry summer.

• Avoid over-fertilization that results in lush, water-demanding growth and less drought tolerance.

• Control weeds to reduce competition for water, nutrients, and light (tall weeds).

• Use mulch to cover the ground and reduce evaporation.

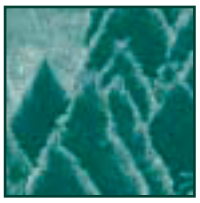
• When preparing a landscape bed, add organic matter to enhance the moisture-holding capacity of sandy soils and increase the drainage and aeration of high-clay soils.

Drought-tolerant plants

The species listed below have shown greater drought-tolerance in our area than other species.

Trees

Carya ovata, Shagbark Hickory
Castanea mollissima, Chinese Chestnut
Catalpa bignonioides, Southern Catalpa
Celtis occidentalis, Common Hackberry
Fraxinus americana, White Ash
Fraxinus pennsylvanica, Green Ash
Ginkgo biloba, Maidenhair Tree
Gleditsia tricanthos var. *inermis,* Thornless Honeylocust
Gymnocladus dioicus, Kentucky Coffeetree
Liquidambar styraciflua, Sweet Gum
Platanus acerifolia, London Plane Tree
Populus grandidentata, Largetooth Aspen
Ptelea trifoliata, Hoptree
Quercus coccinea, Scarlet Oak
Quercus imbricaria, Single Oak
Quercus palustris, Pin Oak
Quercus rubra, Red Oak
Quercus stellata, Post Oak
Sophora japonica, Japanese Pagodatree
Sorbus americana, American Mountain Ash
Zelkova serrata, Japanese Zelkova



Small Trees

Chionanthus virginicus, Fringe Tree
Cotinus coggygria, Smoke Tree
Crataegus phaenopyrum, Washington Hawthorn
Diospyros virginiana, Persimmon
Koelreuteria paniculata, Goldenraintree
Sassafras albidum
Syringa reticulata, Japanese Tree Lilac

Evergreen Trees

Cedrus atlantica, Atlas Cedar
Ilex opaca, American Holly
Juniperus scopulorum, Rocky Mountain Juniper
Juniperus virginiana, Eastern Red Cedar
Picea abies, Norway Spruce
Picea pungens var. and cv., Colorado Spruce varieties and cultivars
Pseudotsuga menziesii, Douglas Fir
Pinus flexilis, Limber Pine
Pinus nigra, Austrian Pine
Pinus sylvestris, Scotts Pine
Pinus thunbergiana, Japanese Black Pine

Deciduous Shrubs

Aronia arbutifolia, Red Chokeberry
Baccharis halimifolia Groundsel bush
Chaenomeles speciosa, Common Flowering quince
Hibiscus syriacus, Rose of Sharon
Hypericum kalmianum, Kalm St.-John's-wort
Ilex verticillata, Winterberry
Jasminum nudiflorum, Winter Jasmine
Prunus x *cistena,* Purpleleaf Sand Cherry
Rhus typhina, Staghorn Sumac
Rhus glabra, Smooth Sumac
Rhus copallina, Winged Sumac
Rosa rugosa, Rugosa Rose
Vitex agnus-castus, Chastetree
Xanthorhiza simplicissima, Yellowroot

Evergreen Shrubs

Abelia x grandiflora, Glossy Abelia
Buxus microphylla, Littleleaf Box
Ilex cornuta cv., Chinese Holly cultivars
Ilex crenata cv., Japanese Holly cultivars
Ilex glabra, Inkberry Holly
Juniperus chinensis cv. Chinese Juniper cultivars
Myrica pensylvanica, Northern Bayberry
Nandina domestica, Heavenly Bamboo
Pyracantha coccinea, Scarlet Firethorn
Taxus baccata, English Yew
Taxus cuspidata, Japanese Yew
Taxus x media, cv. Upright Yew
Yucca filamentosa, Adams Needle

Perennials

Achillea millefolium, Common Yarrow
Althaea rosea, Hollyhock
Anemone x *hybrida,* Japanese Anemone
Anemonella thalictroides, Rue Anemone
Anthemis tinctoria, Golden Marguerite
Aquilegia chrysantha, Golden Columbine
Artemisia schmidtiana, Wormwood
Asclepias tuberosa, Butterflyweed
Aster sp., Aster
Baptisia australis, False Indigo
Calamintha, Calamint
Centaurea montana, Perennial Bachelor's Button
Cerastium tomentosum, Snow-in-Summer
Ceratostigma plumbaginoides, Leadwort
Cimicifuga americana, American Bugbane
Coreopsis verticillata, Threadleaf Coreopsis
Dictamus albus, Gas Plant
Echinacea purpurea, Purple Coneflower
Echinops exaltatus, Globe Thistle
Epimedium spp., Bishop's Hat
Eryngium spp., Sea Holly
Eupatorium coelestinum, Mistflower
Eupatorium perfoliatum, Boneset
Eupatorium purpureum, Bluestem
Eupatorium rugosum, White Snakeroot
Geranium sp., Cranesbill
Gypsophila paniculata, Baby's breath
Helianthemum nummularium, Sun-rose
Hemerocallis cv., Daylily
Iberis sempervirens, Perennial Candytuft
Kniphofia uvaria, Red-hot Poker
Lavandula sp., Lavender
Liatris spicata, Liatris
Linum perenne, Flax
Oenothera fruticosa, Sundrops
Papaver orientale, Oriental Poppy
Penstemon digitalis, Beard-tongue
Phlox subulata, Moss Pink
Polystichum acrostichoides, Christmas Fern
Rudbeckia hirta, Black-eyed Susan
Salvia x *superba,* Perennial Salvia
Santolina chamaecyparissus, Lavender-Cotton
Saxifraga virginiensis, Virginia Saxifrage
Sedum spectabile, Stonecrop
Sempervivum tectorum, Hens-and-Chickens
Silene caroliniana, Wild Pink
Solidago sp., Goldenrod
Stachys byzantina, Lamb's ears
Thymus serpyllum, Thyme
Vinca minor, Periwinkle
Xerophyllum asphodeloides, Turkey-beard Beargrass

Annuals

Amaranthus tricolor, Amaranth, Joseph's Coat
Arctotis stoechadifolia, African Daisy
Catharanthus roseus, Rose Periwinkle
Centaurea cyanus, Cornflower
Cleome spinosa, Spider Flower
Dianthus chinensis, China or Annual Pink
Euphorbia marginata, Snow-on-the-Mountain
Gaillardia pulchella, Maroon Gaillardia
Gomphrena globosa, Globe Amaranth
Gypsophila elegans, Annual Baby's-Breath
Helianthus annuus, Sunflower
Portulaca grandiflora, Rose Moss
Rudbeckia bicolor, Annual Coneflower
Sanvitalia procumbens, Santivalia
Senecio cineraria, Dusty Miller
Tithonia rotundifolia, Mexican Sunflower
Verbena hybrida, Verbena
Zinnia elegans, Zinnia

Vines

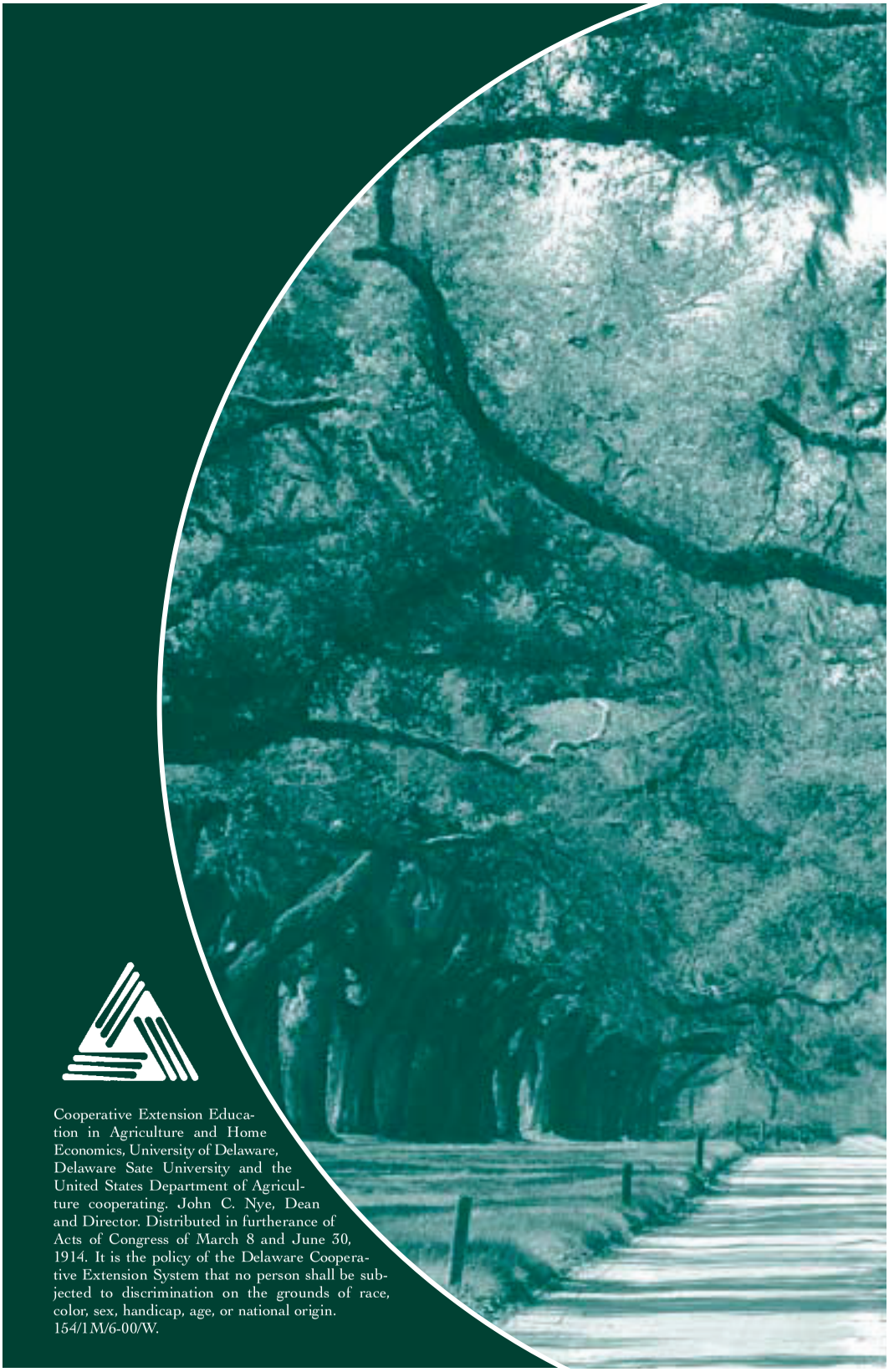
Campsis radicans, Trumpet Creeper
Parthenocissus quinquefollia, Virginia Creeper

Groundcovers

Arctostaphylos uva-ursi, Bearberry
Cerastium tomentosum, Snow-in-Summer
Cotoneaster dammeri, Bearberry Cotoneaster
Fragaria virginiana, Virginia Strawberry
Hemerocallis cv., Daylily
Hypericum calycinum, Aaronsbeard St. Johnswort
Juniperus horizontalis, Creeping Juniper
Liriope spicata, Lilyturf
Sedum sp., Stonecrop
Santolina chamaecyparissus, Lavender Cotton
Thymus serpyllum, Creeping Thyme

Grasses

Calamagrostis x *acutiflora,* 'Karl Foerster' Feather Reed Grass
Helictotrichon sempervirens, Blue Oat Grass
Luzula sylvatica, Greater Woodrush
Panicum virgatum, Switch Grass



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