

Phreatophytes, Xerophytes, and Succulents – Oh My! Understanding Drought Tolerance of Plants

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Introduction:

Land plants lose water continually by evaporation and transpiration. Suitable water relations within the plant and its surrounding environment must be established for plant survival. During dry times, plants must be able adapt to reduced water availability or they will suffer stress or even die.

Objectives:

1. Present how drought stress is induced in plants and describe plant response to drought stress.
2. Describe how plants survive drought and describe different ways plants can avoid, resist or evade drought.
3. Describe how selected plant species respond to limited available water at a site.
4. Describe site and plant characteristics that should be evaluated before selecting plants for a dry site.

Causes of Drought Stress for Plants:

1. Soil dryness
2. High evaporation rates
3. Salts in the soil – reduce water flow
4. Frozen soil
5. Root or vascular disease(s) – block water flow

Plant Responses to Drought:

1. Cell growth stops early after the stress begins
2. Amino acid (and protein) production stops early
3. Nitrate conversion to ammonium stops early

4. Abscisic acid (plant growth regulator) is produced
5. Leaf openings (stomata) close after the stress is underway
6. Photosynthesis is limited – plant is unable to make sugars
7. Plants try to make adjustments in their cells – osmoregulate

Survival of Drought:

Drought resistance – ability of plants to withstand periods of dryness.

Desiccation avoidance – plants avoid a harmful loss of water that could destroy cells.

Desiccation tolerance – plant cells can lose water without becoming damaged.

Xerophytes – plants that escape, resist, avoid or endure drought.

Drought sensitive xerophytes escape drought by completing their life cycle quickly or storing water underground (geophytes).

Drought resistant xerophytes can survive desiccation by improved water uptake, improved water conductivity, reduced transpiration or storing water.

Phreatophytes – plants with very deep root systems to obtain ground water.

Isohydric plants – regulate stomata as the soil becomes dry.

Ansohydric plants – stomata remain open as the soil becomes dry.

Site and Plant Factors to Consider:

1. What is the native environment for the plant?
2. Is the soil moisture reservoir restricted?
3. Is the plant in a location with a high atmospheric demand?
4. What are the plant's morphological characteristics (plant form and structure)?
5. Has the plant been able to adjust to drought?
6. What is the typical duration of the drought or dry period?
7. Is the plant prone to stress-related disease or insect attack?

Summary

See the attached plant list for species that tolerate dry sites

Drought Tolerant Shrubs, Trees, Vines, Annuals, Ornamental Grasses, and Perennials:

Source: <http://www.conngardener.com/drought.html>

Shrubs

Acanthopanax sieboldianus - Fiveleaf Aralia
Aesculus parviflora - Bottlebrush Buckeye
Arctostaphylos uva-ursi - Bearberry
Aronia - Chokeberry
Baccharis halimifolia - Groundsel Tree
Berberis - Barberry
Buddleia davidii - Butterfly Bush
Calluna - Heather
Caryopteris - Blue Mist Shrub
Chaenomeles x superba - Japanese Flowering Quince
Clethra alnifolia - Sweet Pepperbush
Comptonia peregrina - Sweet Fern
Cornus mas - Cornelian Cherry Dogwood
Cotinus coggygria - Smokebush
Cotoneaster - Cotoneaster
Cytissus - Broom
Erica - Heath
Exochorda racemosa - Pearlbush
Forsythia - Forsythia
Hamamelis virginiana - Virginian Witch-Hazel
Hydrangea paniculata - Panicle Hydrangea
Hypericum prolificum - Shrubby St. John's Wort
Itea virginica - Virginia Sweetspire
Kerria japonica - Japanese Rose
Microbiota decussata - Russian arborvitae
Myrica pensylvanica - Bayberry
Philadelphus coronarius - Mockorange
Physocarpus opulfolius - Ninebark
Prunus maritima - Beach Plum
Potentilla fruticosa - Bush Cinquefoil
Rhus - Ornamental Sumac
Rosa rugosa - Saltspray Rose
Rosa virginiana - Virginia Rose
Spirea - Spirea, many species
Symphoricarpos albus - Snowberry
Syringa vulgaris - Lilac
Vaccinium angustifolium - Lowbush Blueberry
Viburnum dentatum - Arrowwood
Viburnum lentago - Nannyberry
Vitex agnus-castus - Chaste Tree

Deciduous Trees

Acer campestre - Hedge Maple
Acer grinnala - Amur Maple
Acer griseum - Paperbark Maple
Carpinus caroliniana - American Hornbeam
Cornus kousa - Kousa Dogwood
Cotinus obovatus - American Smokewood
Crataegus phaenopyrum - Washington Hawthorn
Crataegus viridis 'Winter King' - Hawthorn
Ginkgo biloba - Ginkgo
Halesia tetraptera - Carolina Silverbells
Koelreuteria paniculata - Golden Rain Tree
Liquidambar styraciflua - American Sweet Gum
Magnolia x loebneri - Loebner Hybrid Magnolia
Malus - Crabapple
Platanus x acerifolia - London Plane Tree
Quercus - Oak, many species
Sophora japonica - Japanese pagoda tree
Tilia - Linden
Ulmus parvifolia - Lacebark elm
Zelkova serrata - Japanese zelkova

Needled Evergreens

Abies concolor - White Fir
Cedrus atlantica - Atlas Cedar
Cephalotaxus harringtonia - Japanese Plum Yew
Chamaecyparis pisifera - Sawara False Cypress
Juniperus - Juniper, most species
Picea - Spruce, most species
Pinus - Pine, most species
Taxus - Yew, most species
Thuja occidentalis - Eastern Arborvitae

Broadleaf Evergreens

Ilex crenata - Japanese Holly
Ilex glabra - Inkberry
Ilex x meserveae - Meserve Holly
Ilex opaca - American Holly

Vines

Aristolochia macrophylla (durior) - Dutchman's Pipe
Campsis radicans - Trumpet Vine
Clematis montana - Anemone clematis
Hedera helix - English Ivy
Lonicera sempervirens - Trumpet Honeysuckle
Parthenocissus quinquefolia - Virginia Creeper
Wisteria frutescens - American Wisteria

Annuals

Begonia semperflorens - Wax Begonia
Calendula officinalis - Pot Marigold
Canna x generalis - Canna
Capsicum - Ornamental Peppers
Catharanthus roseus - Madagascar Periwinkle
Celosia cristata - Cockscomb
Centaurea cyanus - Cornflower
Cleome - Spider Plant
Coreopsis tinctoria - Annual Tickseed
Cosmos - Cosmos
Cuphea hyssopifolia - Mexican Heather
Digitalis purpurea - Foxglove
Eschscholzia californica - California Poppy
Gaillardia
Gazania rigens - Gazania
Gomphrena globosa - Globe Amaranth
Helichrysum bracteatum - Strawflower
Helianthus - Sunflowers
Helichrysum bracteatum - Strawflower
Lantana
Lemonium - Statice
Linaria - Toadflax
Melampodium
Nicotiana alata - Flowering Tobacco
Papaver rhoeas - Corn Poppy
Pelargonium x horatum - Geranium
Petunia x hybrid - Petunia
Portulaca grandiflora - Moss Rose
Salvia coccinea - Sage
Rudbeckia hirta - Gloriosa Daisy
Senecio cineraria - Dusty Miller
Tagetes - Marigold
Verbena - Verbena
Vinca rosea - Annual Vinca

Ornamental Grasses

Calamagrostis x acutiflora - Feather Reed Grass
Carex siderosticha 'Variegata' - Sedge
Festuca glauca - Blue fescue
Helictotrichon 'Sapphire' - Oatgrass
Miscanthus - Maiden Grass
Panicum virgatum - Switch grass
Schizachyrium scoparium - Little Blue Stem

Perennials

Achillea - Yarrow
Agastache foeniculum ÔBlue FortuneÕ - Anise Hyssop
Allium - Flowering Onion
Amsonia
Anaphalis - Pearly Everlasting
Anthemis tinctoria - Golden Marguerite
Arabis caucasica - Rock Cress
Artemesia
Asclepias tuberosa - Butterfly Weed
Aurinia saxatilis - Basket of Gold
Baptisia australis - False Indigo
Calamintha. – Calamint
Campanula persicifolia, portenschlagiana, poscharskyana, rotundifolia - Bell Flowers
Centaurea montana - Perennial BachelorÕs Button
Cerastium - Snow-in-Summer
Coreopsis
Crambe maritima - Sea Kale
Delosperma - Ice Plant
Dianthus plumarius - Pinks
Echinacea purpurea - Purple Coneflower
Echinops ritro - Globe Thistle
Epimedium
Eryngium - Sea Holly
Euphorbia - Spurge
Gaillardia - Blanket Flower
Gaura lindheimeri - Wand Flower
Geranium macrorrhizum - Bigroot Geranium
Gypsophila paniculata - BabyÕs Breath
Helianthemum nummularium - Sun Rose
Helleborus - Hellebore
Hemerocallis – Daylily
Hibiscus moscheutos - Marsh Mallow
Hosta
Iberis - Candytuft
Iris germanica - German or Bearded Iris
Iris pallida ÔVariegataÕ
Iris siberica - Siberian iris

Perennials - continued

Iris tectorum - Roof Iris
Kniphofia - Red Hot Poker
Lavendula angustifolia - Lavender
Liatris - Gayfeather
Limonium latifolium - Statice
 Linaria
Linum - Flax
Liriope - Lilyturf
Lychnis coronaria - Campion
Monarda didyma - Bee Balm
Nepeta - Catmint
Nipponanthemum nipponicum - Montauk Daisy
Oenothera fremontii - Lemon Silver - Evening
 Primrose
Opuntia - Prickly Pear Cactus
Origanum - Oregano
Paeonia - Peony
Papaver alpinum - Alpine Poppy
Papaver atlanticum - Atlantic Poppy
Perovskia atroplicifolia - Russian Sage
 Phlox
Platycodon grandiflorus - Balloon Flower

Pycnanthemum muticum - American Mountain
 Mint
Rhazya orientalis - Blue Star
Rudbeckia - Black-eyed Susan
Ruellia humilis - Wild Petunia
Ruta - Rue
Salvia - Sage
Santolina - Lavender Cotton
Saponaria ocymoides - Soapwort
 Sedum
Sempervivum - Hens and Chicks
Silene virginica - Catchfly
Solidago - Goldenrod
Stachys byzantina - Lamb's ears
Stokesia laevis - Stokes's aster
Tanacetum vulgare - Crispum - Curly Tansy
Teucrium canadensis (prostrata) - Prostrate
 Germander
Thymus - Thyme
Verbascum - Mullein
Veronica incana - Speedwell
 Yucca

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