Texas A&M AgriLife Extension

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Plant Strategies
for Surviving Drought

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Texans are no strangers to drought, and the rapid onset of severe drought conditions in 2011 served as a painful reminder of just how devastating they can be. The Texas A&M Forest Service estimated that almost 300 million trees on Texas range and forest lands died as a result of the drought. The hardest hit region was Central Texas. Other regions were not affected to such an extent, and this is partially attributed to varying differences in plant species' response to drought.

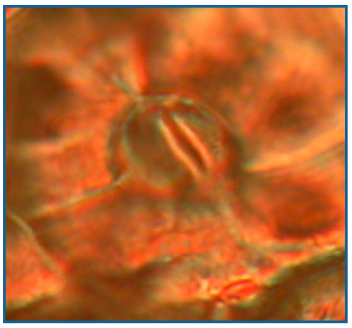

Figure 1. Stomata on a saltcedar leaf photographed in the open position. Source: Georgianne W. Moore

Many plants can alter their physiological functions to cope with short-term water stress, and some plants have physical characteristics that help them better tolerate drought.

Homeowners and range managers who understand these functions and characteristics can take steps to protect their plants during extended dry periods. It will also help you recognize the plant species that are best able to withstand drought in your area.

Water losses

Moisture in the soil is absorbed by plant roots, travels up through the stems, and exits the plant via pores on the leaves called ***stomata.*** This process is called ***transpiration.***

Plants lose as much as 95 percent or more of their water through the stomata. These pores must open to allow the exchange (Fig. 1) of carbon dioxide and oxygen, which are needed for two vital plant functions:

- Photosynthesis, the process that plants use to capture the sun's energy and convert it to food
- Respiration, the process of using that food for energy to survive, grow, and reproduce

The amount of water that plants lose through transpiration is determined primarily by environmental factors such as temperature, relative humidity, and wind speed. Warm, dry air pulls moisture from the soil through the plant and out to the atmosphere.

At the same time, water is evaporating from the soil. The combination of water losses from the soil (evaporation) and from plants (transpiration) is called ***evapotranspiration.***

Plants become drought-stressed when the atmosphere demands more moisture than the soil can supply. As the soil dries, air bubbles will form in the xylem tissue that transports water from the roots through the stems and to the leaves, causing cavitation, or disruption of water flow, within the plant tissues. Cavitation can cause permanent damage or plant death.

Plant responses to water stress

The characteristics and functions that enable plants to endure or avoid drought stress include stem and leaf features, changes in stomata opening times, short lifespans, long seed dormancy periods, and strong root systems.

Physical characteristics

Several leaf and stem features help plants regulate their temperature and minimize water loss (Table 1). Some plants can store large amounts of water in their fleshy stems. Others have small leaves that may be coated with spines, dense hairs called trichomes (Fig. 2), or oily, aromatic chemicals.

Spines and dense hair reflect sunlight, buffer the leaf surface temperature, and reduce evapotranspiration. Plant oils also reduce evaporation.

Plant architecture is another trait that can minimize heat. Stems and branches may be oriented mostly vertical to intercept morning and evening sunlight while avoiding direct exposure during midday. One such plant is creosotebush (Fig. 3).

Figure 2. Trichomes on Mexican coldenia leaves.
Source: Mark Muegge

In contrast, some tropical plants have broad, flat leaves that are oriented parallel to the ground to intercept as much sunlight as possible.

Drought-deciduous plants, such as ocotillo, shed their leaves in dry weather and grow new ones when moisture becomes plentiful again. They may do this several times during a year. Retama and palo verde shrubs are also drought deciduous, but their green stems allow them to conduct photosynthesis even in the absence of leaves.

Table 1. Physical characteristics of selected drought-tolerant plants native to Texas.

Plant	Physical characteristic		
	Leaves modified or ephemeral	Leaf hair dense	Stems green (chlorophyllous)
Allthorn *(Koeberlinia spinosa)*	x		x
Beebrush, whitebrush *(Aloysia gratissima)*	x		
Cenizo, purple sage *(Leucophyllum frutescens)*		x	
Greggs dalea *(Dalea greggii)*		x	
Lotebush *(Zizyphus obtusifolia)*			x
Mexican coldenia *(Coldenia mexicana)*		x	
Mormon's tea *(Ephedra* spp.)	x		x
Ocotillo *(Fouquieria splendens)*	x		x
Palo verde *(Cercidium* spp.)	x		x
Pricklypear *(Opuntia* spp.)	x		x

Figure 3. Creosotebush.

Figure 4. Stem and spines of allthorn plant. The arrows point to the leaves. Source: Mark Muegge

Some plants have modified leaves or very short-lived leaves. For example, allthorn is a desert-adapted shrub that has green branches and spines. Although it does have true leaves, they are small, deciduous, and scale-like (Fig. 4).

Stomata changes

Plants may respond to drought conditions by opening their stomata only in the early morning and late evening, when the atmospheric demand for water is lower. However, this water-conservation strategy is costly to the plant because photosynthesis, and thus food production, decreases when the stomata are closed.

Plants such as cacti, stonecrops (example: sedum), and spurges (gopher plant) can open their stomata at night and begin the process of photosynthesis. These plants have a special type of metabolism known as crassulacean acid metabolism (CAM). During the day, CAM plants complete the photosynthetic process much as non-CAM plants do.

Lifespan

Short-lived plants may avoid drought altogether. Because annual plants germinate, mature, and die in less than a year, they may not be exposed to extreme weather conditions for extended periods.

Plants that have short lifespans and grow only during favorable conditions are called ***ephemerals.*** Their lifespans may be a few days to a few weeks. Ephemerals such as Mexican gold poppies germinate and complete their life cycle during brief rainy seasons.

Dormancy

Some species avoid drought altogether via more stringent germination requirements. The seeds will not germinate until temperature and moisture conditions are optimal.

Root systems

Healthy plants can survive on the energy they have stored in their roots. Plants with vigorous root systems are more likely to survive a drought, and they are able to recover more quickly after the drought ends.

Protecting your plants

Most plants can endure drought stress for short periods. However, some plants are adapted to thrive in water-limited environments. Homeowners and range managers can help mitigate the effects of extended dry periods by protecting their plants before, during, and after a drought.

Practices such as mowing grass too short (scalping) and excessive grazing will shrink and weaken the plants' root systems. Healthy plants with vigorous root systems are more likely to survive periods of stress such as drought and the diseases and insects that often accompany it.

Avoid scalping lawns and overstocking rangeland to enable plants to maintain enough leaf material to conduct photosynthesis and store energy in a healthy root system.

Another protective measure is to use plants that develop deep root systems. Because the upper layers of soil dry out quickly, shallow-rooted short grasses such as buffalograss will experience drought sooner and more severely than will deep-rooted shrubs and bunchgrasses such as sideoats grama.

For more information

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- "Texas A&M Forest Service Survey Shows 301 Million Trees Killed by Drought." Texas Forest Service. http://txforestservice.tamu.edu. 2012.

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