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Water Wise

Drought Effects on Turf in the Landscape

Jim A. Schild, Extension Educator
Scott Dworak, Graduate Teaching and Research Assistant

Periods of drought can damage turfgrass. Through careful selection of turfgrass species and irrigation, turfgrass can remain healthy.

Water availability in the Great Plains is variable. Precipitation can range from excessive one year to deficit the next. Water is often limited during certain months of the year, especially July and August. As populations rise, water demand for agricultural, residential, and industrial applications increase, but water availability is limited. Cities have to manage water quality standards for potable water and find water sources that meet those standards.

Drought occurs when precipitation is significantly below the long-term average for several years. Soil moisture decreases to a point that it negatively effects plant growth and development. Water is the major limiting factor for a healthy, productive turf. In semiarid and arid regions of the United States, such as Nebraska, water availability can limit growth of cool-season and warm-season grasses. Knowledge of the effects of drought stress on turf and ways to manage turf under drought conditions is essential for maintaining quality turf when water availability is limited.

Symptoms of Damage

Symptoms of damage from drought vary depending on turfgrass species or cultivar and the severity of the water limitation.

An initial sign of water stress is an off-color to the grass. For example, Kentucky bluegrass will develop a deeper blue color, and other turf often will turn greyish-blue. Drought-stressed turf does not spring back after foot traffic, and footprints or wheel tracks remain visible in the turf (*Figure 1*). As drought symptoms progress, the turf will continue to discolor and eventually will start showing characteristic browning and yellowing discoloration. Symptoms are easily confused with damage from insects and disease, which also can compromise the root system and affect water distribution within the plants.

The ability of a turfgrass species to survive drought stress and recover is derived from different genetic and physiological characteristics. Turfgrasses with deep, extensive root systems, such as tall fescue, are usually better adapted to survive short drought periods. The water stored deep in the soil profile is available for plant use during drought periods. Some turfgrass species, such as Kentucky bluegrass, can avoid drought damage by entering dormancy. During dormancy, the grass turns brown and appears dead, but the crowns (growing points) of the plants remain protected so that growth resumes upon favorable moisture and temperature. Turfgrasses can typically survive dormancy periods of four to five weeks; however, if temperatures are continually greater than 80°F, survival is greatly reduced after three to four weeks. Applying ¼ to ½ inch of water every two to three weeks will help ensure hydration of the crowns while not greening up the dormant turf. This will greatly increase survival upon re-greening following consistent rainfall or irrigation.

Figure 1. Footprints and wheel paths are easily visible in more severe cases of drought-stressed turf. (Image courtesy of Roch Gaussoin.)

Warm-season grasses evolved to grow during the hot, dry season of the year. Soil moisture is maintained under these grasses during the spring, fall, and winter seasons, which should increase water availability during the summer months when water is often limited. With a deep root system and the stored soil moisture warm-season grasses can survive the hot Nebraska summers. Once soil moisture is depleted, most warm-season grasses enter dormancy. The grass will resume growth with sufficient rainfall or irrigation.

A grass's ability to recuperate from damage and fill in thin, dead areas depends on its life cycle and growth habit. Annual grass species produce their seed prior to maturity and plant death. The seed then germinates when conditions are favorable for growth. This characteristic is not desirable for lawns; therefore, annual species are typically not used for turf. Bunch-type grasses increase in density by developing tillers from the mother plant. This tillering growth habit is effective at filling in small open areas between plants. However, bunch-type grasses are not aggressive enough to fill in large open areas, and as a result, weeds fill the void. Grasses that can spread by rhizomes or stolons are ideal where damage to the turf is expected because, given enough time, these grasses will spread into voids created by extended drought. Nitrogen fertilizer and water applied at the correct time will thicken stand and density of these grasses. Areas up to 6 inches in diameter can quickly be reclaimed by the turfgrass. Larger areas will require reseeding or sodding.

One irrigation strategy to manage turf under water-limiting conditions is called deficit irrigation. This is the practice of continually replenishing some fraction of water lost from evapotranspiration, or ET. Evapotranspiration is the estimated amount of water that turf would use (including surface evaporation) if growing under no stress or nonwater limiting conditions (*Table I*). Deficit irrigation can maintain healthy turf with minimal effects on visual quality. The University of Nebraska–Lincoln has been conducting a long-term deficit irrigation trial in cooperation with the Gering Nebraska Parks and Recreation Department and at a site at the UNL Agricultural Research and Development Center near Mead, Neb., since 2009. Effects of drought and deficit irrigation are being investigated at Mead (eastern part of state) on a silty clay loam soil (28 $in \cdot yr^{-1}$ average precipitation) and Gering (western part of state) (16 $in \cdot yr^{-1}$ average precipitation) on a sandy loam soil. These sites represent two distinctly different climatic and environmental conditions. The images of the turfgrass species in *Figures 2-5* were taken during late summer 2012, which was an extreme drought year. The plots were managed to receive varying amounts of water from 80 percent ET to 0 percent ET (irrigation at 80 percent ET is equivalent to well-watered). Irrigation occurred daily (except during rainfall events).

Table I. Estimated water requirement (100 percent ET) of typical home lawns in western and eastern Nebraska during select months.

	Water amount (inches·week^{-1})	
Month	*Western Nebraska*	*Eastern Nebraska*
April / May	1.0 - 1.25	0.75 - 1.0
June	1.25 - 1.5	1.0 - 1.5
July	2.0 - 2.25	1.5 - 2.0
August	1.25 - 1.5	1.0 - 1.5
September / October	1.0 - 1.25	0.75 - 1.0

Turfgrass Species

Kentucky bluegrass has good ability to withstand drought stress (*Figures 2a* and *2b*). Although this cool-season turfgrass is shallow-rooted (most of the roots are concentrated to the top 6 to 10 inches of soil when mowed regularly and at lawn height), the grass has the ability to enter summer dormancy under water stress. It will stay green with irrigation in Nebraska summers. Kentucky bluegrass may require 1.0 to 1.75 inches of water per week to stay healthy and green during the hottest part of summer in Nebraska, but water needs depend on temperature, soil type and compaction, wind speed, previous turf management practices, mowing height, and many other factors. Therefore, each lawn will have slightly different water requirements.

If the objective is to keep the crowns alive while allowing the grass to go dormant, 0.25 inches every three to four weeks should suffice. Kentucky bluegrass spreads by rhizomes and will recover quickly if damaged, especially if properly fertilized and irrigated in the fall.

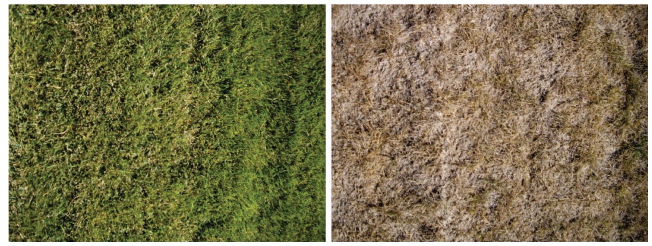

Figure 2a. Four-Season Kentucky bluegrass at Gering at 80 percent ET on the left, 40 percent ET on the right. (Photos for *Figures 2-5* courtesy of Scott Dworak)

Figure 2b. Four-Season Kentucky bluegrass at Mead at 80 percent ET on the left, 40 percent ET on the right.

Tall fescue is a cool-season turfgrass that has a deep, extensive root system capable of reaching 3 feet or more in depth if soil conditions allow. The deep root system can take advantage of moisture deeper in the soil profile than more shallow-rooted turfgrasses, such as Kentucky bluegrass. Tall fescue is generally regarded as "drought tolerant," but under ideal growing conditions it has higher ET rates than Kentucky bluegrass (*Figures 3a* and *3b*). Typical water-use rates are 2.0 to 3.5 inches per week during the growing season. Tall fescue is

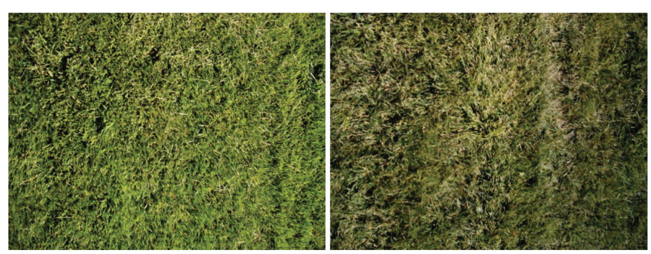

Figure 3a. Spyder LS tall fescue at Gering at 80 percent ET on the left, 40 percent ET on the right. (The yellow appearance in the 80 percent ET turf is due to iron chlorosis, induced by relatively high soil pH.)

Figure 3b. Spyder LS tall fescue at Mead at 80 percent ET on the left, 40 percent ET on the right.

considered a bunch-type grass, but some newer cultivars have short rhizomes and are termed rhizomatous tall fescue (RTF) or lateral spreading (LS) cultivars. This characteristic gives LS cultivars a slight recuperative advantage over traditional tall fescue cultivars, but has no effect on drought tolerance. Older cultivars, notably Kentucky-31, tend to develop wide-bladed regrowth when stressed. The natural difference in blade width adversely affects uniformity and turf visual quality when Kentucky-31 is inter-planted into Kentucky bluegrass or other fine-bladed varieties.

Perennial ryegrass is a cool-season, bunch-type turfgrass. It is has a shallow root system, limiting its ability to withstand prolonged drought (*Figures 4a* and *4b*), plus it is a bunch grass and cannot spread into voids if it does survive drought. It will require more water on average than Kentucky bluegrass throughout the growing season. It also is susceptible to many diseases and has poor winter hardiness in Nebraska. It produces large seeds that germinate quickly, usually in less than a week under favorable conditions. These attributes make it ideal for quick and short-term repair of damaged turf areas. It mixes well with other medium- and fine-bladed turf species, such as Kentucky bluegrass or tall fescue, making it ideal for repairing small areas.

Figure 4a. Caddieshack perennial ryegrass at Gering at 80 percent ET on the left, 40 percent ET on the right. (The yellow appearance in the 80 percent ET turf is due to iron chlorosis, induced by relatively high soil pH.)

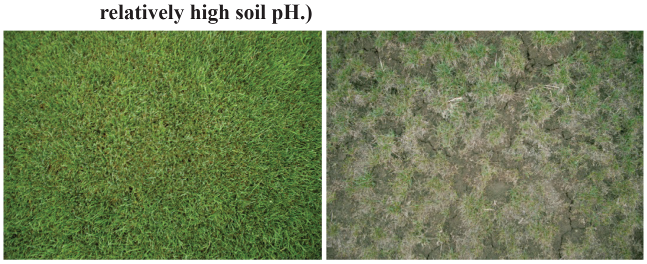

Figure 4b. Caddieshack perennial ryegrass at Mead at 80 percent ET on the left, 40 percent ET on the right.

Buffalograss is a warm-season turfgrass. It is native to Nebraska and has evolved under drought conditions for centuries. Buffalograss has a deep, extensive root system and has excellent drought tolerance (*Figures 5a* and *5b*). Typical water-use rates can be as low as 0.25 to 0.75 inches per week; however, under favorable soil moisture conditions buffalograss can use as much water as Kentucky bluegrass. In western Nebraska, buffalograss will still need supplemental water during the summer months to maintain growth and green color. Like most warm-season species, buffalograss has a relatively long winter dormancy period. It often enters dormancy with the first hard freeze in the fall, reducing the effective growing season by three to four months compared with cool-season species. This long dormancy of buffalograss is desirable to some homeowners and undesirable to others. When cool-season grasses are actively growing during April and May, buffalograss is still dormant, conserving soil moisture instead of using water. Under favorable moisture, buffalograss and Kentucky bluegrass have relatively the same water use requirement, but with a shorter growing season buffalograss has the potential of using 12 to 16 inches less water in a growing season than Kentucky bluegrass. However, buffalograss can be managed with very low inputs (mowing, irrigation, and fertilization) after establishment and thus is attractive to homeowners seeking low-input lawns.

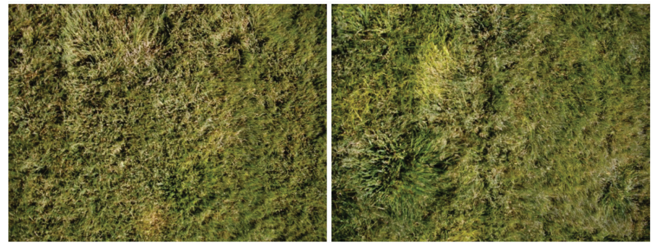

Figure 5a. Bowie buffalograss at Gering at 80 percent ET on the left, 40 percent on the right.

Figure 5b. Bowie buffalograss at Mead at 80 percent ET on the left, 40 percent on the right.

Microclimates and Areas Prone to Drought Damage

Within the landscape, certain areas are more prone to water stress before the majority of the lawn exhibits symptoms. Turf areas with nonuniform water application plus soil variability caused during construction will show stress earlier. Turf areas greater than 5 percent slope will also show early stress, especially those areas that face south and west. Turf exposed to full sun will show symptoms before areas that receive shade. Other potential trouble spots are areas next to cement drives and sidewalks. The cement transfers heat into the nearby turf, causing increased temperatures and greater ET. Areas near sidewalks or driveways may also have a thinner layer of topsoil because the sand base used for the walks may not have been removed before topsoil was applied. Instead of watering the entire lawn for longer periods of time, these areas should be hand-watered or additional sprinkler heads should be installed to supply more water to the trouble areas. Obstructions such as buildings, hedgerows, windbreaks, and other objects can reduce wind speeds, helping to reduce ET. Also, wind can transfer heated air from above nearby parking lots and other similar surfaces to turf (a process called advection), increasing air temperature and ET rates.

Soil type has a significant effect on the amount of moisture that can be held in the soil and how quickly that water can be absorbed (*Table II*). Sandy soils are coarse-textured, have good infiltration, are well-drained, but have relatively low water-holding capacity. Silty and clay loam soils have a high water-holding capacity but have slower infiltration and drain relatively slowly. Loam soils exhibit intermediate texture, water-holding, and drainage characteristics.

The following are some general tips for managing turf under all conditions and especially in preparation for drought:

- Adjust expectations. Dark green turf is not the healthiest turf. Reducing irrigation can be done on most lawns without adverse effects on the turf.
- If puddling or runoff occurs during irrigation, stop watering, wait one to two hours for the water to infiltrate the soil, and then resume irrigation.

Table II. Available soil moisture and infiltration rates for main soil textures

Soil texture	Soil type	Plant-available moisture per foot of soil depth (inches)	Depth (inches) penetrated by 1 inch of water	Infiltration rate (inches·h^{-1})
Light, sandy	Coarse sand Fine sand	0.7 0.9	16	Fast (0.50 - 3.0)
Medium, loamy	Fine sandy loam Silt loam, loam	1.5 1.9	8	Moderate (0.25 - 0.50)
Heavy, clay	Clay loam, Silty clay loam Clay	2.1 2.0	5 - 6	Slow (0.10 - 0.25)

Adapted from Emmons, R.D. 2000. Turfgrass science and management, 3rd ed. Delmar Publishers. Albany, NY.

- Irrigate to wet the soil to the depth of rooting and then do not irrigate again until the lawn shows the first signs of drought stress. This wilt-based approach increases rooting depth and decreases ET. The deeper roots make the turf better equipped to face future drought periods.
- Employ a deficit irrigation strategy. Turf can usually survive with far less irrigation than generally applied. The following are general recommendations. In western Nebraska, buffalograss health can be maintained at 40 to 50 percent ET. For Kentucky bluegrass, irrigate 70 to 80 percent ET. Slightly lower rates can be used, but turf quality will decline. In central Nebraska, 65 to 75 percent ET can maintain Kentucky bluegrass, tall fescue, and buffalograss with little drop in visual quality. In eastern Nebraska, 60 to 70 percent ET can suffice. Evapotranspiration rates differ across the state (*Table 1*).
- Early morning irrigation is best. Irrigating at or just before sunrise will maximize efficiency of delivery and reduce potential for disease.
- Maintain a high mowing height. A year-round mowing height of 3 inches or higher is recommended for most lawns. Turfgrass maintained at higher mowing heights has a deeper root system. The deeper roots will be able to acquire water more easily, especially when water is limited. While longer leaf blades will exhibit more water loss due to ET, the deeper root system benefits will outweigh those effects.
- Never remove more than 1/3 of the leaf blade when mowing. Removing excess leaf tissue will stress the turf and reduce rooting.
- Mow during the early morning or evening. The turf is least stressed during these periods.
- Keep the lawnmower blade sharp. Using a dull blade can cause jagged wounds in the leaf blades and can result in 30 to 50 percent more water loss.
- Reduce nitrogen fertilizer rates. High nitrogen causes turfgrass to grow quickly, but it uses more water. Lush leaf blades from high fertility will be more prone to wilting during drought. Apply most of the nitrogen in the fall for cool-season grasses and in the early summer for warm-season grasses to maximize rooting and minimize top growth.
- Don't let thatch get too thick. Deep thatch layers cause shallow rooting and slow water penetration into the soil. Remove thatch layers with a vertical mower or power rake when they are greater than ½ inch thick. Vertical mowing of Kentucky bluegrass should be done in late summer or early fall, but other species will likely not require dethatching.
- Aerate your lawn. Soil compaction and thatch reduce water infiltration rates and can cause runoff. Aeration, or core cultivation, reduces compaction, allowing for greater water penetration into the soil profile and increased root growth.
- Reduce turf traffic. Foot, lawnmower, or other vehicular traffic can cause serious injury to drought-stressed turf.
- If establishing a new lawn, use drought-tolerant species and cultivars. Buffalograss is an excellent choice for Nebraska. It performs well in very little rainfall, has a relatively deep root system, low ET rates, and excellent ability to tolerate and recover from drought.
- Don't irrigate when it's going to rain. If the weather forecast predicts rain in the near future, irrigation may not be necessary.

Resources

Fertilizing Home Lawns, Publication Turf 2012f, *http://turf.unl.edu/pdfcaextpub/HomeLawnFertilization2012f.pdf*

Tall Fescue Management Calendar, NebGuide G558, *http://www.ianrpubs.unl.edu/sendIt/g558.pdf*

Kentucky Bluegrass Management Calendar, NebGuide G517, *http://www.ianrpubs.unl.edu/sendIt/g517.pdf*

Buffalograss Management Calendar, NebGuide G2178, *http://www.ianrpubs.unl.edu/sendIt/g2178.pdf*

Choosing Grasses for Lawns in the Northern Great Plains, Publication Turf 2012k, *http://turf.unl.edu/pdfcaextpub/Grassesforlawns2012k.pdf*

Irrigating Home Lawns, Publication Turf 2011a, *http://turf.unl.edu/pdfcaextpub/homelawnirrigation2011a.pdf*

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