How to improve short-term drought stress tolerance

by Christopher Sann

AS MANAGEMENT of our nation's water resources becomes an increasing priority, turfgrass managers will need to pay more attention to strategies and materials designed to improve the ability of turf to survive short-term drought stress. By improving the turf's ability to survive short periods of drought, lasting up to six weeks, turfgrass managers can reduce their reliance on supplemental or increased irrigation. Increasing a turf's ability to survive and reducing the reliance on supplemental irrigation can also help reduce the number and frequency of root and leaf damaging diseases.

As turf grass management practices have become more sophisticated, a group of management strategies and specific applied materials has been identified as helping to maintain or improve root mass and, thereby, improving drought stress survivability. These various approaches can be classified into two groups: those that improve the soil and root environment—to allow the turf to respond to the more favorable growing conditions—and those materials that either reduce the turf's need for water or stimulate root growth.

Management strategies that have shown to improve drought stress tolerance by improving the soil environment are

- CORRECTING SOIL NUTRIENT IMBALANCES,
- INCRASING SOIL AVAILABLE CALCIUM LEVELS,
- REDUCING EXISTING COMPACTION,
- REDUCING THATCH LEVELS,
- AVOIDING COMPACTION DEVELOPMENT,
- AND IMPROVING SOIL STRUCTURE.

Materials that have shown an ability to improve drought tolerance by reducing the turfs' water needs are

- SOIL WETTING AGENTS,
- FUNGICIDES THAT REDUCE root damaging diseases,
- INSECTICIDES THAT CONTROL root damaging insects,
- SUPPLEMENTAL IRON APPLICATIONS,
- SUPPLEMENTAL PHOSPHORUS APPLICATIONS,
- AND HIGH POTASSIUM FERTILIZATION.

Materials that stimulate root growth include products such as Roots® and Roots with Iron® and fungicides such as Bayleton® and Banner®.

How to get started?

THE FIRST STEP to solving a turf stand's drought stress problem is to identify the condition or conditions that are contributing to the turf's inability to tolerate short periods of drought *(see page 9 for Drought Stress Identification Form)*. The reason or reasons that a particular stand of turf is having problems will vary from one site to another and may vary within a specific site *(see table on this page)*.

Contributing conditions affect the root mass in different ways

ROOT DAMAGING DISEASES AND INSECTS can cause a massive loss in the number of roots and root hairs. When the total root biomass falls below a critical level and the turf is drought stressed, the root structure is no longer able

CONDITIONS THAT CAN CONTRIBUTE TO SHORT-TERM DROUGHT STRESS

The following is a partial list of conditions that—in combination with reduced rainfall, excessive heat or both—can contribute to short-term drought stress.

- Root damaging diseases
- Root damaging insects
- Soil layering
- Thatch depth greater than 1/2 inch
- Soil compaction
- Poor soil construction
- Nutrient imbalances in soil chemistry
- Poor soil particle structure
- Shallow topsoil mass
- Poor water percolation
- Poor species or variety choices
- Light frequent irrigation

All these conditions have a detrimental effect on a turf stand's root biomass.

to provide sufficient water to the crown and foliar sections of the plant, causing it to wilt and, if prolonged, to die.

Poor soil chemistry—with its nutrient imbalances and restricted nutrient availability—causes poor general plant health. At this reduced level of health, the turf does not "repair" itself well. When up to 80% of the root biomass of turf is replaced each year, this inability to replace all of the previous year's lost root structure leaves the turf vulnerable to short-term drought stress. Poor soil chemistry, if allowed to continue, will not only adversely affect the turf, but will lead to a deterioration of the soil structure. As the highly soluble available calcium levels drop, the soil particle flocculation and granulation, that occurs under high calcium and humic acid levels, deteriorates, causing the soil pore spaces to fill with smaller soil particles—severely restricting the growth of turf roots. Under severe conditions a layer of these finer particles, called a pan, can form, causing an impenetrable subsoil layer—with all of the accompanying water percolation and root damaging disease problems.

Poor soil construction, either native soils that are simple aggregates with no soil particle flocculation, poor soil pore structure and reduced nutrient holding capacity or poor site preparation, caused by using large soil compacting earth-moving machinery, can produce a hostile growing medium leading to poor plant health and drought stress vulnerability.

Soil layering, either naturally occurring, as a developed pan, or man-made, if it occurs in the top 3–4 in., is frequently a problem for which there are no good answers. Layering in the root zone—with its dramatically restricted root biomass—often makes the turf highly vulnerable to short-term drought stress.

Soil compaction—caused by either excessive traffic or the chemical formation of a pan—is known for the detrimental effects that the reduced pore spaces have on the growth of a root structure. Mechanical cultivation, where appropriate—in combination with gypsum and wetting agent applications—can help reduce the drought stress vulnerability.

Poor species choices, such as the use of fine fescues in normally wet areas, can leave the turf highly vulnerable to both short-term and long-term drought stress. Frequent or daily waterings can lead to chronic low level root-damaging disease infestations that are not severe enough to be symptomatic, but can dramatically reduce the root biomass, making the turf drought stress vulnerable.

Is the condition correctable?

ONCE THE TURF GRASS MANAGER has identified the contributing conditions, it is important to decide if the conditions are correctable and, if so, how is that accomplished?

There are some circumstances that, for all practical purposes, are not correctable. It may be possible to reduce some adverse effects of these conditions, but often the only solution to these problems is to adjust the irrigation patterns, where supplemental irrigation is available—or to periodically reseed, with the most drought resistant species available, where supplemental irrigation is not practical.

Soil layering, with underlying impermeable layers of clay or stone and a shallow soil mass, are prime examples of conditions that are difficult to correct.

Soil layering, with underlying impermeable layers of clay or stone and a shallow soil mass is a prime example of a condition that is difficult to correct. In the case of deeper impermeable layering (4–6 in. down), wetting agents and root protecting fungicide applications supplemented with periodic applications of root growth stimulating compounds may help limit drought stress damage, but often reconstruction of the site is the only proper solution. In the case of shallow impermeable layering (down to 4 in.) and shallow soil mass (less than two inches) these techniques will only help for short periods and reconstruction is the best solution.

Other conditions that may be difficult to correct or require a long-term management strategy are poor soil construction, with its reduced soil pore spaces, poor soil particle distribution, such as that which occurs in high sand soils or in the case of a developing pan, and poor soil moisture percolation, which occurs in areas with poor or restricted subsoil water flow patterns. In these cases, identifying the problems for each site and the severity of its effects on the turfgrass stand should provide the clues to whether the problem can be managed, corrected or ignored.

Correctable or partially correctable conditions include inappropriate species, frequent watering, high thatch levels, poor soil chemistry, poor soil construction, soil compaction, poor water percolation and root damaging diseases and insects.

Root damaging disease

ROOT-DAMAGING DISEASES CAN BE DIFFICULT to deal with, particularly because it is not uncommon to have one or more active diseases present—often with no gross visible symptoms. The occurrence of a transient root-damaging disease infestation, the severity of that infestation and its duration can be difficult to predict, because it often depends on adverse weather conditions. Transient infestations may only become a drought problem if they occur on turf that is already under stress from other sources. All of the root damaging diseases that affect cool season turf are candidates for this type of transient infestation, and the decision whether to control the infestation should be made after checking the weather forecast and deciding how much damage is acceptable at that site.

Chronic root-damaging disease infestations are often the byproduct of other long-term drought stress conditions such as layering, poor soil pore space structure, poor soil percola-

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Turf Grass TRENDS

DROUGHT STRESS IDENTIFICATION

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COMPANY NAME

NAME OF SITE ____________________________ APPROXIMATE AREA: _______ ft. x _______ ft.

SURVEYED BY ____________________________ DATE OF SURVEY ______ / ______ / ______

Contributing conditions	Problem	Primary condition	Secondary condition	Recommended action(s)
SOIL	**Thatch** *Use soil probe to examine sample*	❑ Decomposed	**❑ All depths**	❑ Core/aerate, add wetting agent
		❑ Undecomposed	**❑ < 1/2 in. deep**	
			❑ With root invasion	❑ Verticut & add wetting agent
			❑ Poor roots	❑ Verticut & add wetting agent
			❑ Without root invasion	❑ Dethatch (multiple passes)
			❑ Good roots	❑ Dethatch (multiple passes)
			❑ > 1/2 in. deep	
			❑ With root invasion	❑ Verticut, core/aerate & add wetting agent
			❑ Poor roots	❑ Verticut, core/aerate & add wetting agent
			❑ Without root invasion	❑ Dethatch (multiple passes for multiple years)
			❑ Good roots	❑ Dethatch (multiple passes for multiple years)
SOIL	**Soil Layering**	❑ <4 in. deep	❑ Impenetrable	❑ Overseed & watering
			❑ Penetrable	❑ Deep core & heavy wetting agent application(s)
		❑ >4 in. deep	❑ Impenetrable	❑ Overseed & water, add root-protecting fungicide(s)
			❑ Penetrable	❑ Deep shatter aerations & heavy wetting agent application(s)
SOIL	**Soil Compaction**	❑ <3 in. deep	❑ Light to medium	❑ Check soil chemistry, add wetting agent(s)
			❑ Medium to heavy	❑ Coring, check soil chemistry, add wetting agent(s)
		❑ >3 in. deep	❑ < 6 in. deep	❑ Re-direct traffic, add wetting agents(s)
SOIL	**Shallow Top Soil Mass**	❑ < 2 in. deep		❑ Add 2-4 in. topsoil, overseed, water
		❑ > 2 in. deep	❑ < 4 in. deep	❑ Same as above & add root-stimulating compounds
SOIL	**Poor Soil Construction**	❑ < 3 in. deep		❑ Add soil and humus, then till to > 6 in. deep
		❑ > 3 in deep	❑ < 6 in. deep	❑ Add wetting agent(s) & do deep shatter aeration
SOIL	**Poor Particle Construction or Distribution**	❑ < 3 in. deep		❑ Check soil chemistry, raise calcium levels, core & add wetting agent(s)
		❑ > 3 in deep	❑ < 6 in. deep	❑ Same as above
EXTERNAL	**Root damaging Diseases**	**❑ Pythium**	**❑ Warm season**	❑ Apply fungicide(s) for prevention
			❑ Leaf & crown damage	❑ Apply fungicide(s) for prevention
			❑ Cool season	❑ Apply fungicide(s) & root stimulating compounds
			❑ Root rot	❑ Root rot apply fungicide(s) & root stimulating compounds
		❑ Necrotic Ring Spot	❑ Chronic	❑ Add wetting agent(s), fungicide(s) for prevention & root stimulating compounds
			❑ Acute	❑ Apply fungicide(s) at recommended cure rate & root stimulating compounds
		❑ Summer Patch **❑ Take All Patch** **❑ Other Root/ Crown Rots**	❑ Chronic	❑ Apply fungicide(s) for prevention, add wetting agent(s) & root stimulating compounds
			❑ Acute	❑ Apply fungicide(s) at recommended cure rate & add root stimulating compounds
EXTERNAL	**Root Damaging Insects**	❑ Grubs	❑ Occasional	❑ Monitor & treat as needed
			❑ Acute	❑ Apply appropriate insecticide at recommended rate
CULTURAL	**Wrong species**	❑ Fine Fescue	❑ Site changed from shady to sunny	❑ Renovate area
			❑ Site changed from dry to wet	❑ Overseed with bluegrass or tall fescue
		❑ Blugrasses	❑ Site changed from normal to dry	❑ Overseed with tall fescue
CULTURAL	**Watering**	❑ Light, frequent irrigations		❑ Increase amount of water per irrigation
				❑ Decrease frequency of irrgations

tion or any other condition that increases the time water spends in the root zone of the turf. This type of infestation can be very detrimental to the long-term health of a turf stand as well as causing short-term drought stress vulnerability, because, as new root tissue is formed, it is damaged or destroyed by the chronic infestation. Both Necrotic Ring Spot and the Pythium species, as cool season root rot or warm season blights, have been identified as causing chronic infestations. Control of chronic infestations requires that the other contributing factors be controlled, as well as a disease management strategy that coordinates long-term preventive fungicide applications with the use of wetting agents and root growth stimulating compounds.

Poor water percolation through deep impermeable subsoil layers or because of poor subsoil water flow patterns can be very difficult to correct.

Root damaging insects can do considerably more damage to root biomasses in short periods of time than root damaging diseases. However, depending on the species of insect, their infestations are relatively easy to predict and, therefore, easy to prevent—with timely applications of the proper insecticide. If insect infestations have not historically posed a consistent problem, then close monitoring of populations may be all that is necessary.

High thatch levels pose multiple problems. The thatch layer is an ideal breeding area for diseases and insects, and it frequently becomes invaded with turfgrass roots. This root invasion can become a serious problem if the underlying soils are dense or have poor structure. When the largest portion of the root biomass is in the thatch layer, the turf is highly susceptible to short-term drought stress.

Correcting a root-invaded thatch problem can be difficult. First, there is the expense and time to dethatch the site. Often dethatching must be spread out over several seasons to obtain the best results. Then there is the problem of identifying the cause or causes leading to the high thatch levels.

The classic definition of a thatch accumulation—developing where excess material is not being decomposed by the available soil bacteria at a fast enough rate—begs the issue. The most appropriate question is "Why was the excess material being deposited, in the first place?" Most often the answer to that question is low level or chronic disease infestations combined with the over-use of quick release nitrogen sources.

Poor soil chemistry, poor soil particle construction and to some extent soil layering, where a pan is involved, can be corrected by an aggressive soil testing and amendment application program. Establishing and keeping a good balance of available calcium and magnesium is beneficial not only to general plant health, but also to good soil particle structure by maintaining good soil particle flocculation and granulation. Also it will benefit good soil particle distribution by preventing the deposition of smaller soil particles in established soil pore spaces and the eventual formulation of layering as a pan. Keeping a high level of available calcium in relation to a lower level of exchangeable magnesium will help to keep all of the variously sized positively charged soil particles in suspension and avoid the settling-out process that loss of calcium produces. This is a particular problem with sandier soils, and should be monitored with yearly soil tests and amendment applications.

Soil compaction is the mechanical compression of the soil mass solids, which reduces the pore spaces from their nominal 25% of the soil mass down to five to 10%. This reduction in pore spaces causes a dramatic reduction in the normal growth of root structure. The best solution to soil compaction is to avoid the excessive traffic that causes the problem. The use of mechanical cultivation with core and shatter aeration, in combination with applications of wetting agents and root stimulating compounds, can reduce the effects of the compaction. Also, periodic applications of gypsum—a pH neutral source of available calcium—should be made.

Poor water percolation through deep impermeable subsoil layers or because of poor subsoil water flow patterns can be very difficult to correct. The high and prolonged root zone moisture levels that result from this problem will often cause root loss, because of suffocation from lack of oxygen or by prolonged contact with toxic waste byproducts that are flushed from the root zone with normal percolation. These effects can be reduced by the heavy and consistent use of soil wetting agents and/or, where practical, by the use of the new deep penetrating coring or shatter aeration.

Poor species or varietal selections can be identified and corrected by renovation, overseeding or management practices that favor other species in the turf stand. Light frequent watering practices often instituted to avoid short-term drought stress can often become a problem themselves by keeping the root zone soil moisture levels to high. This practice can be changed to deeper less frequent practices as the other contributing problems are corrected.

Controlling the conditions that cause short-term drought stress should be common goal

THE SUCCESS THAT EACH TURFGRASS MANAGER has in identifying and controlling short-term drought stress vulnerability will vary from site to site and condition to condition. And the amount of reduced supplemental irrigation will often depend on the cooperation of the weather, but any management strategy should be persued that can ultimately reduce the amount of time, money, and resources. ■