TURFAX™

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INFILTROMETER SPECIFICATIONS

I frequently get questions regarding how to build a infiltrometer. Infiltration is the downward entry of water into the soil. The water infiltration rate on turfgrass sites can be determined by measuring the rate of decline of ponded water within rings. This is the only relatively simple technique now available for turf managers. The following are some guidelines derived from soil physicists that can be used in constructing an infiltrometer. First it must be a **double ring** infiltrometer. The inner ring should have a diameter of **12 to 18 inches** (300 to 400 mm), while the outer ring should have an approximate diameter of **24 to 40 inches** (600 to 1,000 mm). The rings are preferably made of metal with a wall thickness of 1/16 to 1/8-inch (1.6 to 3.2 mm), or could be made from thick-walled PVC. The edge of the two rings entering the soil should be beveled to help cut through the turf and into the soil with minimal disruption. The heights of the rings are typically in the range of **6 to 8 inches** (150 to 200 mm) and are driven through the turf and into the soil to a depth of **1- to 2-inches** (25 to 50 mm).

A float-valve mechanism should be installed within each ring that is capable of maintaining a **1- to 2-inch** (25 to 50 mm) water depth. There also should be a reliable source of water. It is important that the water heights be kept as equal as possible in both rings so the water moves into soil at a uniform rate. The head of water should be maintained for a minimum of **30 minutes,** and up to 60 minutes, before any readings are taken. The procedures for readings may involve using a float valve to measure the decrease in water volume within the ring over a time interval. An alternate technique is to attach a container of known volume to the inner ring and to measure the time required for the water to be used.

Careful installation of the rings is essential to achieve as accurate a measurement as possible. It is important to minimize "bypass flow" along the edges where the rings have cut through the turf thatch or mat.

Even when made by well-trained scientists, replicated infiltration rate measurements exhibit considerable variability within an individual turf site. Thus, the infiltration measurements should be considered rough estimates. Obviously the larger number of replicated readings made per site, the more representative the results. Also, any diameter smaller than **12 inches** (300 mm) is more affected by lateral flow outward from the ring perimeter.

JB COMMENTS - CHEMICAL USE

In this issue there is reference to the tendency of turf managers to simply pull chemicals, particularly fungicides, off the shelf as summer-kill problems start to appear without proper diagnosis of the actual cause. Some of these fungicides are being applied at intervals as short as every two days. The excess applications may involve a separate chemical and in some cases the fungicides are being mixed with other chemicals.

The question that is not being raised and for which adequate published research information is lacking is what effects these intense chemical fungicide applications have on turfgrass phytotoxicity. Researchers who assess herbicides routinely characterize them in terms of potential phytotoxicity. Rarely is any mention made of the potential phytotoxicity from fungicides. There is the possibility that injury is occurring, especially during summerkill periods.

Just what is the safety or selectivity of the various fungicides when used intensively during periods of heat stress? What are the potential problems in terms of (a) leaf chlorosis, (b) actual leaf tip necrosis, (c) stomatal closure and resultant loss of turf from heat stress, and (d) injury to the root system, especially the very sensitive but critically important root hairs? There is a need for definitive research addressing these potential problems. It is my "guess" that under summer stress conditions turfgrass injury may occur.

Equally important is the question of what effects very intense fungicide use has on the beneficial soil organisms, encompassing fungi and microorganisms. Does intense fungicide use so disrupt the balance of beneficial and potential pathogenic soil organisms such that future development of serious turfgrass diseases is actually increased and as a result that an even greater intensity of fungicide applications will be required? Obviously we need some answers to these serious issues.

NEW PUBLICATION AVAILABLE

Managing Turfgrass Pests. by authors Thomas L. Watschke, Peter H. Dernoeden, and David Shetlar. Lewis Publishers. 361 pages. (1994).

This book is a comprehensive reference text on turfgrass pests organized in three sections of (a) weeds, (b) diseases, and (c) insects and mites. Emphasis is placed on developing an understanding of the conditions under which individual pests become active in damaging turfs and the environmental manipulations and cultural practices that can be used in minimizing the potential for injury. It encompasses pest problems on both cool-season and warm-season turfgrasses. There are 24 pages with 94 full-color photographs, plus 160 detailed drawings. The book is part of the Advances in Turfgrass Science Series. Price U.S. $69.95.

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JB VISITATIONS

Montreal - July

Presented an invited lecture before the Annual Conference of the American Association of Botanic Gardens and Arboreta (AAGBA). The specific invitation was to present information on grass selection and cultural practices that will minimize the adverse environmental effects of turfgrasses. My approach, of course, was to utilize the research information developed in the last 5 years concerning the actual benefits derived from turfgrasses in protecting the quality of our environment in terms of water conservation, ground water quality, surface water quality, and human health.

This was a key group before which to present this type of information, as they have contact with large numbers of the general public. Most in attendance had only been exposed to the allegations of activists. It was interesting to observe their reaction and to hear their comments after the presentation. They had assumed based on popular press information that turfgrasses presented many problems. Most were pleased to hear about the benefits of turfgrasses and to learn of the research that not only disproves most of the allegation, but in fact supports major benefits that can be derived from the use of turfgrasses.

Tennessee - August

Visited golf courses in the transitional climatic region that had been subjected to a very adverse summer of extraordinarily high temperatures and high humidities over a sustained period of time. Much of this time there also was a lack of wind movement. Mid-August soil temperatures at a 1-inch (25-mm) depth were monitored in the range of 103 to 107°F (39 to 42°C) on bentgrass putting greens. I should note that in 18 years of turf research at Texas A&M University where soil temperatures of putting greens were monitored continuously, there was only one time for a period of 10 days when the temperatures exceeded 100°F (37°C), and even during that time never exceeded 102°F (39°C).

Obviously, much grass has been lost on closely mowed turfs this summer, especially on golf courses in the United States. Based on a number of phone calls, too many golf course superintendents have been attempting to solve the problem by an uninformed shot-gun approach of pulling chemicals off the shelf for application. When one fungicide didn't work, another one was applied in a couple days, if that one didn't work then another one was applied in another couple days. Why? This approach makes no sense.

It is important to make a proper diagnosis as to the cause of the problem. Interestingly, when I asked the question of these golf course superintendents as to what the soil temperatures were on their greens, they had not made any measurements. Also, they had no history of measurements from previous years in order to have a reference base to determine whether the temperatures being experienced in 1995 were significantly higher, and thus a more likely cause of the problem. Turf managers must realize there is a point at which high temperatures have a lethal effect on cool-season turfgrasses. No amount of fungicides can prevent this from occurring. For more about this situation see the feature article in this Turfax™.

UPCOMING JB VISITATIONS

Provided for Institute Affiliates who might wish to request a visitation when I'm nearby.

- September 5 to 12 - Portland, Oregon.
- September 26 to 28 - Columbus, Ohio.
- October 1 to 9 - Italy and Europe.
- October 13 to 21 - Japan
- October 28 to Nov. 1 - St. Louis, Missouri.

MONITORING TEMPERATURES

Basically, temperature assessment involves measurement of the thermal energy of a body. There are three basic vertical zones where temperature monitoring can be conducted on turf areas. They include (a) the above-ground air or atmospheric temperature, (b) the turf canopy temperature, and (c) the below-ground soil temperature. Air temperatures can be measured at 5 feet (1.5 m) and 0.5 inch (13 mm) over the canopy, while soil temperatures are monitored at 1.0 and 4.0 inches (25 and 100 mm) below the soil surface; and a sensor also can be placed within the actual canopy, being sure it is fully shaded by the turfgrass shoots. Note that 5 foot is the height at which the US Weather Bureau monitors and reports temperatures.

There are two basic components of the temperature monitoring system, (a) the sensor, and (b) the allied monitoring system. The monitoring system may involve instantaneous measurements with a standard thermometer, involving either direct reading or a dial. A second type of sensor involves a thermocouple connected to a instantaneous readout digital unit or to a continuous monitoring-recorder system. The thermocouple is the simplest, most reliable, and least costly sensor for continual monitoring. It typically involves a 0.5 mm diameter copper-constantan wire with silver-soldered junctions.

The atmospheric monitoring thermocouples should be shielded or shaded from solar radiation and ventilated via an aspirated device providing minimum air movement of 0.5 meter per second (1.6 feet per second).

In the case of the soil temperature sensor, it should be inserted at the prescribed depth in a horizontal orientation into an undisturbed plane through an opening made in the turf-soil profile.

For the instantaneous measurement of leaf canopy temperatures, there are light-weight portable, infrared thermometers available with digital readouts. They will indicate a developing turfgrass stress problem via an increase in canopy temperature before actual visual purpling of the turf occurs. Thus, it provides an earlier warning system. Note - it is difficult to measure leaf canopy temperatures with contact sensors because of the inability to achieve intimate contact with the leaves while at the same time avoiding direct solar radiation exposure.

Finally, as with any monitoring sensor they should be periodically calibrated for accuracy. This should be done at least annually, and perhaps more frequently depending on the intensity and severity of use.

TIFTBLAIR RELEASED

Dr. Wayne Hanna, USDA Research Geneticist at the Coastal Plain Experiment Station in Tifton, Georgia, recently announced the release of TiftBlair centipedegrass [*Eremochloa ophiuroides* (Munro.) Hack.] . The key improvement in this cultivar is low temperature hardiness. He also reports that in comparison to "common" centipedegrass, TiftBlair has a faster rate of growth and better turf quality under quite low soil pH's in the 4.0 to 5.0 range. The turf color, overall visual turf quality, and spring green-up rate are similar to that for "common" centipedegrass. This new cultivar originated in 1980 from genetic changes induced by exposure of "common" centipedegrass seeds to gamma radiation.

The next step is to follow the performance of this cultivar under varying climatic, soil, and cultural conditions to determine how broad a range of adaptation it might have. Remember - four growing seasons in a replicated comparative assessment is required before final adaptation - performance conclusions can be made for a specific region.

Centipedegrass is used primarily in the warm-humid climates of southeastern United States. Does this low maintenance, warm-season turfgrass have a place in other parts of the World? Probably!

TURFGRASS HEAT STRESS: WHAT CAN BE DONE?

The summer of 1995 will go on record as one dominated by serious turfgrass environmental stresses in the central United States, ranging from the Mid-Atlantic region into the Great Plains area. It was characterized by extraordinarily high temperatures and high humidities, that were sustained for several months, plus periods where the absence of wind movement further accentuated the heat and humidity levels near the surface of the turfgrass.

Unfortunately, too many turfgrass managers attempted to correct the problem by just removing chemicals from the shelf and applying them at intervals as close as two days. This was frequently done without having properly diagnose that in fact a disease problem existed.

Apparently the turfgrass manager has difficulty accepting the possibility that the loss of turf is occurring as a result of an environmental stress such as heat. Perhaps this is due to a lack of understanding of plant stress resulting from super-optimal temperatures. Thus, the thrust of this article will be to provide an understanding of heat stress kill mechanisms and the appropriate allied terminology to use, plus approaches for minimizing heat stress.

Heat or high temperature stress is most commonly a problem with C_3 cool-season turfgrasses. Attempts to extend these grasses into the transitional and warm climatic regions further accentuate the problem. For example, creeping bentgrass (*Agrostis stolonifera* var. *stolonifera*) is being extended beyond its normal limits in terms of heat stress.

Lethal heat stress results from the destruction of the critical protoplasm proteins in living cells. Injury is first observed in shoot cross sections at the junction of the leaf blade and leaf sheath of the second and third youngest leaves. Plant death occurs at temperatures of 106°F (41°C) and higher, depending on the particular turfgrass species and cultivar. The most critical heat pool affecting the turfgrass plant is the soil temperature. Thus, heat stress is more likely to occur later in the summer after soil temperatures are raised to their peak levels. The heat hardiness of turfgrasses is reduced (a) when grown under shaded environments, (b) by excessive nitrogen (N) levels, (c) deficiencies of potassium (K), and (d) older plant tissues.

It is important to understand that two distinct types of heat resistance exist: (a) heat avoidance and (b) heat tolerance. **Heat avoidance** is the ability to sustain tissue temperatures below lethal heat stress levels via transpirational cooling. The higher the evapotranspiration rate of a cultivar, the greater the heat avoidance, assuming adequate rooting can be sustained for water uptake. In contrast, **heat tolerance** is the internal physiological ability of the plant to survive high internal tissue temperatures.

Certain turfgrass cultivars that exhibit improved heat resistance in low humidity climates (such as Arizona, California, or Kansas), may fail to exhibit comparable heat resistance in humid areas (such as Florida, Georgia, New Jersey, and Tennessee) if the heat resistance is of the heat avoidance type. In contrast, turfgrass cultivars with good internal heat tolerance will exhibit heat resistance in both humid and arid climatic regions. This is an important distinction to understand.

The approaches to minimizing the adverse effects of heat stress are multi-dimensional, including the following:

1. **Proper Root Zone Modification.** Water has the highest heat accumulation ability of any material. Wet or water-saturated soils require more energy to warm up and a longer time to cool down. Thus, the construction of high-sand root zones with USGA specifications to ensure maximum drainage of excess water also reduces the level of soil heat accumulation, when compared to poorly drained, clayey root zones.

2. **Maximize Heat Stress Resistance** through proper cultural practices, such as by:

a. **High potassium (K) levels.** Potassium enhances rooting for improved heat avoidance and physiological tissue hardiness for improved heat tolerance. Chemical tests should reveal the appropriate levels in the leaf tissue and soil.
b. **Modest to minimal nitrogen (N) levels.** Sufficient tissue nitrogen levels should be maintained to ensure a healthy turfgrass plant, while avoiding excessive high levels that force leaf growth and cause a physiological reduction in heat tolerance.
c. **Minimal thatch or mat.** Preventive thatch and mat depth control enhance rooting.
d. **Cutting height elevation.** A slight height elevation, especially on putting greens, during severe heat stress periods may prove beneficial and has minimal effect on putting speed as the grass growth has been slowed.

3. **Use of Heat Tolerant Cultivars.** Bermudagrasses (*Cynodon* spp.) and zoysiagrasses (*Zoysia* spp.) are C_4, warm-season turfgrass that physiologically adapted in terms of optimum growth at temperatures of 80 to 95°F (27 to 35°C). In contrast, creeping bentgrass (*Agrostis* spp.) and annual bluegrass (*Poa annua*) are C_3, cool-season turfgrass that are physiologically adapted to optimum growth at temperatures of 60 to 75°F (16 to 24°C). The use of cool-season grasses beyond their adaptation zone may exceed the limit for survival.

Unfortunately, a number of turfgrass cultivars are being promoted as heat tolerant when in fact they are only heat avoiding in terms of the heat resistance mechanism. Thus, it is important when selecting heat-tolerant turfgrass cultivars for humid climatic regions to obtain in writing with supportive replicated research data that the cultivar has demonstrated true heat tolerance rather than only heat avoidance. It is best to obtain independent, comparative, replicated assessment data that have been conducted for a minimum of four-years duration under similar humid conditions that demonstrates significant improvements in inherent heat tolerance when exposed to high internal tissue temperatures.

4. **Syringing For Heat Stress Avoidance.** Syringing is the application of a very light amount of water in which only the leaves are wetted. It can be used for the purpose of cooling the turf canopy. It has the potential of reducing temperatures in the order of 10°F (5.5°C), if applied 1.5 to 2 hours before maximum mid-day temperatures that typically occur around 2:00 p.m. A low atmospheric humidity adjacent to the turf canopy maximizes evapotranspirational cooling. In hot, arid portions of the country, such as Arizona, syringing during mid-day heat stress has been used to maximize heat avoidance through high evapotranspiration rates. Unfortunately, this method of heat avoidance is severely restricted in regions and during periods of high humidity, and on certain days it may be of no value.

5. **Air Movement Enhancement.** Air stagnation on putting green sites, especially when surrounded by trees in the direction of the prevailing wind, accentuates the stratification of higher temperatures and higher humidities near the turf canopy. This in turn accentuates heat build-up in the root zone itself.

If a tree-shrub barrier is the primary problem, then cutting an opening in the direction of the prevailing wind may be beneficial. Air stagnation also can be significantly reduced through the mixing action achieved by mechanical fans. This author conducted the first research in the late 1950's that demonstrating the value of fans in reducing heat levels on bentgrass putting green turfs. At least a 14°F (7.8°C) cooler turf temperature can be achieved by the use of fans. Criteria to consider in selecting fans include:

(a) noise level generated.
(b) effective distance.
(c) effective pattern.
(d) oscillating versus stationary.
(e) relative unsightliness.