Turf Subirrigation — Technique of Tomorrow?

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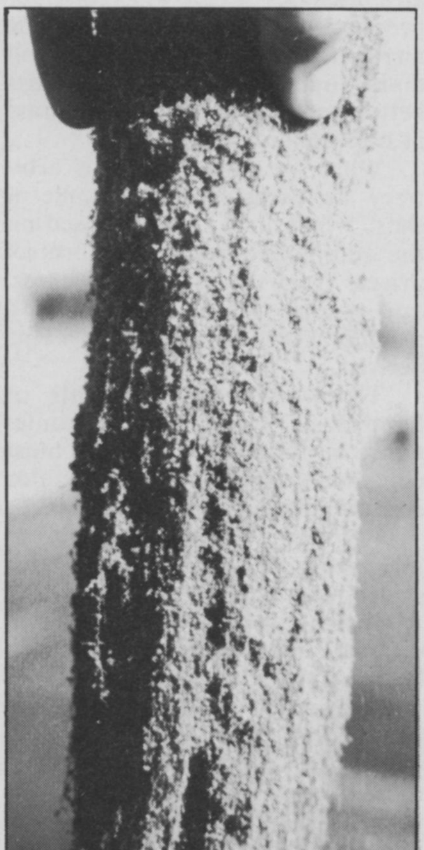
SUBIRRIGATION involves the application of water to the plant from beneath the surface. This method of irrigation supplies water for root uptake by capillary action and avoids wetting the soil surface.

Subirrigation has been shown to minimize soil compaction and reduce water usage resulting from excessive surface evaporation and runoff. The most common methods of subirrigation provide water from either: a) a constant or fluctuating water table, or b) perforated tile.

The constant or fluctuating water table system is employed by surrounding a localized area of soil with an impermeable barrier and maintaining a water table above the barrier at a desired level beneath the soil surface. This system requires that the distance between the soil surface and a level plane of the barrier be maintained constant for uniform water distribution.



Turfgrass root development was quite extensive on the subirrigation plots with a fluctuating water table.

The perforated tile method involves burial of plastic pipe or tile beneath the soil surface usually to a depth just below normal root penetration. This system supplies a specified amount of water to replenish the soil moisture reservoir, but at a very slow rate to minimize seepage loss below the root zone. Clogging of the tile and lack of uniform distribution are common problems.

The use of subirrigation has usually been limited to areas with naturally occuring high water tables. These areas are mostly in agricultural crops with the exception of some commercial sod production on organic soil. Few studies have been reported on the use of subirrigation for turf.

Early research was conducted at the University of Arizona using perforated plastic pipe.[1] They showed that subirrigation can be managed to provide good bermudagrass turf with water use similar to sprinkler irrigation.

The PURR-WICK root zone system has been developed and successfully used for irrigation of recreational turf in a temperate climate.[2]

A recent field study was conducted at the University of Arizona to evaluate the merits of subirrigation on high maintenance bentgrass turf during prolonged summer heat stress.[4] Some of the more important aspects of that work are presented herein.

Treatments included a conventional sprinkler irrigation system, subirrigation with a stable water table 12 inches below the soil surface, and subirrigation with a fluctuating water table. The fluctuating water table ranged between five (after subirrigation) and 20 inches (after depletion). Two artificial soils were used: a) a 52 percent sand, 24 percent loamite (a product formerly processed from wood by the Loamite Corporation, Santa Rosa, Calif.), and 24 percent sandy clay loam soil mixture; and b) an unamended washed mortar sand. Nitrogen was supplied by dissolving ammonium sulfate in the irrigation water before it was applied for each of the subirrigation methods.

Color, Growth and Root Development

In general, turfgrass growth on subirrigation using a fluctuating water table was similar to sprinkler irrigated plots and superior to turf produced under subirrigation with a stable water table. Turf color, as measured by chlorophyll content, was noticeably darker green on sprinkler irrigation treatments compared with both methods of subirrigation treatments. Root growth and development was measured at the end of the summer and revealed that subirrigation treatments with a fluctuating water table had the greatest amount of root development; subirrigation with a stable water table produced less root development; and sprinkler irrigation had the poorest root development.

Overall, the summer evaluations indicated that the major contribution of subirrigation and fertilization were that root development was noticeably greater and the turf did not require periodic syringing on hot windy days. The major disadvantage associated with subirrigation and fertilization practice was a lighter green turf, especially on subirrigation treatments with a stable water table. Salt accumulation on subirrigation treatments did not build up to detrimental levels. Overall, the sand and mix showed similar growth and color characteristics. Root development, however, was significantly greater on the sand than mix.

Nitrogen Fertilization

Turfgrass color on subirrigated treatments showed typical symptoms of nitrogen deficiency. Tissue analysis of leaf material revealed nitrogen content on subirrigation treatments significantly lower than sprinkler irrigated plots. These lower nitrogen levels on subirrigation treatments were comparable to tissue nitrogen levels of sprinkler irrigated bentgrass at the onset of nitrogen deficiency under similar temperatures.[3]

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Additional nitrogen was applied to the subirrigation water during the latter part of July and throughout August to promote greener color. This increase in nitrogen fertilization resulted in a two-fold increase in soil nitrogen levels. However, a nitrogen response resulting in greener turf failed to occur until temperatures became cooler in late September and October.

Total utilization of applied nitrogen was extremely poor for the subirrigated treatments. This inefficient use of nitrogen was believed to be related to the anaerobic conditions associated with the subirrigation treatments combined with the effects of high summer temperature. Denitrification or accumulation of toxic substances are possible factors contributing to this situation. This problem of nitrogen chlorosis has not been reported to occur on subirrigated bentgrass grown in cool climates and may be of concern only during prolonged hot weather.

Summary

Subirrigation of turf provides a

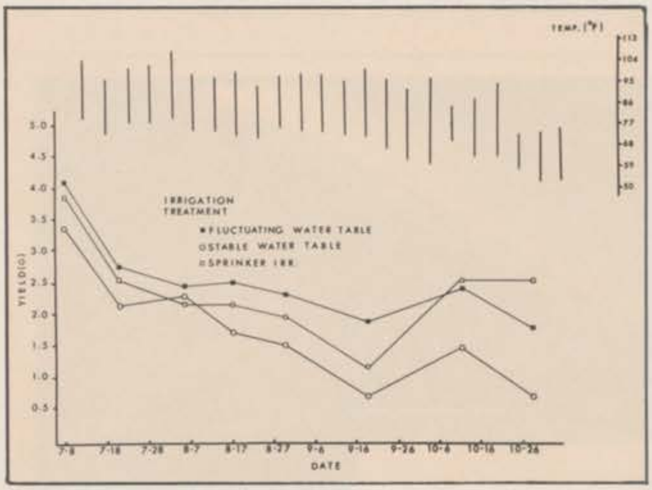

Figure 1: Effect of irrigation treatment and temperature on the yield of bentgrass.

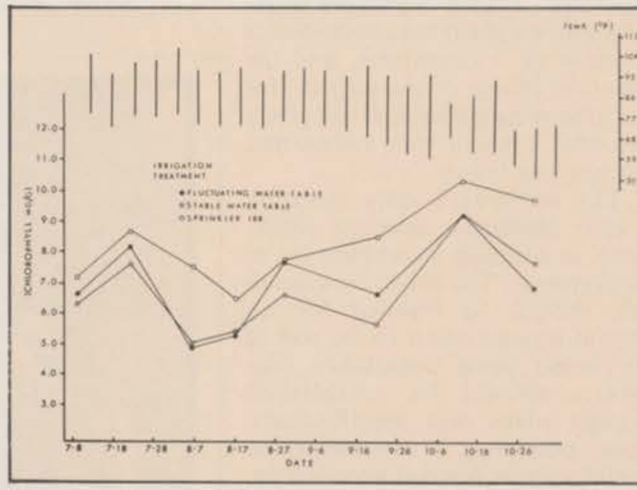

Figure 2: Effect of irrigation treatment and temperature on chlorophyll content of bentgrass.

means for improving irrigation efficiency and effectiveness. The main turf response to subirrigation is that of improved root development. This response is especially significant to the survival of cool-season turf grown during prolonged heat stress. The additional root mass increases the soil volume from which water may be obtained, thus lessening the incidence of drought and need for syringing. Addition of nitrogen to subirrigation water during prolonged periods of high temperature can be detrimental to the turf and should be avoided. Additional work at the University of Arizona has demonstrated that this problem is circumvented by surface application of nitrogen followed by a light sprinkler irrigation. Continued investigations on subirrigation of turf at the University of Arizona should provide additional useful information on this irrigation technique in the near future.

Literature Cited

[1] Bush, C. D., and W. R. Kneebone. 1966. Subsurface irrigation with perforated plastic pipe. Trans. ASAE 9:100-101.

[2] Daniel, W. H. 1970. PURR-WICK root zone system for turf. Midwest Turf Bull. 40.

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[4] Krans, J. V., and G. V. Johnson. 1974. Some effects of subirrigation on bentgrass during heat stress in the field. Agr. J. 66:526-530.

Figure 3 (below): Removal of applied nitrogen in bentgrass clippings as influenced by irrigation treatment and kind of soil during prolonged hot weather.