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- Research Report -

Subsurface Drip Irrigation

by

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The Center for Irrigation Technology (CIT) field trials of subsurface drip irrigation for turfgrass are entering their third season. While long-term effects are as yet unknown, certain trends have appeared that suggest when and how the system can work.

Demonstration Plots

CIT established the subsurface drip trials in the fall of 1989 on the campus of California State University, Fresno. Drip lines were buried 4 inches below the soil surface, which was then sodded with tall fescue turf and sprinkler irrigated to establish the turf. Three drip line spacings for each product were used: the spacing recommended by the manufacturer, and spacings 30% closer and wider that this. Products tested included drip lines with discrete emission points, and porous tube products. Water for the trials came from a domestic source, and was filtered through a 200 mesh screen.

During 1990, the plots were irrigated at a rate calculated to replace turf water use, adjusted to compensate for any non-uniformity in the emission rates (along the line) of the products. Turf quality was rated 1 to 9 scale based on density, color and the absence of weeds or insect pests. The turf quality ratings varied with product, spacing between drip lines, and the amount of water applied.

Irrigation during the 1991 season was controlled to supply 150% of the estimated turf water requirements. The 50% over-application may sound like a lot, but it represents the amount of water required to irrigate the turf with a sprinkler system of "average" uniformity. At this watering rate, most products and spacings produced superior quality turf (rated 7 or above).

Two of the discrete emitter products failed to produce even average quality turf. Pepco Laser Tube 3 showed severe problems due to root intrusion, which clogged the emission holes. Later, Drip-In emitters exhibited similar problems. The Drip-In plots were renovated using pressure compensating emitters. Half of the new emitters had been treated with Treflan by the Rootguard process, half were untreated.

During summer 1991, an additional plot of Tifgreen hybrid bermuda, irrigated by Geoflow emitters, was installed and established solely with subsurface drip irrigation. During the fall, an additional plot of tall fescue was established solely with the drip system.

For the 1992 season, AGWA-III soil moisture sensors from Agwatronics were installed midway between the driplines to control the irrigations in all plots. The irrigation control system is set to apply many frequent light irrigations. The soil moisture sensors prevent any irrigation until the soil moisture tension exceeds 20 centibars. The sensor and control system is designed to apply only as much water as is needed to maintain high quality turf.

What Works

One of the big worries with subsurface drip irrigation is that grass roots might grow into the drippers and clog them. Based on our results, this is a very serious problem for some products, but not for others. Further, there seem to be two methods of preventing root intrusion - chemical and physical.

The Rootguard process for treating emitters with the herbicide Treflan does seem to work. None of the treated products from Drip-In or Geoflow have suffered from root intrusion so far. The herbicide keeps the roots away from the emitters. Excavation of some of the Geoflow emitters showed a sphere of root-free soil for about one inch around each emitter.

Mechanical or physical barriers to root intrusion may also work. The Techline (formerly RAM) emitters from Netafim are not Treflan treated, yet remain free of root intrusion in this trial. These are the only untreated emitters that have not failed due to root intrusion.

As long as root intrusion can be avoided, subsurface drip irrigation is potentially a very high efficiency system. Preliminary results with the new sensor controlled system suggest that unclogged subsurface drip lines can maintain high quality turf with water application rates at or even below estimated turf water requirements. Irrigating somewhat below the required rate seems to slow growth of the turf without affecting quality.

Establishing of new turf may be possible with subsurface drip irrigation, although an automated system may be required. Since establishing the original plots in 1989 using sprinklers, two additional plots have been established using only irrigation from the subsurface drip system. The Bermuda sod plot was established during July, the period of maximum evaporative demand in Fresno. The irrigation system was programmed for as many as eight irrigations per day, which kept the sod-soil interface moist, and allowed the roots to grow into the native soil.

We had some success installing subsurface drip irrigation lines into established turf. The lines were shanked into the turf at the proper depth. A coulter ahead of the shank sliced through the turf minimizing damage. A water filled roller was then used to compact the soil and turf. Within a few weeks, evidence of the installation was gone.

What Doesn't

Emitters without chemical treatment or suitable physical barriers succumb to root intrusion. Until more is known, we can't say in advance what design characteristics will result in a sufficient physical barrier to prevent root intrusion. For the time being then, only chemically treated products, or those untreated products that have been proven by field test to block root intrusion, can be recommended.

As a class, porous pipe products have not performed well. Their uniformity of application along the line is relatively low, averaging 70% compared to 97% for the discrete emitter products remaining in the trials (these results are for new tubing). To maintain high quality turf, extra water must be applied to compensate for this lack of uniformity, approximately 40% more than for equivalent discrete emitter systems.

All porous pipe products tested, Aquapore, CTA and Irri-Namic, have suffered from a gradual reduction in flow. This reduction is the most severe in the downstream ends of the line. Apparently 200 mesh filtration is not sufficient to prevent these products from slow plugging with fine slit particles in the water. Between October 1989 and January 1993, flows in the Irri-Namic tubing were down to 16% at the inlet end of the tube, and 1% at the downstream end, compared to the initial flow rate. In an attempt to overcome these reduced flows porous pipe plots the automated control system has called for irrigation at rates up to 4.5 times the estimated turf requirement.

Laboratory tests indicate that repeated high pressure flushing of these plugged lines can restore at least some of the original flow. The Irri-Namic tubing recovered to 75% of normal flow in the downstream section after high pressure flush treatment.

Further Observation

Some experts have suggested that the washing effects of sprinkler irrigation are necessary to keep the grass leaves free of dust. This does not seem to be the case. Even though the subsurface drip plots at CIT are surrounded on all sides by barren fields, the turf does not appear "dirty" nor are growth or quality impaired.

Another fear has been that subsurface drip lines would be subject to gopher damage. We have not seen any gopher damage to drip lines, even though there has been substantial gopher activity in the plot area (up to 15 mounds per 1,000 square feet).

The field trial area has a large fetch of dry ground upwind, and the hot dry air blowing onto the turf increases the water requirement on the upwind edge of the plots. In cases where turf might be planted adjacent to parking lots or roadways, similar problems might result. Extra water needs to be applied near the upwind edge, perhaps by additional driplines installed parallel to the "dry" edge.

Incidence of damaging fungi and weeds in the subsurface drip irrigated plots has been very slight. By eliminating a moist zone at the surface, the soil and grass leaves remain dry, preventing weed seed germination.

Maintenance of the irrigation system is essential. The filter and drip lines must be flushed regularly. At least monthly flushing of line is recommended for discrete emitter products, twice a month for porous pipe products.

Future Work

The field trials at the Center for Irrigation Technology will continue. Our focus during 1992 will be on the amount of water that needs to be applied by each product and spacing in order to maintain superior turf quality.

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Authors' Note

Commercial product names are used for the convenience of the reader. This does not imply endorsement by the Center of Irrigation Technology, nor preference over similar products not mentioned.

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