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Subsurface Drip Irrigation (SDI) on Turfgrass: A University Experience

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OVERVIEW OF SUBSURFACE DRIP IRRIGATION SYSTEMS

The application of subsurface drip irrigation (SDI) on turfgrass requires placing drip emitters and driplines in close proximity to provide a continuous wetted pattern throughout the turfgrass growing area. Field trials conducted at the Center for Irrigation Technology (CIT) since 1989 indicate healthy turfgrass can be grown using the SDI system. A total of 12 products were evaluated in the test plots. These products included hard hose, drip tapes, and porous tubing.

Of the products tested, some showed signs of root intrusion within 60 days. Others, like the porous tubing, showed no signs of root intrusion, but distribution uniformity declines were noted after several years of operation due to the buildup of fine particles in the water passages. These particles are smaller than 200 mesh, but larger than the water passages (Solomon and Jorgensen 1992).

From the original 12 products which began the SDI evaluation, only two continue to maintain the appearance of problem-free, high-quality turfgrass. In the spring of 1994, nine emitters from each of these two products were excavated to evaluate root intrusion. One product showed two of nine emitters to have roots penetrating the labyrinth, affecting the discharge rate. The second product showed no signs of root intrusion in any of emission pathways. This second product incorporates an herbicide into the plastic which is continuing to provide protection from roots after five years of service.

The drip tubing for the SDI test plot evaluations was installed prior to sod installation at a depth of four inches (net depth with turf was ± 5 in.). Distance between the lines ranged from 10 to 24 inches. Irrigation scheduling was designed to replace 150 percent of actual crop ET. The application of 50 percent more than actual crop ET represents the non-uniformity found in many sprinkler irrigation systems.

CAMPUS PROJECT

The campus project was to retrofit approximately seven acres of an existing irrigation system used on turfgrass and permanent landscape planting (trees and State University, Fresno campus. The existing system was installed using galvanized pipe and was manually operated. However, corrosion buildup had significantly reduced effective diameter in the pipes.

It was decided it would be necessary to abandon the existing network of pipes.

The SDI installation sites were limited to three, totaling slightly over one acre. Originally more turfgrass was to be irrigated by SDI, but some areas were changed to sprinklers due to the physical barriers presented by a large number of 30-year-old trees and their massive root systems. Two of the SDI sites had no trees, and the other site had only two large trees.

Subsurface drip installation requires one person to hold lines in place while the tractor operator lowers the insertion shank.

Design and Installation

Two types of irrigation systems were installed on the campus for practical and comparative purposes. One system consisted of conventional gear drive sprinklers operating at 414 kPa (60 psi). The other was the SDI system, which operated at 103 kPa (15 psi). Both systems were designed to deliver water at approximately 12.7 mm (0.5 in.) per hour. Laterals for these systems used 38 mm (1-1/2 in.) control valves and 50 mm (2 in.) pipes.

The SDI system was installed at an average depth of 20 cm (8 in.). This was done in an effort to accommodate the possible mechanical aeration of the soil down to 15.4 cm (6 in.). The emitter spacing is 38 cm (15 in.) on center and 46 cm (18 in.) between hoses. The emitter selected for this installation is an inline, non-compensating 2 l/h (1/2 gph) unit, which is herbicide impregnated. The product was selected partially on the manufacturer's warranty of 10 years against manufacturing defects and root intrusion.

The control head consists of an electrically activated hydraulic valve, followed by a disc filter, and finally a pre-set pressure regulation valve. All valve zones allow for measurement of flow rate, total flow, and pressure readings. The ends of the supply hoses are joined together as a common manifold for flushing. Each flush manifold is connected to a self-flushing valve which has an instantaneous flush each time the set is pressurized and acts as a vacuum relief when the set is shut down.

Photo at left shows lines being installed. At right, insertion shank is raised up at the end of the row, where lines are cut.

Installation

The drip tubing was installed using commercially manufactured installation shanks. Originally three shanks were installed on the tool bar and pulled in the ground using a four-wheel-drive tractor. The installation shanks utilized gauge wheels to set the depth, and this seemed to worked adequately. However, the pulling of three driplines at a time did cause wheel slippage in parts of the installation area. Therefore, one shank was removed and the rest of the system was installed two lines at a time. This seemed to improve the process of installation and control.

Soil preparation should also be considered in the case of severely compacted soils. In the worst soils encountered on this project, the installation shanks were used to pre-rip the soil, with the tubing applied on the second pass. Shear bolts were installed on the connection between the installation shanks and the tool bar. On several occasion these bolts were broken when the shanks hooked galvanized pipe underground. The bolts were replaced with little or no damage to the installation tools.

Operation and Maintenance

A key lesson from this experience is to make sure to involve the field staff who will be ultimately responsible for the successful operation and maintenance of the SDI system. In this case we failed to work closely enough with the operations staff in making them part of the installation project and assigning them quality control responsibilities. The net effect of this mistake was to have an important part of the team standing by as an outsider.

A second task in converting from managing sprinkler systems to SDI systems is to shift paradigms. The irrigator no longer can rely simply on the performance of the sprinkler, which allows for visual evaluation of defects in the system. The irrigator must now use secondary observations like changes in pressure or flow rate to detect system delivery changes.

A direct comparison was made of differences between the two newly installed systems. Energy savings identified with the use of SDI on this project comprised a net difference of 276 kPa (40 psi) in operating pressure between the sprinkler and SDI system. In this case, the sprinkler system also required the installation and operation of a booster pump to meet system pressure requirements. Thus, substantial savings in capital pump costs and pump operation are attributed to the SDI system.

A review of work orders and public input into the operation of the two systems revealed the following information:

1) The SDI system required zero hours of maintenance during the 1994 irrigation season. The conventional sprinkler system required eight hours of maintenance to repair/replace damaged sprinkler heads due to mowing and vehicle traffic during this time.

2) The SDI system received zero complaints due to water run-off. The conventional irrigation system received six complaints due to water running on sidewalks and over spray.

3) Less water was applied to the turfgrass using the SDI system than the turfgrass irrigated using the conventional sprinkler system.

CONCLUSIONS

The use of SDI to irrigate turfgrass has passed from the stage of university research to commercial application. While it is true there is still much to learn in this area, we firmly believe the industry possesses the knowledge to make such a system work. The use of SDI may not be appropriate in all instances. It certainly has special applications in niche markets, and most surely will continue to gain wider acceptance in the future.

A caveat to the SDI method of irrigation is vacuum. Care must be take to insure that the irrigation system does not draw a vacuum at shut-down and with it contaminants back into the emitter passage. This is particularly true with areas of severe elevation changes.

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