Section M

Irrigation water management for subsurface drip

Subsurface drip system

Subsurface drip irrigation (SDI) refers to an irrigation system where the water delivery occurs below the soil surface and directly to the root zone of the growing crop. Water is delivered using a series of polyethylene tubing installed at depths between 12 and 16 inches below the soil surface. The installation process includes use of a tractor equipped with an auto-steer system and a drip tape installation implement (*Figure M-1A*). When the crop is planted in 30-inch rows, the drip lines are typically installed on 60-inch spacings to provide each crop row with equal access to water (*Figure M-1B*).

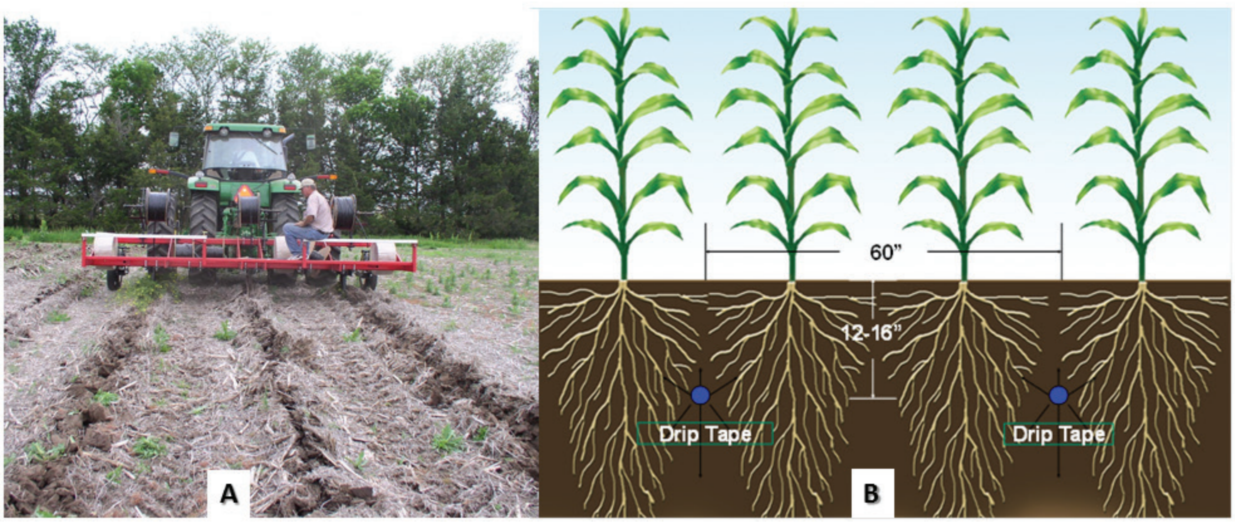

Figure M-1. Diagram showing a cross-section of a cornfield with SDI drip tape installed to provide equal access to water by each corn row.

Emitter or dripper is a device used to control the discharge of water from a dripline or drip tape to plants either above or below ground level.

SDI drip tape is equipped with **emitters** spaced in equal increments along the line. Typical installations have emitters spaced at 18- or 24-inch increments. The emitters consist of a very small opening in the drip tape that allows water to exit the tape after flowing through a zig-zag like apparatus (*Figure M-2*). The combination of the spacing between drip tapes (tape spacing), the area being irrigated, the flow rate per emitter, and the spacing between emitters allows the flow rate to be calculated prior to selecting a pump.

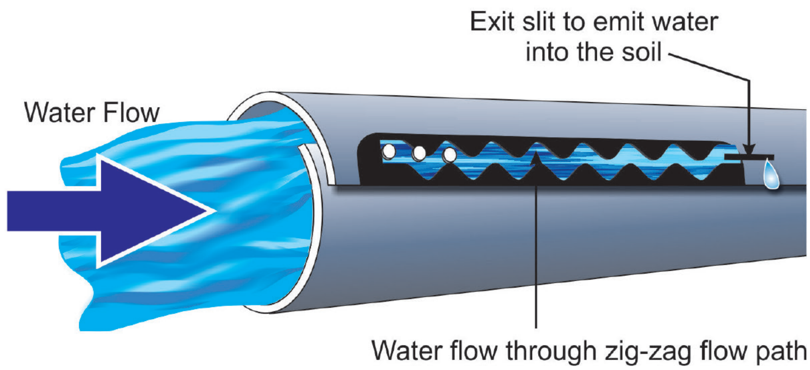

Figure M-2. Schematic drawing of a subsurface drip emitter.

SDI irrigation systems include several components that are not typically installed on other irrigation systems. *Figure M-3* shows a schematic of a field installation identifying the key components. Because SDI water application occurs below ground, it is difficult to evaluate whether water is being delivered equally by each emitter. For management purposes, the installation calls for an accurate water meter and pressure gauges positioned to provide the manager with information needed to make sure the system is operating properly.

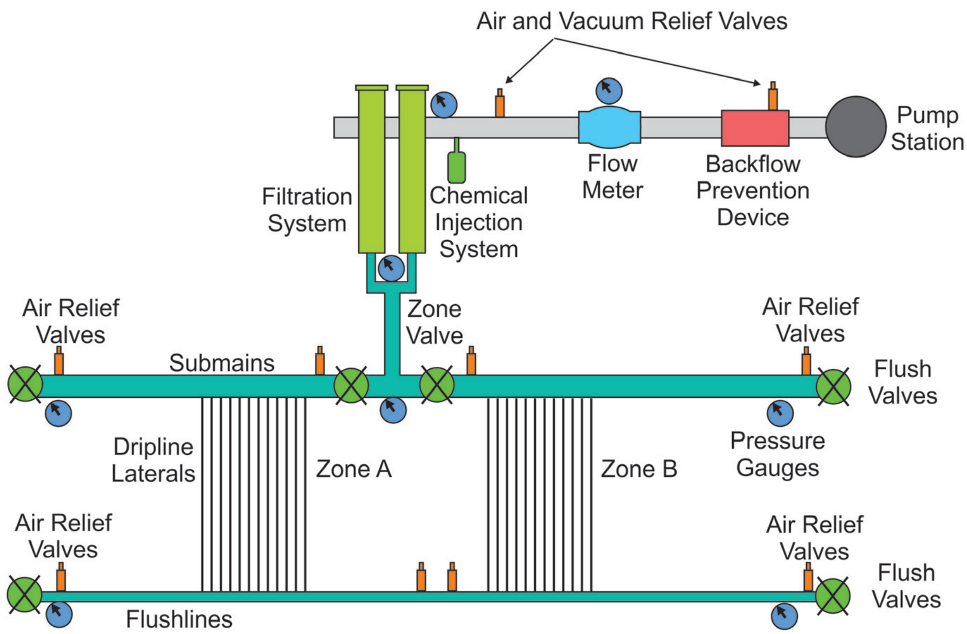

Figure M-3. Installation components recommended for an SDI system (modeled after image by Kansas State University).

Since water is delivered through small emitter openings, the emitter can become clogged with organic matter or soil particles that are contained in the water supply. To prevent clogging the installation includes a very fine filtering system (*Figure M-4*). Inclusion of the filtering system allows most any water supply (wells, canals, ponds) to be used without major issues with emitter clogging. The pressure gauges will give an indication of when the water application characteristics of the system change that requires maintenance.

It is common for various solid materials to get into the SDI drip tapes. Changes in water chemistry, rodent damage and repair procedures, and the installation process can result in unwanted solids in the drip tape. Thus at the end of each zone or combination of zones, flush valves (*Figure M-4*) are installed to allow these solids to be moved out of the drip lines. Good practices include flushing water through the drip lines at least twice per growing season (beginning and end of the season).

It is legal to apply fertilizers with irrigation water delivered using a SDI system. However, most pesticides are not labeled for application via a subsurface drip irrigation system and the Nebraska Department of Environmental Quality requires an underground injection well permit before the SDI system can be installed. In some cases where the water table is close to the soil surface, the permit may not be issued due to the near direct contact with groundwater. Once installed, similar chemigation rules apply to SDI systems as for other irrigation water delivery methods.

Figure M-4. Typical filtration system (left) and flush valve installations for SDI systems (right).

Water application efficiency

One of the major advantages of SDI is that the drip tape is installed below ground level sufficiently far that the soil surface is not wetted during each irrigation event. This conserves the water that would typically evaporate directly from the soil surface using sprinkler or furrow irrigation systems. A related benefit of the drip tape position is that only a portion of the soil is wetted, which leaves areas of drier soil to store water received as precipitation. This allows the manager to account for the precipitation and helps minimize the potential for deep percolation that often occurs with furrow irrigation systems and to a lesser extent with sprinkler application systems.

The final factor is that SDI system management is based on the ability to apply small application depths and thus SDI systems offer the potential to apply water at very high water application efficiency levels. Research indicates that water application efficiencies of over 95% are possible with good management and maintenance practices. However, like all other systems, poor irrigation management practices can reduce the water application efficiency dramatically.

Small application depths are critical to the success of SDI management because the systems rely on capillary forces to move the water horizontally from the location of the emitter. However, capillary forces are not as strong as gravity which tends to move the water vertically into the soil. Thus, small application depths keep deep percolation in check. Minimizing deep percolation loss is an absolute necessity if fertilizer is applied with irrigation water via chemigation.

Researchers in Kansas and Nebraska have reported that due to the high management potential and position of the water application system relative to the soil surface irrigation water applications can be reduced by 20-25% with SDI. On average, this allows approximately 7 inches of water to be conserved when compared to a well operated furrow irrigation system.

Finally, there is some evidence that SDI systems can produce additional grain with small, frequent irrigation water applications. This is particularly true when overall water supplies are limited to less than full irrigation management. Applying water to replace the previous day's crop water use is one management scheme that appears to have some merit.

Disadvantages

SDI is not without difficulties. For example, one of the largest issues is the control of rodent damage to the drip tape (*Figure M-5*). Small field mice, 13-lined ground squirrels, and gophers all seem to find the drip tapes and begin chewing. If field conditions are right, the leak will eventually force water to the surface where the manager can isolate the location and fix the leak. Large field areas make it difficult to isolate exactly where some of the more minor leaks are. Installation of relatively small irrigation zones will help the manager isolate the leak while large areas make it more difficult. Pressure gauges and the flow meter should be used to identify when leaks develop. If the pressure decreases and the flow rate increases, a leak needs to be fixed.

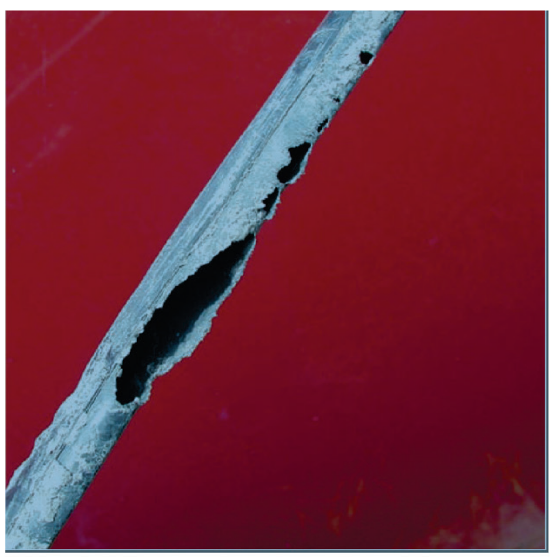

Figure M-5. Holes in SDI drip tape from rodent damage.

Small emitters can become clogged due to water quality issues even if a good filtration system is used. The flow meter and pressure gauges allow the manager to identify when the emitters are being clogged by calcium, magnesium, or iron that makes its way past the filter. Application of fertilizers can cause the water chemistry to change enough so that these salts will tend to precipitate out and clog the emitters. If the flow rate gradually decreases and the pressure rises, the manager will know that some emitters in the zone are becoming clogged by some solid or organic material. In extremely dry springs seed germination can be an issue in some portions of Nebraska.

If the crop is planted into dry soil, sprinkler irrigators could apply a small amount of water to complete the germination process. With the drip tape positioned 14-16 inches below soil surface, it may require extremely large water application depths to ensure seed germination. Thus, in the western Nebraska, it may be advisable to install the drip tape at no more than 14 inches deep. In extremely dry areas, one option is to have a backup irrigation system to apply water needed for germination.

If water is applied at a rate greater than the infiltration rate of the soil a saturated zone can develop forcing water to the soil surface. In this case it is sometimes difficult to tell whether the wet soil is due to a leak or to the "chimney" effect. Once water begins to chimney in a specific area, it is more difficult to get water to move laterally from the emitter or to eliminate the chimney. In severe cases, surface soil erosion can result in rills down to the emitter depth.

One final potential disadvantage of subsurface drip irrigation is taht the water application occurs below ground level. Despite the potential for high irrigation efficiencies, poor managment can lead to deep percolation loss and nitrate leaching. *Figure M-6* depicts a water patttern from a SDI drip tape. If excessive depths of irrigation are applied, the position of teh tape 12-16 inches below the soil surface can transport nitrate from the rootzone. Thus it is critical that irrigation water management is practiced with SDI systems.

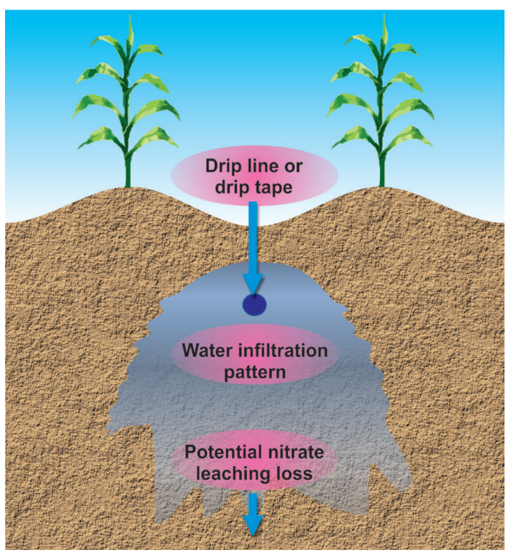

Figure M-6. Water application pattern for a subsurface drip irrigation system depicting nitrate leaching loss due to over irrigation.

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EC776, Advantages and Disadvantages of Subsurface Drip Irrigation