# 6 Subsurface Emitter Installation and Management

Subsurface drip irrigation (SDI) is still relatively new but can offer benefits to producers over the more conventional surface drip irrigation methods. The objectives of SDI systems are to improve crop yield and quality; maintain a dry soil surface to reduce weed growth, moisture loss and diseases; and achieve a broad lateral spread throughout the soil profile that maximizes the wetted root volume and minimizes percolation losses.

The design, maintenance and installation of SDI systems are different than for surface systems.

## 6.1 Evaluation of SDI Technology

Subsurface drip irrigation may offer benefits to producers that include:

- less surface evaporation;
- eliminating tape movement by wind;
- reduce damage by rabbits, coyotes and mice chewing on the laterals;
- reduce salt crystallizing on the emitter orifice in areas with high salt content in the water supply;
- less interference with conducting field operations with the system in place, even with the system operating;
- covering a much larger wetted volume of soil with the same amount of water than surface systems ( up to 40% ), reducing the amount of saturated soil in the root zone and the amount of water lost to deep percolation.

There are also challenges associated with the burial of drip irrigation lines. These include:

- water being piped to the soil surface through “chimneys” caused by the flushing of sand and clay particles close to the emitter outlet and through a vertical path to the soil surface;
- root intrusion plugging the emitter;
- flow being restricted by the lateral lines becoming pinched upon installation or as a result of soil compaction over time;
- reduced flow rates in buried emitters of 10 – 20% due to hydraulic pressure that builds up in the saturated soil around the emitter;
- it is not easy to check the system visually to determine if it is operating properly.

## 6.2 Emitter Orientation

Contaminants that settle out of the irrigation water will be deposited at the bottom of the lateral. Therefore, as with surface systems, SDI systems should always have the emitter installed with the orifice pointing up, allowing sediments and organic particles to settle down and away from the outlets. See Figure 6.1. Although this may increase the possibility of the “chimney effect” described above, the system can be managed to reduce this effect. See Section 6.5.

The effective wetted volume of soil from a subsurface drip system is greater than that of a surface system, as shown in Figure 5.10.

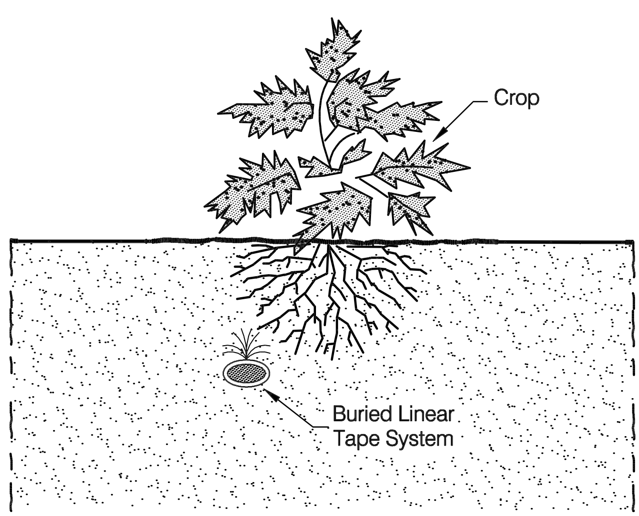


*Figure 6.1* *Emitter Orientation for SDI Systems*

## 6.3 Depth of Burial

The depth of burial will depend on the type of product used, crop to be grown and soil conditions. Typically depth of burial is between 100 – 600 mm (4" – 24"). The optimum depth for each crop and soil condition will depend on:

- The type of crop. Trees and vines will usually have deeper installations since the installation is expected to last a number of years.
- The vertical movement of water through the soil profile.
- The probability of traffic driving over the lateral. A deeper burial will shield the lateral more.
- Tillage practices. The lateral must be installed below the tillage depth.
- The rooting pattern of the crop. Deeper burial may be required to prevent the roots from pinching the laterals for tree and vine crops.
- Impermeable or restrictive soil layers in the soil profile.
- The use of a plastic mulch will effect distribution of water through the soil. Shallower depths of burial can be used if the crop is mulched with plastic.

Deep installations reduce evaporation from the soil and also allow for deeper tillage operations. However, deep installations will effect seed germination for annual crops and restrict the availability of nutrients applied at the soil surface.

If salt build-up in the soil is a problem, shallow sub-surface installation will give better results than deep installations. Deep installations that do not allow the wetted area to touch the soil surface may cause salt build up just below the soil surface, in the plant's rooting area. See Figure 6.2.

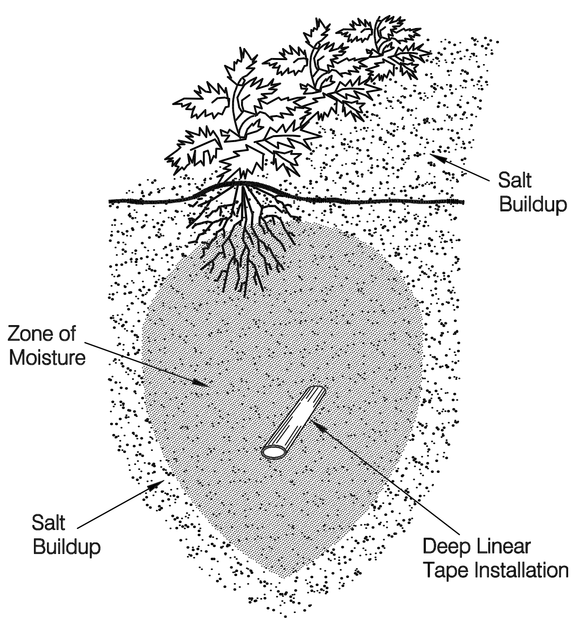


*Figure 6.2* *Linear Tape Installation Below Soil Surface*

Drip tape is usually buried beneath the soil or mulch for row crops grown in raised beds. These row crops are usually annual crops and the drip tape can be easily installed and maintained for the growing season. However, for tree and vine crops the systems must be designed and installed to operate for many seasons. Long term operation makes burying the system more risky. Emitter plugging, root intrusion, crushing of the lateral lines and other factors make operating a buried drip system over the long term difficult. *For permanent crops, lateral tubing or "hose" is often used instead of the thin walled tape, as a longer product life is required.*

For crops such as asparagus, corn and others that are not grown in raised beds the depth of burial is usually 300 mm (12") or more. The depth selected should allow for proper field tillage practices without disturbing the lateral lines. Since these crops are deep rooted the water can be applied at a greater depth, provided that germination can be achieved.

For single row crops such as tomatoes, cucumbers, watermelons etc. the drip line should be buried 50 – 100 mm ( 2 – 4 in) deep and be offset from the centre of the bed by 100 – 150 mm (4 – 6 in). For double row crops such as eggplant, peppers, squash etc. the drip line should be placed between the two rows and buried 50 – 100 mm deep. Table 6.1 provides guidelines for burial depths of drip tape with various crops.

Figure 6.3 shows an example of the type of equipment that can be used to bury drip lines.

*From: Rainbird®*

*Figure 6.3* *Installation Equipment for Subsurface Drip*

# 6.4 Drip Line Spacing

The line spacing is often dictated by the row spacing of the crop while the emitter spacing is determined by plant spacing within the row. Spacings that are too wide will result in poor uniformity and result in excess water having to be applied to achieve sufficient lateral water movement. Wide spacing could result in excess deep percolation for most soil types.

The line spacing should be determined by estimating the lateral extent of the crop root zone and the lateral movement of water in the soil.

For crops grown in beds less than 0.75 m wide one drip line should suffice. Crops grown in beds that are wider than 0.75 m may require more than one drip line per bed. Lateral spacing will depend on the crop rooting depth, mulching and soil factors. Table 6.1 can be used as a guide to determine the burial depth and corresponding lateral spacing for SDI systems.

**Table 6.1 Drip Tape Spacing and Burial Depth Guidelines**

| Crop | Burial Depth | Line Spacing |
|---|---|---|
| Tree fruits and grapes | > 400 mm | as per row spacing |
| Blueberries, raspberries | > 200 mm | as per row spacing |
| Row crops - corn, asparagus | > 300 mm | maximum of 1.5 m |
| Raised Beds - single row<br>Tomatoes, cucumbers | 50 - 100 mm | one line offset 100 - 150 mm from centre of bed |
| Raised Beds - double row<br>Eggplant, peppers, strawberries | 50 - 100 mm | one line down centre of bed |
| Raised Beds - double row<br>> 0.75 m bed width | 75 - 150 mm | two lines spaced 1/2 the bed width apart |

# 6.5 Managing SDI Systems

The following management techniques are suggested for improving the performance of SDI systems on permanent crops. Annual row crops are well suited to SDI systems and may not experience the same type of problems as tape only needs to perform for one season.

Note: for permanent crops lateral tubing or “hose” should be used instead of drip “tape”. Tape products are fine for annual crops or shallow installations where the product life is not expected to last longer than 3 years.

## Tape Installation

SDI systems usually use 8 – 12 mil products. These products are suited for deeper burial. Very thin 4 mil product can be used if the system is expected to last only one season, is buried close to the surface in sandy soil with no rocks and is fumigated to kill soil insects.

Thicker tape (15 mil) offers some advantages such as allowing higher operating pressures to increase lateral flush rates and easier extraction from the field after the growing season. Although the tape may not break upon installation or removal the tape discharge can change due to elongation or stretching. Tapes can stretch from 120% to 150% of their original length due tension. The $C_v$ of the tape can also be altered due to elongation, changing the performance characteristics of the product.

## Crushing

Immediately after installation, thin walled buried tape should be turned on to prevent the line from being crushed flat. In some case the line should also be turned on once a week, even if irrigation is not required, to prevent crushing. Tape products that are very thin walled, 4 mil or less, is not recommended for burial in soils that form large clods. This tape cannot be pressurized enough to overcome the crushing force caused by the soil clods.

Where soil clods have crushed the tape it may take 24 hours of wetting for the clods to soften enough for the obstruction to disappear.

## Surface Ponding

The longer operating times required for permanent crops may result in water erupting to the soil surface via the installation trench rather than spreading around the emitter. The following steps can be taken to reduce the risk of this happening.

- Pulse the irrigation cycle with set times of one hour or less. To pulse the system properly the irrigation submains should remain full of water between cycles to maintain system uniformity. Check valves can be used to accomplish this.
- Low emitter flow rates (2 Lph) should be used and the number of emitters on the lateral increased if the soil has a low infiltration capability.

- Minimize disturbance of the soil during installation.
- Ensure the line is installed within the crop row where equipment will not compact soil over the drip line.
- Lightly till compacted soil over the buried drip line if compaction occurs.
- Water infiltration problems are also affected by the total salinity of the water (EC) and the relative sodium content. Relative sodium content is measured through a value called the Sodium Adsorption Ratio (SAR). See Chapter 11 for further information on SAR. Adding calcium to the irrigation water may be of some benefit.
- If the EC of the water is very low (< 0.6 dS/m), continuous injection of fine grades of gypsum at rates of 2.5 meq/L (590 lbs per acre-foot) may help. Rates lower than this are generally ineffective. If the problem has been ongoing rates as a high as 5.0 meq/L for 6 – 8 weeks, then slowly reduced over time may be of some benefit.
- If the calcium – magnesium ratio of the water is less than 1:1, gypsum can be added to increase the ratio to as high as 2:1.
- If the water contains a high level of bicarbonates and the soil pH is higher than 6.5, an acid can be added to lower the water pH. Soils that have a pH lower than 6.5 will convert the bicarbonate naturally into $CO_2$ in the soil.
- Fertilizers with calcium and nitrate rather than sodium and ammonium should be used.

## Salinity

Salts are added to the soil with every irrigation. The crop removes the water from the soil to meet its needs but leaves behind most of the salts. Salts will therefore build up in the soil over time. To reduce salinity problems the drip system must keep the moisture level in the soil at a high enough level to leach the salts outside the plant root zone. Salts will usually build up on the outer edges of the wetted area. To prevent the salts from accumulating in the crop rooting area sufficient water must be applied to develop a large enough wetted area to allow good root development. Irrigation must also be frequent to prevent the soil from drying, allowing salts to move back into the crop rooting zone.

In areas that have high salinity problems, the laterals should not be buried too deeply. Shallow burial allows the water to reach the soil surface, leaching salts away from the plant's roots. See Section 12.2.

Areas that receive sufficient winter precipitation usually do not have salinity problems.

## Ensuring Adequate Fertility

Fertigation should be incorporated with any buried drip system to insure sufficient nutrients are applied to the crop. The injection system used to apply acids or chlorine for system treatment can be used for fertigation as well. See Chapter 14 for further information.

## Vacuum Ingestion of Soil Particles

A vacuum effect on shutdown may cause soil particles to be ingested into the emitter. This problem can be reduced by ensuring that adequate relief valves are installed on all the high points of the submains for each zone. Twice the normal number of vacuum relief valves should be used for this purpose. An emitter can also be left above ground at the beginning and end of each lateral to act as a mini vacuum relief valve.

## Preventing Root Intrusion

For SDI systems it is important to prevent root intrusion immediately after installing the system. Some manufacturer's are now locating emitters away from the seams in the drip tape as roots tend to grow along the seams. Root intrusion can be rapid in dry soils. This can be minimized by frequent irrigations and eliminating any deficit irrigation. Frequent use of acidic fertilizers also helps in preventing root intrusion into the emitter orifice. Root intrusion is more prevalent in crops such as celery, asparagus and sweet potato.

Chemicals can also be used to reduce root intrusion. Prevention measures can be taken weekly by dropping the pH to low levels for short periods of time. Irrigation durations of 1/2 hour at a pH of 2.0 may be successful. *For accurate control this can only be done on small blocks because of the time it takes for the chemical to travel through the zone. On large blocks the travel time will mean longer durations on parts of the zone to achieve the minimum effective duration at the far end of zones. The low pH for long periods of times could cause plant damage.*

There is also a product available that has Treflan fused into the emitter. The treflan is slowly discharged into the soil over time preventing roots from entering the emitter orifice.

Once roots have intruded into the emitter there is nothing that can be done and the system must be replaced.

## Insects

Chemicals may be used to kill soil insects that could block the emitter outlet. Chemical registration should be checked to ensure the chemical can be used for this purpose.

## Gopher Strikes

Gophers and other rodents are usually not a significant problem. To reduce the risk lines should be buried 450 mm deep. Also ensure that the wetted area from each emitter overlap so that the entire line is in wetted soil. Gophers prefer digging in dry soil.

# 6.6 Monitoring SDI Systems



A flow meter and pressure gauge should be installed with a new system. A standard flow rate and pressure can then be established for each zone. A monitoring schedule should be set up to determine if there is a reduction in the flow rate from year to year.

The pressure should be measured at an appropriate location on the line to obtain accurate and repeatable results. The best location is a straight section of pipe that is after the mainline control valve but before the system flow meter. See Figure 8.1.

The flow should be measured after the system has operated for at least one hour as the flow will have a tendency to slow as the soil begins to resist infiltration. Accurate repeatable readings are more likely to be achieved after the soil has been wetted. The flow rate should be determined by timing how long it takes for several hundred litres to pass through the meter. The instant flow reading provided by the meter may not be accurate. The measurement should be repeated two or three times at the same pressure to establish reliability.

The flow should be checked every few weeks. If there is more than a 5% variation in flow the system should be checked.

If the flow rate has increased check the following:

- Are there any breaks in the system?
- If the emitters used are turbulent or laminar flow and there are no breaks, check the pressure regulators to ensure that the operating pressure within the zones have not gone up. With turbulent or laminar flow emitters an increase in flow usually indicates a broken lateral, leaking pipe or a defective flow meter.
- If the emitters are pressure compensating and there are no breaks, dig up the emitter line to see if the diaphragm is being held open by foreign matter. If not check the flow of individual emitters for hardening of the diaphragm.

If the flow rate has decreased check the following:

- Visually observe all equipment such as flow meters, pressure gauges and regulators to ensure they are working correctly.
- If the monitoring equipment is working correctly it is likely that at least some of the emitters are partially plugged.
- Clean the system with chlorine or acid. See Chapter 11 for maintenance requirements.
- If the flow is not restored a section of the emitter line should be dug up and inspected to see what is causing the plugging. Select a section near the end of the lateral as this is where plugging is most likely to begin.