United States
Department of
Agriculture

**Soil
Conservation
Service**

National
Engineering
Handbook

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Section 15

Irrigation

Chapter 7

Trickle Irrigation

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Preface

Experimental efforts in trickle irrigation date back to the 1860's, but it was not until the mid-1960's, after the development and wide availability of low-cost plastic pipe and fittings, that commercial trickle irrigation became feasible. Today trickle-irrigated croplands and orchards amount to more than 800 thousand acres worldwide, including more than 100 thousand acres in the United States.

This chapter of the National Engineering Handbook describes design procedures for trickle irrigation systems. It covers logical design procedures for the major types of trickle irrigation systems in current use and contains detailed, complete sample designs. The chapter is written for engineers and experienced technicians; however, it should also be of value to others interested in the design and application of trickle irrigation systems.

Chapter 7
Trickle Irrigation

Description

Trickle irrigation is the slow application of water on or beneath the soil surface by drip, subsurface, bubbler, and spray systems. Water is applied as discrete or continuous drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line. Water is dissipated from a pipe distribution network under low pressure in a predetermined pattern. The outlet device that emits water to the soil is called an "emitter." The shape of the emitter reduces the operating pressure in the supply line, and a small volume of water is discharged at the emission point. Water flows from the emission points through the soil by capillarity and gravity.

Types of Systems

Drip

In drip irrigation, water is applied slowly to the soil surface as discrete or continuous drops or tiny streams through small openings (fig. 7–1). Discharge rates are less than 3 gallons per hour (gph) for widely spaced individual applicators and less than 1 gph/ft for closely spaced outlets along a tube (or porous tubing).

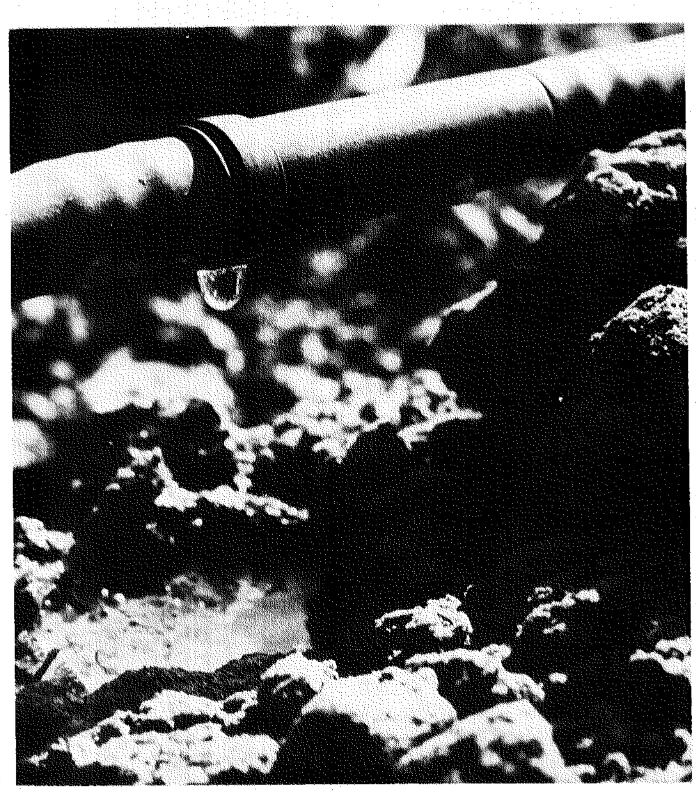

Figure 7–1.—In-line drip emitter.

Subsurface

In subsurface irrigation, water is applied slowly below the soil surface through emitters with discharge rates in the same range as those for drip irrigation. This method of application is not to be confused with subirrigation, in which the root zone is irrigated through or by water table control.

Bubbler

In bubbler irrigation, water is applied to the soil surface in a small stream or fountain from an opening with a point discharge rate greater than that for drip or subsurface irrigation but less than 1 gallon per minute (gpm). The emitter discharge rate normally exceeds the infiltration rate of the soil, and a small basin is required to control the distribution of water.

Spray

In spray irrigation, water is applied to the soil surface as a small spray or mist. The air is instrumental in distributing the water, whereas in drip, bubbler, and subsurface irrigation, the soil is primarily responsible for distributing the water. Discharge rates in spray irrigation are lower than 30 gph.

Advantages

Trickle irrigation is a convenient means of supplying each plant, such as a tree or vine, with a low-tension supply of soil moisture sufficient to meet evapotranspiration demands. A trickle irrigation system offers unique agronomic, agrotechnical, and economic advantages for efficient use of water and labor.

Water and Farm Operation Cost Savings

Trickle irrigation can reduce water loss and operating costs because only the amount of water required by the crop is applied. Labor costs for irrigating are reduced because trickle systems are equipped with automatic timing devices.

Much of the soil surface remains dry with trickle irrigation (fig. 7–2); this has two benefits. First,

Figure 7–2.—Drip system for grapes, leaving much of soil surface dry.

weed growth is reduced, so labor and chemical costs for weed control are reduced. Second, uninterrupted orchard operations are possible, and with row crops on beds, the furrows remain relatively dry and provide firm footing for farm workers.

Fertilizers and pesticides can be injected into the irrigation water to avoid the labor needed for their ground application. Several highly soluble materials are available, and new products that widen the choice are being introduced. Greater control over fertilizer placement and timing through trickle irrigation may improve fertilization efficiency.

Use of Saline Water

Frequent irrigation maintains a stable soil moisture condition that keeps salts in soil water more dilute. Thus it is possible to irrigate with water of higher salinity.

Use of Rocky Soils and Steep Slopes

Trickle irrigation systems can be designed to operate efficiently on almost any topography. Systems are operating on avocado ranches that are almost too steep to harvest (fig. 7–3). Because the water is applied close to each tree, rocky areas can be trickle irrigated effectively even when tree spacing is irregular and tree size varies.

Figure 7–3.—Drip system on slope of avocado ranch.

Disadvantages

The main disadvantages inherent in trickle irrigation systems are their comparatively high cost, proneness to clogging, tendency to build up local salinity, and, when they are improperly designed, spotty distribution pattern.

Cost

Trickle irrigation systems are expensive because of their requirements for large quantities of piping and filtration equipment to clean the water. System costs can vary considerably depending on the crop, terrain, and quantity of water available. Steep terrain may require several pressure regulators in the system. Because of spacing, some crops require less pipe than others. The degree of automation affects the cost. In general, the cost is far greater for a trickle system than for a sprinkler or flood system.

Clogging

Because the emitter outlets are very small, they can become clogged easily by mineral or organic matter particles. Clogging can reduce emission rates or upset uniformity of water distribution, and cause plant damage. In some instances, particles are not adequately removed from the irrigation water before it enters the pipe network. In others, particles may form in water as it stands in the lines or evaporates from emitter openings between irrigations. Iron oxide, calcium carbonate, algae, and microbial slimes form in irrigation systems in certain locations. Chemical treatment and proper filtration of water usually can prevent or correct emitter clogging.

Lack of Uniformity

Most trickle irrigation emitters operate at low pressures, 3 to 20 pounds per square inch (psi). If a field slopes steeply, the emitter discharge during irrigation may differ as much as 50 percent from the volume intended, and water in the lines may drain through lower emitters after the water is shut off. Some plants receive too much water; others receive too little.

Salt Accumulation

Salts tend to concentrate at the soil surface and constitute a potential hazard because light rains can move them into the root zone (fig. 7–4). When a rain of less than 2 in. falls after a period of salt accumulation, irrigation should continue on schedule to ensure that salts leach below the root zone.

During trickle irrigation, salts also concentrate below the surface at the perimeter of the soil volume wetted by each emitter (fig. 7–4). If this soil dries between irrigations, reverse movement of soil water may carry salt from the perimeter back toward the emitter. Water movement must always be away from the emitter to avoid salt damage.

Other Hazards

If uncontrolled events interrupt irrigation, crops can be damaged quickly because roots can extract nutrients and water only from the relatively small volume of soil wetted.

Rodents are known to chew polyethylene laterals. Rodent damage can be prevented by rodent control or use of polyvinyl chloride (PVC) laterals.

A main supply line can be broken, or the filtration system can malfunction and allow contaminants into the system. One filtration malfunction can result in the plugging of many emitters that then must be cleaned or replaced.

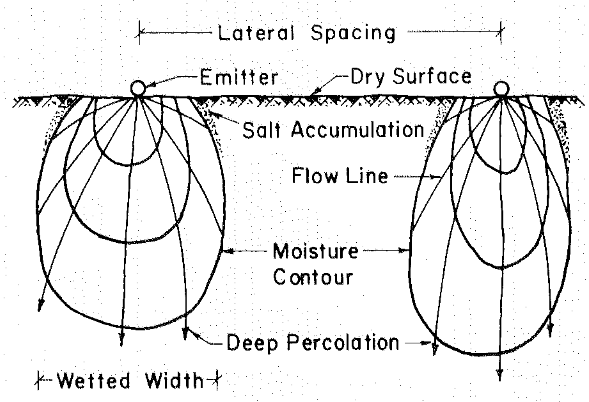

Figure 7–4.—Typical soil moisture pattern under trickle irrigation, showing salt accumulation.