DRIP IRRIGATION FOR VEGETABLES

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Drip (trickle) irrigation was pioneered in the 1940s in England, but not until the advent of polyethylene plastics in the 1960s did field application of this efficient watering method become widespread. Drip irrigation is a method of applying small amounts of water, often on a daily basis, to the plant's root zone.

A drip irrigation system has four major components and two options.

Major Components

- Delivery system: emitters or line source drip tubing
- Filters: sand, disk, or screen
- Pressure regulators: spring or valve
- Valves: hand-operated, hydraulic, or electrical

Options

- Controller: simple electric clock or computer
- Fertigation system: electric pumps, hydraulic pumps, venturi systems, etc.

How you put these components together, and which options you choose, will depend on the size of the system, the water source, the crop, and the degree of sophistication you desire.

ADVANTAGES AND DISADVANTAGES

Although many advantages favor installation of a drip system, there are some limitations as well.

Advantages

1. Smaller water sources can be used, as trickle irrigation may require less than half of the water needed for sprinkler irrigation.
2. Lower pressures mean reduced energy for pumping.
3. High levels of water management are achieved because plants can be supplied with precise amounts of water.
4. Diseases may be lessened because foliage remains dry.
5. Labor and operating costs are generally less, and extensive automation is possible.
6. Water applications are precisely targeted. No applications are made between rows or other non-productive areas.
7. Field operations can continue during irrigation because the areas between rows remain dry, resulting in better weed control and lower production costs.
8. Fertilizers can be applied efficiently to roots through the drip system.
9. Watering can be done on varied terrains and in varied soil conditions.
10. Soil erosion and nutrient leaching can be reduced.

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Disadvantages or problems

1. Initial investment costs may be more on a per acre basis than other irrigation options.
2. Management requirements are high. A critical delay in operation decisions may cause irreversible damage to crops.
3. Frost protection that can be achieved by sprinkler systems is not possible with drip systems.
4. Rodent, insect, or human damage to drip tubes may cause leaks.
5. Filtration of water for trickle irrigation is necessary to prevent clogging of the small openings in the trickle line.
6. Water distribution in the soil is restricted.

SPECIFIC ADAPTATIONS TO VEGETABLES

Drip irrigation can be used in orchard, nursery, windbreaks, landscape, and other crop applications. This publication will concentrate only on applications for vegetable crops.

Because vegetables are usually planted in rows, a drip tubing with prepunched emitter holes, called a line source emitter, is used to wet a continuous strip along the row. Also, because most vegetables are considered annuals and are grown for only one season, a thin-walled disposable tubing (4 or 8 mil thick) generally is used for only one season. Less emphasis is usually placed on buried mainlines and sub-mainlines to allow the system to be dismantled and moved from season to season. Costs may be high, so a goal should be to develop an inexpensive yet functional system that allows maximum production with minimal costs. You may purchase an entire system from an irrigation dealer or adapt your own components. Assistance in design from an irrigation dealer or professional can be very helpful in avoiding problems later on.

WATER SOURCES

The water supply may come from wells, ponds, lakes, municipal lines, or pits. Well water sources generally are fairly clean and require only a screen filter to remove particles. However, precipitates or other contaminants in the water should be determined by a water quality test prior to considering a drip system. Municipal sources generally provide documentation of water quality tests, making it easier to spot potential problems. Surface water such as streams, ponds, pits or rivers will contain bacteria, algae or other aquatic life, and sand filters are an absolute necessity. Sand filters are generally more expensive.

MAJOR COMPONENTS OF A DRIP SYSTEM

1. Delivery system
   - Mainline distribution to field
   - Sub-mainline (header line)
   - Feeder tubes
   - Drip tube
2. Filters
3. Pressure regulators
4. Valves or gauges

Delivery System

- *Mainline distribution to field:* Underground plastic or PVC pipe or above-ground aluminum pipe can be used to deliver water from its source (pump, filtering system, etc.) to sub-mainline (header line).
- *Sub-mainline (header):* It is common to use vinyl "lay flat" hose as the sub-mainline (header line). The hose is durable, long-lasting, and lays flat when not in use so equipment can be driven over it. The lay flat hose and feeder tubes are retrieved after each growing season and stored until the following year.
- *Feeder tubes:* Water flows to the drip tubing through small plastic tubes called feeder tubes connecting the sub-mainline (header line) and each drip tube. Feeder tubes can be inserted directly into the vinyl hose.
- *Drip tube:* The design of most drip tubing consists of an inner and outer chamber that allows for even water distribution over a wide range of conditions. Most tubing is polyethylene black plastic, 4 to 8 mil thick, with holes at intervals of 8 to 24 inches. In general, the sandier the soil, the closer the spacing needed. A 12-inch spacing

is common. The tubing is shipped flattened on a roll and is often called drip tape. Most drip tapes emit water at about 25 gallons per 100 feet per hour when operated at l0 psi pressure. Standard rolls of tape contain enough tubing tape for 1 acre of crop on 5-foot row centers.

Filters

Filters are essential to the operation of a drip system and may be viewed as the most important component of a drip system. For wells or municipal water a screen filter or disc filter can be used. Screen filters (150 to 200 mesh screen) are available in sizes from ¾ inch (used only for ½ acre) to 6-inch (used with several acres). Some filters have a valve to open and flush the filter. Disc filters operate with a series of discs stacked vertically to separate out small particles. Although more expensive to purchase, they are reliable and easy to clean.

For any open or surface water sources, sand filters are an absolute necessity. They are installed as pairs of sand-filled canisters and can be back-flushed to accomplish cleaning. Canisters from 14 inches (enough for 2 acres) to 48 inches in diameter are used, depending on the size of the system.

The need to clean or flush filters can be determined by the loss of pressure through the filter. You can install pressure gauges on either side of the filter to indicate the need to flush when pressure loss exceeds 5 to 7 psi. With only one pressure gauge behind the filter, watch for reduced operating pressure in normal operation. When stream or river water is used, a sand separator is usually needed to remove suspended sand from the water before it enters the sand filter.

Pressure Regulators

Most drip tubing is designed to operate at 8 to 15 psi pressure, with 10 psi being standard operating pressure. A spring-type (used on smaller systems) or diaphragm-type pressure regulator can be purchased to hold pressure steady. These are inexpensive and reliable. Both adjustable and pre-set types are available.

Valves or Gauges

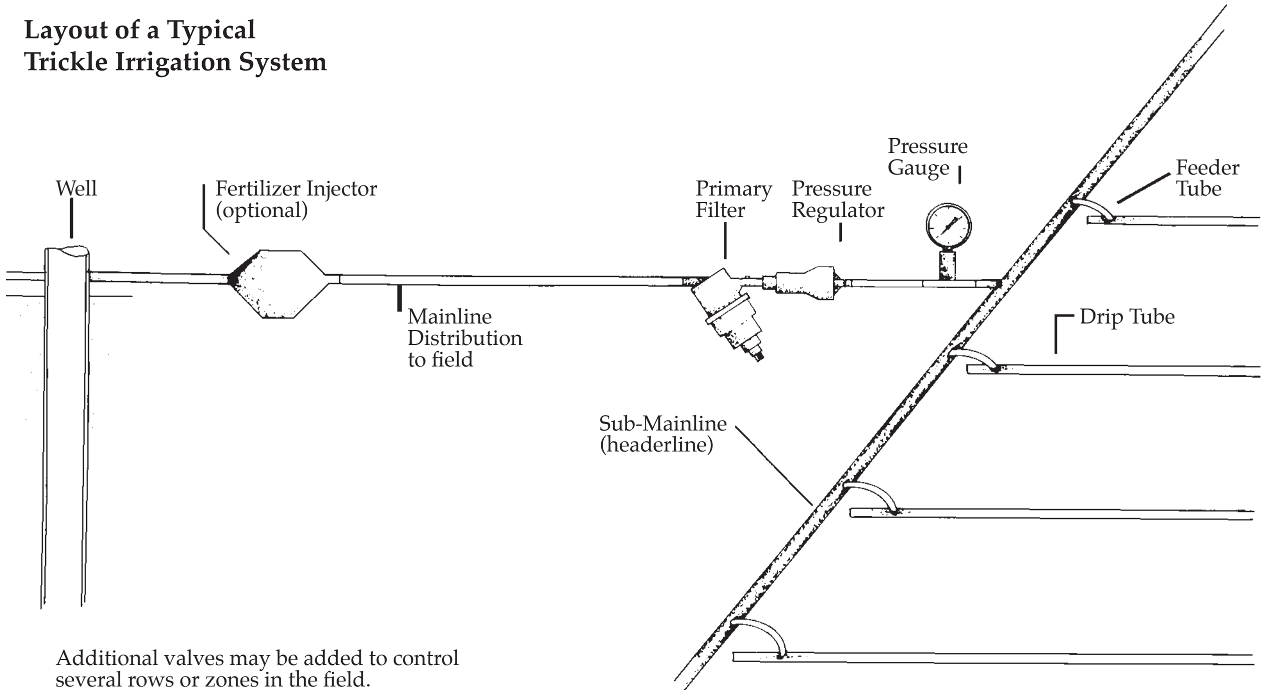
Watering several fields or sections of fields from one water source can be accomplished by a zone system using valves to open and close various lines. A backflow/anti-siphon valve is a necessity on a well or municipal source where fertilizers or chemicals are to be injected into the line. Hand-operated gate or ball valves or electric solenoid valves can be used to automate the system using a time clock, water need sensor (discussed later), or automatic controller box ("computer" controller).

Optional Additions

Fertigation or chemigation: Soluble fertilizers can be added to the drip irrigation water to provide uniform crop fertilization. A simple "hozon" venturi injector siphons soluble fertilizer from a bucket or jug into the line at a pre-set ratio (usually 1:16 or 1 gallon for every 16 gallons of water flowing through the line). The hozon injection system, however, is only suitable for ½ acre plantings or less. Other venturi units are available in sizes up to 2 inches in diameter. More expensive injectors with greater capacity and accuracy, use electric or hydraulic "pumps" to inject fertilizer solutions from a stock tank into the line. A hydraulic device, called a Dosatron, can be set at various dilution rates and operates with water flowing directly through the device which is placed in the mainline. Use only high quality, soluble fertilizers that completely dissolve. *All fertilizer injections should be made ahead of the main filters in the line so that any contaminants are filtered out*.

Fertigation is most commonly used to supply nitrogen since it is highly soluble and moves easily through soils to roots. Phosphate and potash are best applied before planting and not injected through the irrigation system. Other chemigation applications may include pest control measures, but *check label restrictions on use in chemigation applications*. If fertilizer or chemicals are applied through the system a check valve to ensure no contamination of the water source is a *necessity*. For regulations on water use, well and valve requirements, and water permits contact the Division of Water Resources of the Kansas Department of Agriculture, Topeka.

Layout of a Typical Trickle Irrigation System



MULCHES

Drip systems operate most effectively when used in conjunction with plastic mulches. Mulches reduce evaporation of water from soils and improve economy of drip water application. Vegetable operators typically use 4-foot-wide rolls of black or white-on-black polyethylene plastic mulch on 5-foot row centers with drip tape buried 1 to 3 inches deep below the plastic and either 3 to 5 inches to the side of the row or in the center, depending upon whether a single- or double-row crop is being grown. Use care in laying tubing straight so it will not be damaged when transplanting. Plastic laying machines can lay drip tape and plastic mulch in one operation.

WATER MANAGEMENT AND OPERATION

Drip irrigation is, in many ways, a different way of irrigating. A small supply of water is applied as the plant needs it, usually on a daily or more frequent basis. The goal should be to achieve a high level of efficiency to get maximum production of produce from minimal amounts of water. As the plant grows, larger quantities of water are needed as root systems become more extensive and foliage growth increases. Thus, as the season progresses, more water needs to be applied and, obviously, under hot, dry conditions, more water is needed to replace evaporative losses (crop water use).

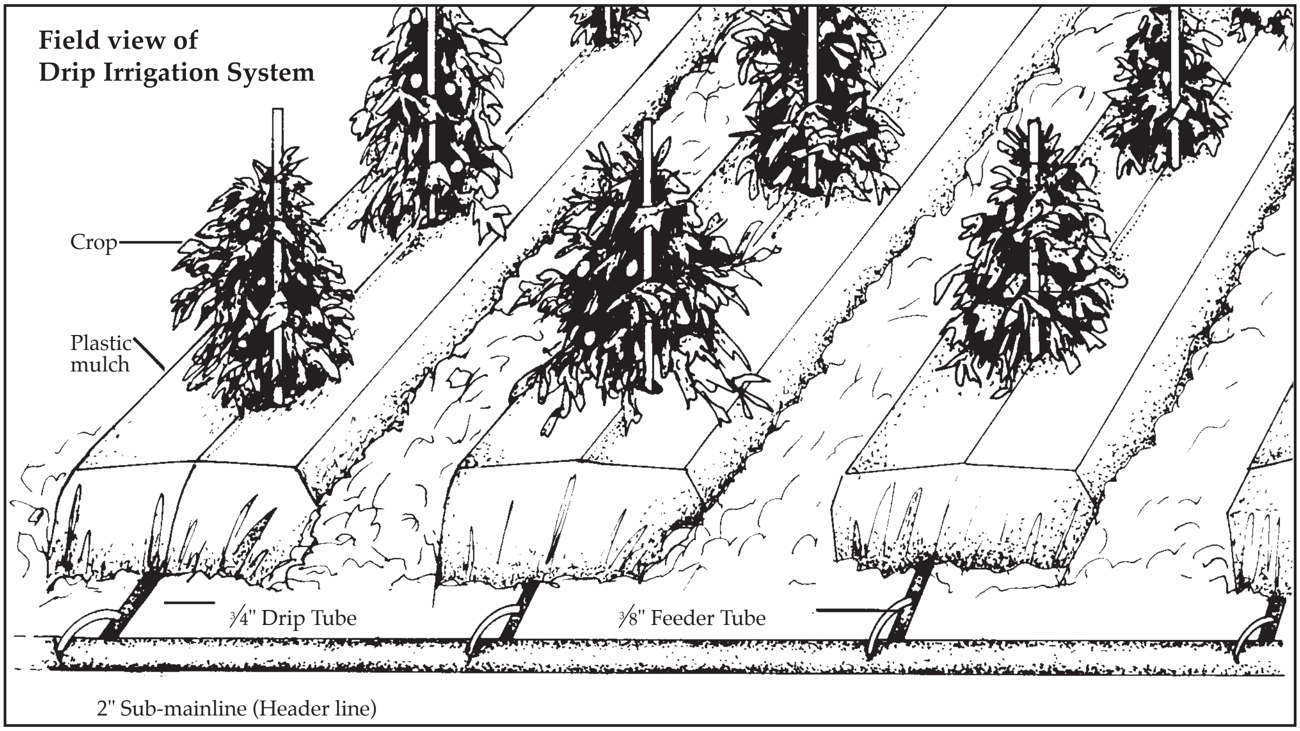
As an example, the operation time needed for a young crop in cool weather on a typical Kansas vegetable crop may be one to two hours every two or three days. As the crop grows, two or three hours per day may be required. In extreme stresses, three or more hours may be required. The exact water requirement, however, will depend on crop, weather, soil and system capacity.

Water lost by evapotranspiration can be estimated by an open pan and is usually quoted by agricultural weather reports as *pan evaporation*.
A crop in full vegetative growth usually needs to be replenished at about 80 percent of the pan evaporation level.

Calculations are made using the formula:

Gallons/100 ft/day = 50 × 80% pan evaporation × Row spacing in feet

Example: If .25 inch of water is lost per day from pan evaporation on a crop of melons on 5-foot row centers, how much water should be supplied?



Gallons/100 ft/day = 50 × (0.25 in × 80%) × 5 ft

= 50 × 0.2 × 5

= 50 gallons/100 ft

If your drip tube drips at 25 gallons/100 ft/hour, then two hours would be necessary to replace water lost.

TENSIOMETERS

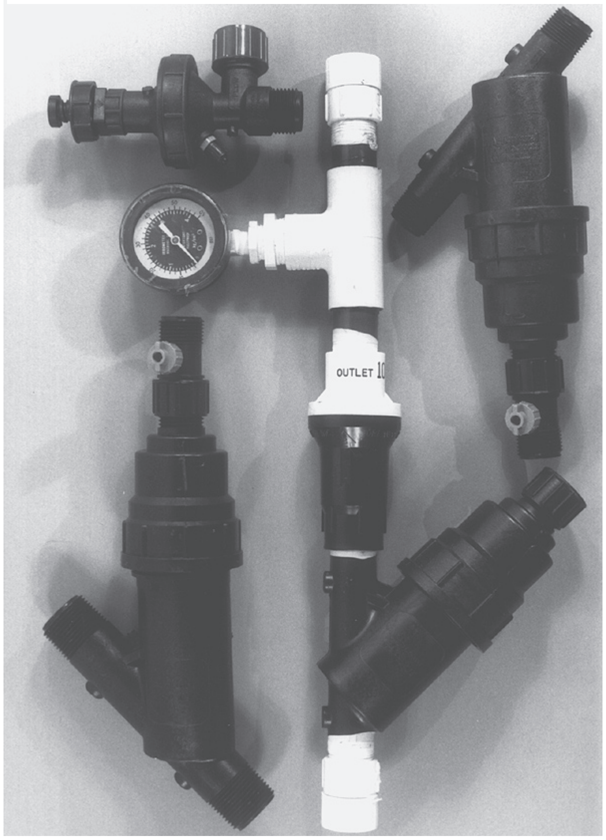
A far easier method of determining daily crop water needed for crops on drip irrigation system is the use of tensiometers. A tensiometer consists of a porous, porcelain-tipped tube of water with a vacuum gauge at the top. The tensiometer is placed at root zone depth with the porous tip buried in the soil. As water moves from the porous tip, a vacuum reading (in centibars of soil suction) indicates the soil water status. Tensiometers work well in the sandy soils of Kansas vegetable growing areas. A value of 0 means the soil is completely saturated with water. A reading of 10 represents a normal field capacity soil water status. Irrigation systems should begin when a reading of 20 to 30 is indicated on the gauge.

Tensiometers are usually installed in *pairs*, called a "station," one at a 6-inch depth and one at a 12-inch depth. They are installed in the crop row about 4 inches from the row middle on the side opposite the drip tube. The drip system is turned on when the deeper (12-inch) tensiometer reads 20 to 30 and turned off when the shallow (6-inch) tensiometer drops to 10 or below. Tensiometers can be purchased with solenoid switches to allow com-plete automation of the irrigation process. For additional information see K-State Research and Extension leaflet, "Tensiometer Use in Scheduling Irrigation," L-796.

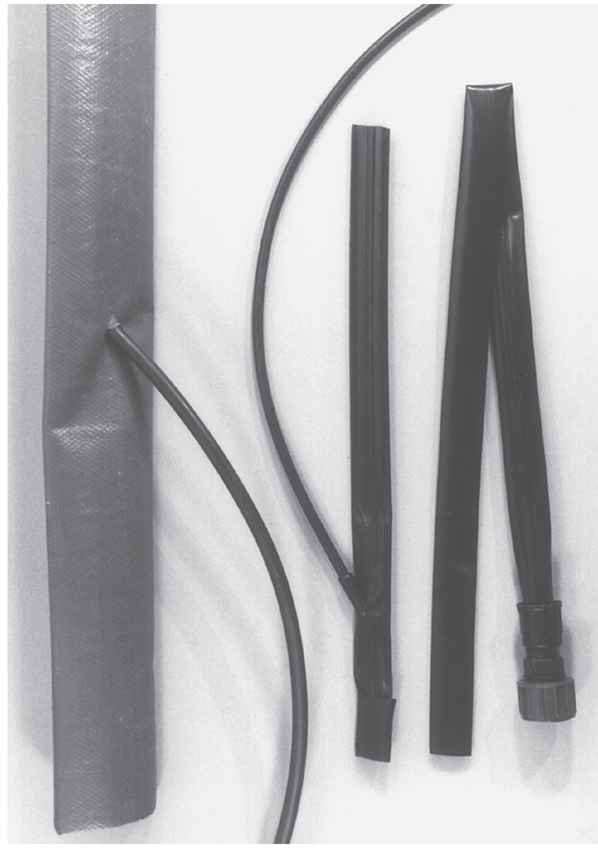
MAINTENANCE

The drip system filter should be checked daily and cleaned if necessary. A clogged screen filter can be cleaned with a stiff bristle brush or by soak-ing in water. Sand filters need to be back-flushed. Check lines for excessive leaking. A large wet area in the field indicates a leaking drip tube. You can install a connector to the leaking tube or bypass the leak with a short piece of feeder tube.

Excessive mineral precipitates on drip lines can be dissolved with acids, usually phosphoric acid. Tapes buried under plastic mulches are much less apt to become clogged from precipitates.



Regulator and Filtration
Adustable pressure regulator (upper left), Preset pressure regulator, pressure gauge and filter (center), Y filters (lower left and upper right).



Vinyl lay flat hose with feeder tube attached (left), Feeder tube inserted into drip tape (center), and plastic drip tape (right).

Bacteria, algae and "slime" in lines can be removed by injections of chlorine or commercial bacterial control agents applied through the fertigation system. Use a 2 ppm chlorine daily "rinse" at the end of the irrigation cycle or a 30 ppm "shock treatment" if slime becomes a problem in the system. Consult with a drip system representative for dilution rates for commercial cleaning products.

Periodic flushing of the mainline, sub-mainline and drip tape is an excellent maintenance practice. Adapters are available for the ends of each drip tape to automatically flush lines at the end of each irrigation cycle, or they can be manually opened to allow a few gallons of water to flush from the end. This will prevent any build-up of particles or slime at the end of the drip line.

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