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WHAT ABOUT DRIP IRRIGATION

by

Jack Keller and R. J. Hanks

Drip or trickle irrigation is a relatively new method for irrigating farm crops. The general idea is to utilize a pipeline system with very closely spaced outlets in order to apply water almost directly to each plant. The concept of applying water directly to each plant has had a long history of utilization in greenhouse culture. It is a relatively new practice, however, for utilization in extensively grown vegetable, orchard and field crops.

The use of drip irrigation for farm crops was not practical until low cost plastic tubing became available. The first field application of drip irrigation was somewhat by accident. It had been discovered that the rather continuous application of water to a growing plant was capable of producing some unusual yield responses. The early innovators first tried to develop an underground or sub-irrigation system using small buried pipelines underneath each row of plants with closely spaced water outlets or emitters. These systems not only had clogging problems from dirt in the water but also the roots entered the drippers and clogged them from the outside.

To overcome the root clogging problem, the small pipelines were laid directly on the ground surface and we have what is called drip or trickle irrigation. The development of drip irrigation began over ten years ago. For a number of crops, water, soils and climatic conditions, the results have been outstanding. Because of these successes there has been a great deal of enthusiasm, not only on the part of farmers who are potential users of the equipment, but also among manufacturers who might be potential suppliers since a great deal of equipment is involved.

Today drip irrigation is being used throughout the world with major areas of concentration in the United States, Australia, Israel and South Africa. It has been estimated that there are over 10,000 acres of drip irrigation in the U.S. today and the acreage is apt to double within the next year or so. Reports from Australia and Israel indicate they have similar levels of activity. All in all there may be as many as 30,000 to 50,000 acres under drip irrigation throughout the world and it is expected that the area will double within the next two years.

Advantages

A survey made of Australian farmers that have been using trickle irrigation list the following advantages (by order of importance):

1. Labor saving
2. Better yields
3. Access to orchard at all times
4. Water saving
5. Water control
6. Cheap installation
7. Weed control

Labor savings result from the trickle system since it is a permanent system which, once purchased and installed, is relatively easy to run. Better yields result from better water control.

Since water is delivered to the soil almost continuously, there is a portion of the soil root zone that has a water content between saturation and field capacity. For many plants this has a decided advantage because marketable yield is highly dependent on the water potential of the soil.

Yield increases are generally accepted to be due to the high frequency of irrigation rather than the type of system where no problems resulted from soils with low infiltration. In many instances, yield were not only greater but the size of fruit was greater and more uniform, thus bringing higher prices per unit weight. In some instances, more uniform ripening resulted in a shorter and more efficiently managed harvest season. Less problems caused by sorting, etc. have been reported.

The trickler system also allows water to be placed in the plant row with minimum wetting between rows. This feature minimized weed growth between rows and allows for passage of machines at any time. Wetting only in the rows decreases the amount of surface evaporation of water also thus making more water available for transpiration. For wide spaced crops considerable saving of water needed (especially when plants are small in the early stage of growth) to maintain growth can be realized. For an orchard, the water needed immediately after planting may be only one-fifth that which is needed with sprinklers. At maturity the savings will be less but still may be substantial with trickle using about three-fourths as much as sprinkling. For the same amount of water applied, the water applied by trickler wets the soil underneath the roots to a deeper depth than if sprinklers were used.

Trickler irrigation may have some advantage in the control of diseases and pests because of the avoidance of wetting of the leaves, thus reducing the humidity near the leaf surfaces compared to a sprinkler system. In addition, trickle irrigation does not wash off any insecticide or fungicide sprays as sprinkling may.

Another advantage of the trickler system is associated with the low application rate. This application rate is lower than the infiltration capacity of all soils--thus there is no run-off. Since there is no run-off, the need for leveling before planting is minimized. The system can be used effectively on all soils especially problem soils such as dense

clays, that swell upon wetting with ordinary irrigation and cause considerable run-off and erosion.

The trickler system is said to have advantages where soils are salty or the irrigation water is salty. Since the water content in the root zone is kept higher with tricklers than with other systems, the salt concentration in the soil solution will be lower for the trickler than other systems and thus plant growth will be influenced by the salt to a smaller extent. The same amount of water will wet deeper, in the root zone, in a trickler than the conventional systems which may also aid in removing salts from the root zone. Since water is delivered to the soil rather than into the air, as with sprinklers, plant leaves are not wetted. Wetting of leaves can be a serious problem if the water is salty as well as contributing to some disease problems. There are some disadvantages involving salty soils or salty water that will be discussed later.

Disadvantages

As would be expected with an irrigation system offering better control of water applied, the disadvantages are mostly related to economics and convenience in working the soil in the field.

Since the water flow rate from each dripper is low, many drippers are needed to apply the same amount of water as can be applied with one sprinkler. At least one water line is needed for each row because of the low flow rate and nearly constant flow. Thus, the system is essentially a solid set system. Economics will dictate that the systems be used only on high economic return crops and/or wide row crops. The economics of the system is discussed in another section.

With the many water lines needed there will need to be special effort made to bury supply lines so that traffic will not be impeded where needed, which will further contribute to the expense.

Another disadvantage is the need for very clean water if the dripper orifices are not to clog. Numerous "drippers" have been proposed, only a few of which do not have serious "clogging" problems. Since hundreds of drippers are needed for every acre it has been found most practical to filter the water rather than attempt to mechanically clean clogged drippers. Filters are recommended for all drippers currently manufactured. There is a distinct need for better filters requiring less cleaning. The filter system used should be carefully considered because it will be a major part of the system.

Where salty water is used much remains to be learned about the best way of handling the salt that accumulates at the edge of the wetted area, especially near the surface. Careful attention must be paid to the placement of rows the year following the use of the trickler system to assure that seeds are not planted in the salty spots between the rows of the previous year. If salts are a problem, other methods other than the trickler system will probably have to be used to leach the salt because of the low water application rate, non-uniform wetting, and the long time required to achieve leaching associated with the trickler system.

One potential disadvantage with maintaining soil-water at a high level is consequent maintenance of soil-air at a low level. However, no aeration (air level too low) problems have been reported using the trickler system. This may be due to the wetting of only part of the soil--thus, only part of the plant roots are in a low air condition. This incomplete wetting by the tricklers would be an advantage compared to a sprinkler system even if the frequency were the same.

Drip irrigation systems are really very simple. The uniqueness of the system is based on the concept of applying an almost continuous supply of water to every plant through an extensive surface pipeline network with dripper outlets. Water oozes or drips from the outlet directly onto the ground with a minimum of pressure required. Rate of discharge from the drippers must be very low so the water can soak into the ground where it falls. Common rates of discharge range between one and ten quarts per hour.

Base operating pressures in the neighborhood of 10 to 30 pounds per square inch are normally utilized. Actually, lower pressures would be possible, however, a reasonable base pressure is needed in order to reduce the variations in flow which would occur due to friction loss in the pipe system and differences in elevation.

One of the major problems with the drippers is that of clogging. A number of ingenious methods have been suggested for achieving a non-clogging opening which discharges very little water even at relatively high pressures. Perhaps the most universally used and proven concept to date has been the utilization of a dripper wherein the water leaves the lateral pipe and travels through a long capillary spiral before being discharged on to the ground. Discharge is controlled by the length of the tube rather than by using tiny passage ways or orifices. Thus, even fairly large particles of sand do not cause clogging.

The drippers, which are made of plastic, are attached at periodic spacings along small diameter plastic pipes called lateral lines. Low density black polyetheline 1/2-inch hose is the most commonly used lateral pipe material. Although very thin walled pipe can be used for the low pressures involved, a wall thickness of 0.05 inches has been recommended for 1/2-inch pipe in order to resist kinking and still be fairly flexible.

The lateral lines are connected to plastic sub-main pipes which are installed at right angles to the laterals. In turn, the submains are supplied from a main pipeline network.

Note the photograph of a typical drip irrigation system layout for vegetable crops. In this picture the small diameter pipes with drippers installed are attached to an underground sub-main. The main supply line can also be seen. The sub-main is buried since it runs at right angles to the laterals and would be an obstacle to cultivation and other farming practices if it were on the surface. Obviously, one of the problems with the system is the high density of pipe on the ground which does hinder farming operations.

In addition to the pipeline and dripper network, a very sophisticated filtration system is normally required (except when a very clean well water is available). Most suspended solids that are likely to block the systems can be removed by a fine mesh screen provided a sufficient surface area is employed. Centrifugal filters have been successfully used to remove fine sand and silt when operated at their optimum design capacity. Filters fine enough to remove algae usually block quickly and chemical treatment of the water supply seems to be the most effective answer. Carbonate formations and flocculated colloids are a serious problem and must be removed by treating with weak concentrations of hydrochloric acid.

The final components of the drip irrigation system involve the pumping plant and the equipment for adding fertilizer to the water.

System Costs

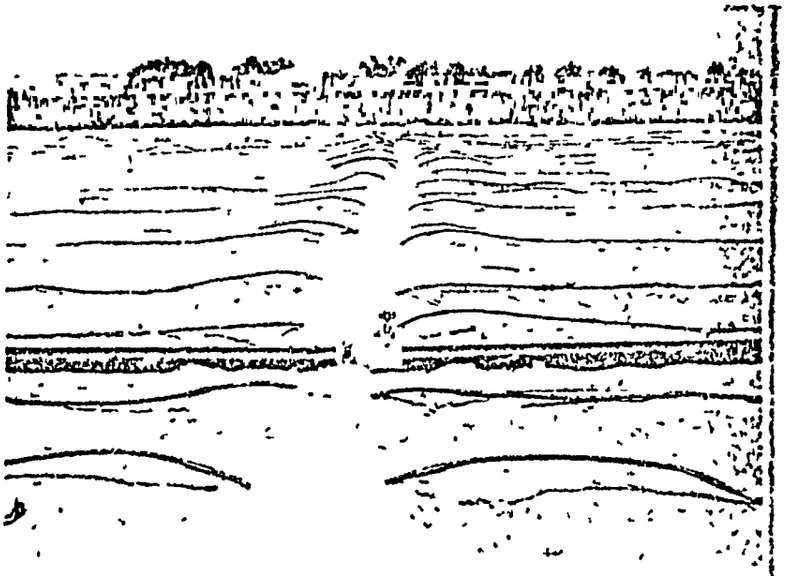
The major cost items in drip irrigation systems are the drippers, the laterals, the mainlines, and the pumping plant with filters and fertilizer injectors. Dripper prices range anywhere from approximately 10 cents to 75 cents installed in the lateral. Since very large numbers of drippers are needed, these generally make up the major cost item in the system. Although the lateral pipe costs in the neighborhood of 2 cents per foot, it also is a major cost item because of the length of pipe involved. Table 1 shows an estimate of the drip irrigation system needs and cost per acre for various types of crops. The cost estimates are for the drip irrigation system assuming the water supply is already provided to the field. From Table 1, it is apparent that the greater number of plants per acre, the more expensive the system. It is also evident that except for orchards and vineyards, drip irrigation is probably only feasible for very high value crops.

Estimates of the costs of owning and operating drip systems would indicate the following in orchards where water costs are very low, costs may be competive with surface and sprinkler irrigation systems. With very high water costs and under more adverse conditions of poor infiltration, steep slopes, salinity, etc., drip irrigation may be less expensive than sprinkler or surface irrigation systems. For most crops, drip irrigation is only feasible where the added productivity can offset the high costs.

Table 1. General estimate of drip irrigation system equipment needs and cost per acre for various types of crops.

Type of crop	Ordinary orchards	Dwarf orchards and vineyards	Berries and wide spaced row crops	Greenhouse and close-spaced row crops
Row spacing	20 ft.	12 ft.	5 ft.	40 in.
Trees, vines or plants per acre	100	400	6,000+	10,000+
Drippers per acre	200-600	800	3,000+	4,000+
Length of lateral per acre	2,500 ft.	4,000 ft.	9,000 ft.	14,000 ft.
Cost per acre*	$150-250	$350	$700+	$1,200+

*Cost of drip irrigation equipment and filters--does not include cost of water supply system.



Photograph of a typical drip irrigation system layout for vegetable crops. The small diameter pipes with drippers installed are attached to an underground sub main. The main supply line can also be seen. The sub main is buried since it runs at right angles to the laterals and would be an obstacle to cultivation and other farming practices if it were on the surface. Obviously, one of the problems with the system is the high density of pipe on the ground which does hinder farming operations.