A Brief Discussion on the Research Status of Subsurface Drip Irrigation Technology in China

Jing He1, 2, 3, 4, *

1Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd, Xi’an, China
2Shaanxi Provincial Land Engineering Construction Group Co., Ltd, Xi’an, China
3Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xi’an, China
4Shaanxi Provincial Land Consolidation Engineering Technology Research Center, Xi’an, China

*Corresponding author e-mail: dqguang@stu.xjtu.edu.cn

Abstract. Subsurface drip irrigation technology is a new water-saving irrigation technology formed by continuous improvement in the agricultural production process. At this stage of development, Subsurface drip irrigation technology has been extremely mature, from its theoretical basis to equipment production and on-site irrigation production.

1. Introduction

The main driving force of water in the soil is the capillary force, which flows densely in the form of water flow or diffuses in the form of water vapor. When the soil is dry, the capillary force is greater than gravity, so that the water will spread evenly, including upward flow; with the gradual wetting of the soil, the capillary force will decrease, and gravity will gradually occupy the dominant position, causing the water to move downward under its action. Therefore, the basic management method is to combine the subsurface drip irrigation technology with high-frequency pulse irrigation. The capillary force is mainly used to control the water and flow, so the crop can often absorb what it needs in a small area around the root area. Water and nutrients.

For crops, subsurface drip irrigation may be the latest, most complex, and most efficient irrigation method, which can optimize water use efficiency and crop yield at the same time. Subsurface drip irrigation is a kind of microscopic technology. It means that water or water and fertilizer mixture flows slowly into the surrounding soil through the irrigator on the buried capillary, and uses capillary force or gravity to diffuse water to the roots of the crop. The area is for crop absorption and utilization. There is little disturbance to the soil structure during the irrigation process, which can better ensure the permeability of the soil in the active area of the crop roots, reduce the evaporation of irrigation water, and have a significant effect of saving water and increasing production. The field water pipeline is buried underground, which is convenient for farming and crop planting, and enhances the anti-aging performance of the pipeline and is not easy to be damaged or lost [1].
2. The advantages and disadvantages of subsurface drip irrigation

2.1. Advantages

Compared with other irrigation technologies, the subsurface drip irrigation technology has the following advantages:

- **Save water and energy.** Compared with ground irrigation, it saves 1/3 to 1/2 of water, 15% to 20% of water compared to spray pipes, and has low energy consumption. Surface irrigation is the simplest method at present, but the utilization rate of water resources is too low, resulting in a lot of waste of water resources, such as ground evaporation, surface runoff, deep leakage, etc.; sprinkler irrigation is greatly affected by wind, evaporation, drift and interception. Disadvantages such as large loss, large energy consumption, one-time investment and high operation management and maintenance costs;

- It can produce good environmental benefits. The subsurface drip irrigation technology can deliver nutrients or pesticides directly to the roots of crops, and there is almost no deep leakage and soluble salts below the roots of plants, reducing the pollution of deep soil and groundwater;

- It can improve the quality and yield of agricultural products. Subsurface drip irrigation can reduce the humidity of the ground surface and maintain a higher surface temperature. The soil structure of the cultivated layer is good, which creates a good environment for crop growth, is conducive to overwintering and early maturity of crops, reduces and prevents the occurrence of pests and diseases, and is conducive to improving crop products. Quality, improve the quality of crop products.

- Fourth, the fertilizer utilization rate is improved. Subsurface drip irrigation can deliver water and nutrients to the roots in a timely and appropriate amount during the entire growth period of the crop, and irrigate the water and fertilizer together to accurately deliver the root zone to reduce water evaporation and fertilizer migration and loss.

2.2. Disadvantages

While the subsurface drip irrigation system has many advantages, it also has certain disadvantages. The disadvantages are as follows:

- Easy to cause blockage. The clogging of the dripper is the most important problem in the current drip irrigation application. In severe cases, the entire system will not work properly or even be scrapped. The cause of blockage can be physical, biological or chemical. Such as sediment, organic matter or microorganisms and chemical sediments in the water. Therefore, the water quality requirements for drip irrigation are strict, and it should generally be filtered, and sedimentation and chemical treatments are required when necessary;

- Irrigation uniformity is not easy to control. Because the pipes and emitters of subsurface drip irrigation are located underground, it is not easy to measure the irrigation flow. Due to the small flow rate, it is easy to be affected by temperature and manufacturing deviation, making the flow rate uneven. And its irrigator is in direct contact with the soil, which is affected by soil texture, compactness and water conductivity.

- Third, it is not conducive to seed germination and seedling growth. Because the pipeline is buried at a certain depth underground, the surface soil layer is generally dry. After sowing, the water irrigation required for germination of seeds cannot be met, and other measures are needed to replenish them.

- Fourth, the requirements for operation management are high. Since the pipeline is buried in the ground, once a failure occurs, inspection and repair will take time and cost. Therefore, the daily maintenance requirements for the subsurface drip irrigation system are very high.

3. The composition of subsurface drip irrigation

The drip irrigation system is mainly composed of four parts: water source, head hub, water transmission and distribution pipe network and dripper [2]:

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Water source: rivers, lakes, canals, ponds and wells can all be used as water sources for drip irrigation. However, the water body containing dirt and sand has caused the dripper to be blocked, which is not suitable as a water source. When the water body is not suitable for drip irrigation, it must be properly treated. In order to ensure the water source of drip irrigation, it is often necessary to build special water source projects, such as reservoirs, diversion channels, etc.

The first hub: The first hub of the drip irrigation project includes water pumps, power machinery, control valves, fertilizer tanks, filters, control and measuring instruments and protection equipment. Its function is: pumping, fertilizing, filtering, and sending a certain amount of water into the main pipe under a certain pressure; it is an important part of the whole system control and scheduling, and it is also the core of the entire drip irrigation system;

Water transmission and distribution network: The water transmission and distribution network of the drip irrigation system includes three-stage pipelines of main pipes, branch pipes, capillary pipes and necessary adjustment equipment (such as pressure gauges, gate valves, flow regulators, etc.). The task of water distribution is generally buried below the depth of the local frozen soil layer, and the capillary is responsible for field irrigation tasks, depending on the situation whether it is buried in the ground. Its function is to evenly deliver pressurized water to the dripper;

Dripper: Its function is to make the water flow through tiny pores to form energy loss, reduce its pressure, and make it drip into the soil in a drip. The dripper is usually placed on the surface of the soil, but it can also be shallowly buried for protection.

4. Research status of subsurface drip irrigation

4.1. Irrigators and equipment
All subsurface drip irrigation equipment used abroad comes from ground drip irrigation, and the irrigator uses built-in or compensating drippers to ensure the uniformity of the system's water supply. The main research is the uniformity and dripper clogging. Domestically, certain results have been achieved in terms of uniformity and blockage, as well as the relationship between wetting body and pressure flow.

4.2. Buried depth and spacing of capillary
Studies believe that the depth of capillary burial must be compatible with soil conditions, crop root depth, and farming requirements. Different burial depths have different effects on deep leakage, irrigation uniformity, root system and above-ground growth during crop growth period.

The spacing between capillary tubes mainly depends on the local climate conditions, soil texture and crop types. For crops planted in sandy soil or arid areas, the use of smaller capillary spacing helps to evenly distribute water in the field, but the corresponding equipment costs will increase. In rainy and humid areas, a wider capillary spacing is used, but this depends on the crops grown, soil conditions, and acceptable risk levels [3].

4.3. Irrigation schedule
The irrigation system of subsurface drip irrigation is generally formulated based on the measured or calculated evaporation, soil and crop characteristics. If the time is determined according to the water consumption rate of the crop, a small fixed amount of water should be used for multiple irrigation; when the soil moisture drops to a certain lower limit of water, the irrigation starts, and the irrigation is enough once a few days. The first irrigation frequency is generally used for crops with more water content.

4.4. Application of chemical fertilizers and pesticides
Relevant studies have shown that reducing the application of nitrogen fertilizers allows to maintain the same yield, and the application of phosphate fertilizers is less than that of ground drip irrigation.
4.5. Design and management
The design method of surface drip irrigation system is still applicable to subsurface drip irrigation system, especially in terms of pipe hydraulic performance and irrigation water uniformity. But it also has its own characteristics, such as the need to install intake and exhaust valves.

4.6. Economic adaptability
Existing subsurface drip irrigation experiments have shown that, compared with other irrigation methods, the crop yield of subsurface drip irrigation is increased, at least not reduced, and its water saving effect is obvious.

4.7. Environmental benefits
The research in this area is mainly about deep-seated leakage, NO3- leaching and salt accumulation on the soil surface. There are controversies about deep leakage. Some studies believe that the deep leakage of subsurface drip irrigation is greater than that of above ground drip irrigation, and some believe that it reduces the amount of deep leakage. However, it has become a consensus that subsurface drip irrigation can reduce the pollution caused by agricultural irrigation.

5. Conclusion
Subsurface drip irrigation is recognized as one of the most promising high-efficiency water-saving irrigation technologies. Nowadays, the research on subsurface drip irrigation technology is basically based on the cognition on the basis of the understanding of ground drip irrigation. There is a lack of sufficient research results to meet the needs of practice. Therefore, further research on subsurface drip irrigation technology is needed to overcome its shortcomings. In order to promote the development of water-saving irrigation technology in our country, to alleviate the shortage of water resources in our country, and to eliminate the contradiction in water use in our country, it is of great significance.

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