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Sub-Surface Drip Irrigation (SSDI)

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Abstract

Sub-surface drip irrigation (SSDI) is a low pressure, high efficiency irrigation system that uses buried drip laterals to meet crop water requirements. A sub-surface drip irrigation system is flexible and can provide frequent irrigations. This is more suitable for arid, semi-arid, hot, and windy areas with limited water supply, especially on sandy type soils. Since the water is supplied below the soil surface, the effect of surface irrigation characteristics, such as crusting, saturated conditions of ponding water, and potential surface runoff are eliminated. With well-maintained system, water application is highly uniform and efficient. Wetting occurs around the lateral and moisture moves out in all directions due to capillarity.

Introduction

Sub-surface drip irrigation applies water directly into the root zone of the crop (Figure 1). It will improve yield due to high application uniformity and also reduced weed, surface water evaporation and disease incidence. SSDI systems can have higher long-life expectancy, but good design and maintenance are essential for that. Clogging of dripper or emitters is the primary reason for system failure. When managed properly with a fertilizer injector, water and fertilizer application efficiencies are enhanced, and labour requirement are reduced. Field operations are also possible, even when irrigation is applied.

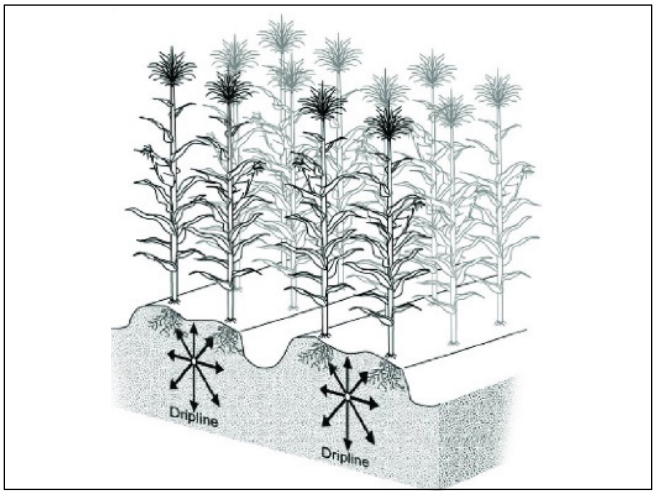


Figure 1: Sub-Surface Drip Irrigation system

Layout

A typical system layout consists of a pumping unit, pressure relief valve, non-return valve, a filter, fertigation unit and PVC pipe lines delivery system to carry the water to the field. The delivery system is composed of main, sub-main and manifold, to which the laterals are attached. Water meter and pressure gauges are essential

to monitor the performance of the system. It is essential to provide an air release valve at the manifold for the release of trapped air when the pump is shut off. This valve has to be installed at the highest point in the pipe lines. Flush valves and end cap at the end of each pipe line and tube at the end of the field are also essential for clearing small soil particles that have passed through the filter system and for draining the pipes and tubes at the end of the irrigation season.

Placement of Laterals

The laterals are laid below the soil surface (Figure 2). The depth of placement of laterals may vary from 15 to 25 centimetres, depending on the soil, top soil depth and crop. Shallow-rooted crops, may require placement as shallow as 10 to 15 centimetres below the surface. Laying of laterals in the soil profile depends on the capillary action of the soil. Some soils, such as quick draining sandy or gravel soils, do not distribute moisture evenly out from emitters. Placing the laterals deeper in the soil also enhances soil tillage benefits. Once a lateral depth is decided on, consistent depth placement of lateral helps to achieve uniform soil-water content throughout the field (Lamm *et al.*, 2003).

Figure 2: Placement of lateral

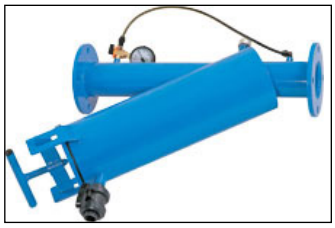
Filtration

Filtration unit is necessary, that will filter all the particles that are bigger than the dipper orifice size. As a thumb rule, filters should remove particles four times smaller than the emitter opening (Reich *et al.,* 2014). A filtration system mainly consists of sand media filters [Figure 3(a)]; however, a combination of screen [Figure 3(b)] and disk filter [Figure 3(c)] with sand media filters is highly desirable. A screen filter installed before sand media filters will remove larger organic and inorganic debris (*e.g.,* leaves, algae) before the suspended material reaches the sand filter. A 200 mesh filter is adequate for most types of emitters although some emitters require only 100 mesh. Hydrocylcone filter [Figure 3(d)] is needed when the water is pumped from very deep bore wells.

Fertigation

Fertigation is a process that combines fertilization and irrigation. Fertilizer is added into an irrigation system. Fertigation reduces the nutrient deficiencies more effectively. It also reduces soil erosion and water consumption, reduces the amount of fertilizer utilized, and controls the time and rate it is released. Fertigation is done through ventury, fertilizer tank and fertilizer injector pump.

(a) Sand filter



(b) Screen filter

(c) Disc filter

(d) Hydrocyclone filter

Figure 3: Different types of filters

Ventury [Figure 4 (a)]

Very simple and low-cost device. A partial vacuum is created in the ventury, which allows suction of the fertilizer solution into the irrigation system through ventury action. The vacuum is created by diverting a small portion of water flow from the main and passes it through a constriction which increases the velocity of flow thus creating a drop in pressure. When the pressure drops the fertilizer, solution is sucked into the ventury through a suction pipe from the tank and from there enters into irrigation stream.

Fertilizer Tank [Figure 4 (b)]

In the fertilizer tank portion of irrigation water is diverted from the main line of flow through a tank containing the fertilizer in a fluid form, before returning to the mainline, the pressure in the tank and the mainline is the same but as light drop in pressure is created between the offtake and return pipes for the tank by means of a pressure reducing valve. This causes water from mainline to flow through the tank causing dilution and flow of the diluted fertilizer into the irrigation stream. With this system the concentration of the fertilizer entering the irrigation water charges continuously with the time, starting at high concentration.

Fertilizer Injector Pump [Figure 4 (c)]

Fertilizer injector pumps are piston or diaphragm pumps which are driven by the water pressure of the irrigation system and such as the injection rate is proportional to the flow of water in the system. A high degree of control over

(a) Ventury

(b) Fertilizer Tank

(c) Fertilizer Injector Pump

Figure 4. Types of fertigation equipments

the fertilizer injection rate is possible. If the flow of water stops, fertilizer injection also automatically stops.

Conclusion

SSDI can be a sustainable irrigation system option, but many issues should be carefully considered before installing the system. The initial investment costs for an SSDI system are high. Designing efforts are to be taken to minimize investment costs whenever possible and practical. For water conservation and water quality protection, proper design procedures must be followed. SSDI system must be properly designed to ensure system longevity.

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