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DRIP IRRIGATION: A MODERN SOLUTION FOR WATER EFFICIENCY

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Introduction

Drip irrigation, also known as trickle or micro-irrigation, is a cutting-edge way of watering plants that is especially useful in areas with limited water supplies or difficult soil conditions. By supplying modest amounts of water directly to the root zone, this approach guarantees that plants receive the moisture they require without waste. In locations where traditional irrigation technologies are inadequate, drip irrigation provides a long-term alternative for increasing crop productivity while reducing water usage. Drip irrigation, invented by Simcha Blass in Israel, is now widely employed in both big agricultural farms and tiny home gardens around the world. It operates with low water pressure and uses plastic pipes, valves, and drippers, making it both water-efficient and cost-effective in the long run. In this post, we will look at the major components, advantages, limitations, and costs of drip irrigation systems.

Highlights of drip irrigation

Simcha Blass of Israel pioneered drip irrigation, which has transformed modern agricultural techniques by providing an efficient water management option. This technology supplies water at a low rate, often less than 12 liters per hour, ensuring that plants receive the moisture they require directly at their roots, reducing waste. The system works at 2.5 kg/cm², resulting in significant water savings of 40-70%. Additionally, drip irrigation can improve agricultural yields by 25-100%, demonstrating its usefulness. Reduced pumping hours and reduced friction losses can result in energy savings of up to 50%. Overall, drip irrigation may reach water consumption efficiencies of up to 90%, making it an ideal resource conservation approach for sustainable agriculture.

Area coverage of Drip irrigation in India

The overall area under micro-irrigation increased significantly between 2018 and 2019, indicating a good trend in the adoption of these systems. The overall area has increased from 10,254,407 hectares in 2018 to 11,412,926 hectares in 2019. Maharashtra continued to have the most micro-irrigated land in both years, with a significant use of drip irrigation, followed by Rajasthan, Karnataka, and Andhra Pradesh. Among the states with significant gains, Gujarat saw a growth from 1,281,136 hectares in 2018 to 1,421,914 in 2019. Tamil Nadu increased from 503,206 to 675,651 hectares, whereas Telangana increased from 221,910 to 262,291 hectares within the same time period. However, states such as Arunachal Pradesh, Jammu and Kashmir, and Manipur saw little change in their micro-irrigation coverage, most likely due to topographical and climatic constraints that prevent widespread implementation.

Components of drip irrigation

Drip irrigation systems are composed of several critical components, each designed to ensure the precise delivery of water to plants:

Water Source

Typically, groundwater or surface water are used. Groundwater is favored due to its superior quality; however, surface water may require further filtering to avoid clogs. Water is distributed by a network of main lines, sub-mains, and lateral pipes. Drippers or emitters are inserted along the laterals to give water to the plant roots at a slow, steady rate.

Pump

A centrifugal pump or an overhead tank is employed to create enough pressure for the system. These pumps are necessary to ensure that water is distributed evenly over the irrigation field

Filters

Gravel, screen, and disk filters are used to remove pollutants from the water. These filters avoid blockages and provide a continuous flow of water to the plants.

- Gravel or media filters use fine gravel or coarse quartz sand (1.5-4 mm in diameter) in a cylindrical tank to remove light suspended contaminants from irrigation water such as algae, fine sand, and silt. These filters are crucial for first filtration, particularly in open reservoirs and canals. Water comes from the top, and the filter is cleaned by reversing the flow and opening a drainage valve. Pressure gauges measure head loss, and if it reaches 30 kPa, backwashing is necessary.
- Screen filters serve as the final filtration stage, capturing any minute particles that pass through the media filter. Screen filters are made of non-corrosive metal or plastic and come in a variety of sizes. They filter physical contaminants from water before it enters the irrigation system. The screen size ranges from 20 to 200 mesh, depending on the irrigation system.
- Centrifugal filters extract heavier materials, such as sand and fine gravel, from water by spinning them. Water is supplied tangentially at the top of a cone, where centrifugal force causes heavy particles to collide with the walls and settle at the bottom.

- Disk filters are made of stacked, grooved disks that catch trash, particularly organic material and algae. These filters are incredibly effective and come in diameters ranging from 25 to 400 microns. Backflushing can clean them, although it requires high pressure (up to 2-3 kg/cm²).

Fertigation

Fertigation, also known as nutrigation, is the administration of soluble fertilizers and micronutrients to crops using an irrigation system. Drip irrigation is ideal for fertigation. Fertigation is primarily utilized to meet the crop's nitrogen, phosphorus, potassium, calcium, and magnesium requirements. Soluble and liquid versions of certain micronutrients are now acceptable for use in fertigation. When utilizing these goods, take care not to cause incompatibility difficulties.

Fertilizers Suitable for Fertigation

Name	Chemical form	N-p_2o_5-k_2o
Ammonium Nitrate	NH4NO3	34-0-0
Ammonium Sulfate	$(NH4)_2SO_4$	21-0-0
Urea	$CO(NH_2)_2$	46-0-0
Diammonium Phosphate	$(NH4)_2HP_2O_5$	18-46-0
Potassium Chloride	KCl	0-0-60
Potassium Nitrate	KNO_3	13-0-44
Potassium Sulfate	K_2SO_4	0-0-50
Phosphoric acid	H_3PO_4	0-52-0

Equipment and Methods for Fertilizer Injection: Injecting fertilizer and other agrochemicals such as herbicides and pesticides into the drip irrigation system is done using

i) using-pass pressure tank
ii) Venturi system;
iii) Direct injection system.

i) By-pass Pressure Tank:

Fertilizer (dry or liquid) is placed in a tank that is linked to the main irrigation line via a bypass. A portion of the irrigation water travels through the tank and dilutes the fertilizer. This flow is regulated by a pressure difference caused by a valve or constriction in the main line.

ii) Venturi Injector: This technology generates a vacuum by limiting the main water flow, sucking fertilizer solution from a reservoir into the irrigation system. It is a simple and cost-effective approach that uses valves to manage injection rates.

iii) Direct Injection System:

A pump injects fertilizer straight into the irrigation line. The pump can be powered by an engine, an electric motor, or hydraulic pressure generated by the irrigation system. This approach allows for exact control of the injection rate, little head loss, and low operational expenses. The hydraulic pump is useful because it immediately stops the fertilizer flow if the irrigation system stops.

To prevent corrosion and clogging, two injection sites (before and after the filter) should be installed. The capacity of the system is determined by the concentration, rate, and frequency with which fertilizer is applied.

Clogging

Dripper clogging or plugging can occur as a result of precipitation and accumulation of dissolved salts such as carbonates, bicarbonates, iron, calcium, and manganese. Clogging is also caused by the presence of microorganisms, as well as iron and sulfur slimes produced by algae and bacteria. Clogging is typically avoided or cleaned through chemical treatment of water. Chemical treatments often employed in drip irrigation systems include adding chloride and/or acid to the water supply.

Acid treatment

Hydrochloric acid (HCl) is delivered into drip systems at the recommended rate. The acid treatment is continued until the pH reaches 4, at which point the system is turned off for 24 hours. The following day, the system is flushed by opening the flush valve and lateral ends.

Chlorine Treatment

Chlorine treatment in the form of bleaching powder is used to prevent the growth of organisms like algae and bacteria. The bleaching powder is dissolved in water and injected into the system for approximately 30 minutes. Then the system is turned off for 24 hours. After 24 hours, the lateral ends and flush valves are opened to clear the water of contaminants. Bleaching powder can be applied directly to the water source at a rate of 2 mg/liter, or through a venturi assembly.

Advantages of drip irrigation

- **Water Efficiency:** Drip irrigation saves water by delivering it directly to the root zone, reducing evaporation and runoff. This technique enables farmers to grow more crops using less water, so addressing the issue of water scarcity.
- **Increased Crop harvests:** A consistent and exact water delivery ensures that plants receive the proper moisture levels, resulting in healthier growth and larger harvests. In dry places where traditional methods may fail, drip irrigation provides long-term agriculture.
- **Fertigation:** Fertilizers and other nutrients can be delivered via the irrigation system, ensuring that plants receive a balanced supply of nutrients at the appropriate time. This technology reduces manual effort while also ensuring that crops are fertilized uniformly.
- **Energy Savings:** Drip irrigation uses less energy for water distribution, which lowers operational costs. Pumps run for shorter periods of time, resulting in lower energy use than typical irrigation systems.
- **Improved Soil Health:** Drip irrigation reduces soil erosion and waterlogging, which can harm plant roots and impair soil quality. The system's precise water application helps to maintain soil structure.

Limitations of drip irrigation

- **High initial costs:** Installing a drip irrigation system necessitates a significant upfront investment in equipment such as pipes, pumps, and filters. Small-scale farmers may find the installation costs exorbitant, but government incentives can sometimes help.
- **Maintenance Requirements:** To avoid blockage, the system should be maintained on a regular basis. Filters must be cleaned, and pipes must be inspected to ensure they are clear of clogs.
- **Clogging Issues:** Clogged drippers can limit system efficiency, especially if the water quality is low. Fine particles, algae, and salts can accumulate in pipes, decreasing the flow of water.
- **Rodent Damage:** In certain areas, mice and wild animals can eat through plastic pipes, resulting in leaks and system failures.
- **Water Distribution Difficulties:** In places with uneven terrain, establishing consistent water

distribution can be challenging without adequate system design

Conclusion

Drip irrigation is an innovative and efficient option for modern agriculture, particularly in water-scarce countries. By supplying water directly to plant roots, the technology maximizes water resource utilization, increases agricultural yields, and lowers operational costs. While the initial investment and maintenance can be difficult, the long-term benefits make drip irrigation an attractive option for farmers.

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