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Introduction to Micro-irrigation

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Micro-irrigation refers to low-pressure irrigation systems that spray, mist, sprinkle or drip. The water discharge patterns differ because emission devices are designed for specific applications due to agronomic or horticultural requirements. Micro-irrigation components include pipes, tubes, water emitting devices, flow control equipment, installation tools, fittings and accessories.
For first time users, it can be a confusing array of components and gadgets. It can be a challenge to select the right type of system and assemble the components suitable for irrigation needs. A description of various micro-irrigation systems, its many uses and limitations will help.

Micro-irrigation

The term "micro-irrigation" describes a family of irrigation systems that apply water through small devices. These devices deliver water onto the soil surface very near the plant or below the soil surface directly into the plant root zone. Growers, producers and landscapers have adapted micro-irrigation systems to suit their needs for precision water application. Micro-irrigation systems are immensely popular not only in arid regions and urban settings but also in subhumid and humid zones where water supplies are limited or water is expensive. In irrigated agriculture, micro-irrigation is used extensively for row crops, mulched crops, orchards, gardens, greenhouses and nurseries. In urban landscapes, micro-irrigation is widely used with ornamental plantings.

Emission devices

The actual application of water in a micro-irrigation system is through an emitter. The emitter is a metering device made from plastic that delivers a small but precise discharge. The quantity of water delivered from these emitters is usually expressed in gallons per hour (gph). These emitters dissipate water pressure through the use of long-paths, small orifices or diaphragms. Some emitters are pressure compensating meaning they discharge water at a constant rate over a range of pressures. Emission devices deliver water in three different modes: drip, bubbler and micro-sprinkler. In **drip mode**, water is applied as droplets or trickles. In **bubbler mode**, water 'bubbles out' from the emitters. Water is sprinkled, sprayed, or misted in the **micro-sprinkler mode**. Emitters for each of these modes are available in several discharge increments. Some emitters are adapted to apply water to closely spaced crops planted in rows. Other emitters are used to irrigate several plants at once. There are emitters that apply water to a single plant.

Drip irrigation

Depending on how the emitters are placed in the plastic polyethylene distribution line, the drip mode can be further delineated as a line source or a point source. The **line source** type emitters are placed internally in equally spaced holes or slits made along the line. Water applied from the close and equally spaced holes usually runs along the line and forms a continuous wetting pattern. This wetting pattern is suited for close row crops. The **point source** type emitters are attached external to the lateral pipe. The installer can select the desired location to suit the planting configuration or place them at equally spaced intervals. Water applied from the point source emitter usually forms a round deep wetting spot. The point source wetting pattern is suited for widely spaced plants in orchards, vineyards and for landscape trees or shrubs.

Line source emitter

Line source emitters are suitable for closely spaced row crops in fields and gardens. Line source emitters are available in two variations:

- Thin wall drip line
- Thick wall drip hose.

A thin walled drip line has internal emitters molded or glued together at set distances within a thin plastic distribution line (Figure 1). The drip line is available in a wide range of diameters, wall thickness, emitter spacing and flow rates. The emitter spacing is selected to closely fit plant spacing for most row crops. The flow rate is typically expressed in gallons per minute (gpm) along a 100-foot section. Drip lines are either buried below the ground or laid on the surface. Burial of the drip line is preferable to avoid degradation from heat and ultraviolet rays and displacement from strong winds. However, some specialized equipment to install and extract the thin drip distribution line is required.

The thick walled drip hose (Figure 2) is a robust variation of the thin walled drip line. The internal emitters are molded or glued to the drip hose. It is more durable because of its considerable thickness. The diameter of the drip hose is similar to that of the thin walled drip line. Unlike the thin wall drip line, the drip hose emitter spacing is wider and it operates at a higher pressure. The emitter discharges ranges from 0.2 to 2 gph. Thick walled drip hose is typically laid on the ground and retrieved at the end of the cropping season.

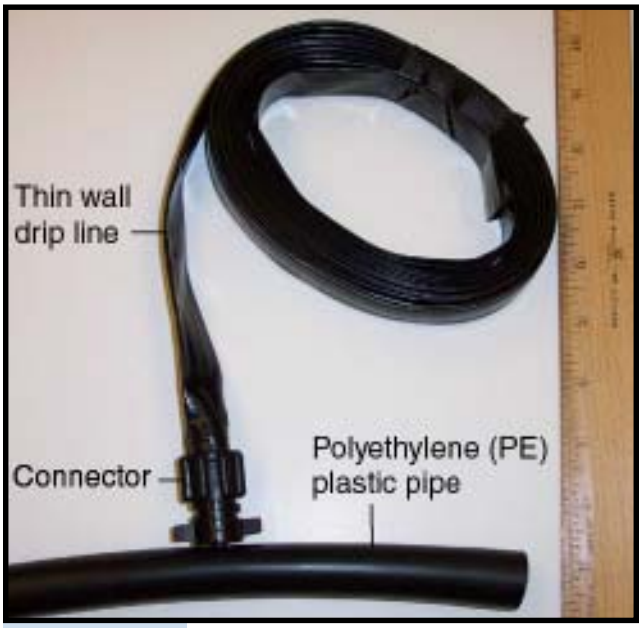

Figure 1. Thin wall drip line (sometimes called "drip tape") connected to a polyethylene (PE) plastic distribution pipe.

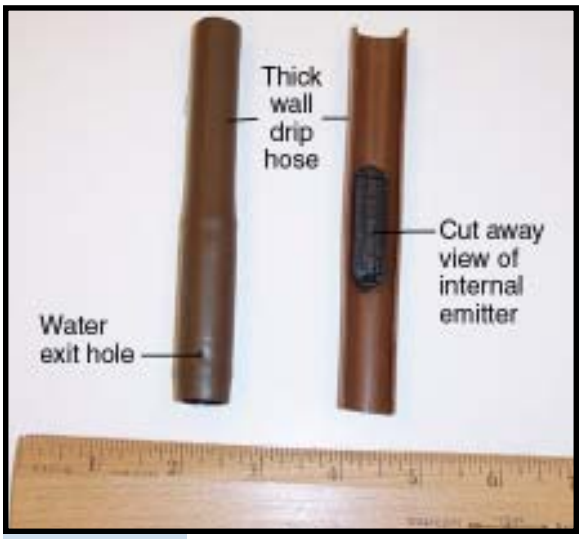

Figure 2. Thick wall drip hose specimen showing the water exit hole and the cutaway view of the internal emitter.

Point source emitters

Point source emitters (Figure 3) are typically installed on the outside of the distribution line. Point source emitters dissipate water pressure through a long narrow path and a vortex chamber or a small orifice before discharging into the air. The emitters can take a predetermined water pressure at its inlet and reduce it to almost zero as the water exits. Some can be taken apart and manually cleaned. The typical flow rates range from 0.5 to 2.0 gph.

Figure 3. Point source emitters of different shapes and sizes.

Bubbler irrigation

Bubblers (Figure 4) typically apply water on a "per plant" basis. Bubblers are very similar to the point source external emitters in shape but differ in performance. Water from the bubbler head either runs down from the emission device or spreads a few inches in an umbrella pattern. The bubbler emitters dissipate water pressure through a variety of diaphragm materials and deflect water through small orifices. Most bubbler emitters are marketed as pressure compensating. The bubbler emission devices are equipped with single or multiple port outlets. Most bubbler heads are used in planter boxes, tree wells, or specialized landscape applications where deep localized watering is preferable. The typical flow rate from bubbler emitters is between 2 and 20 gph.

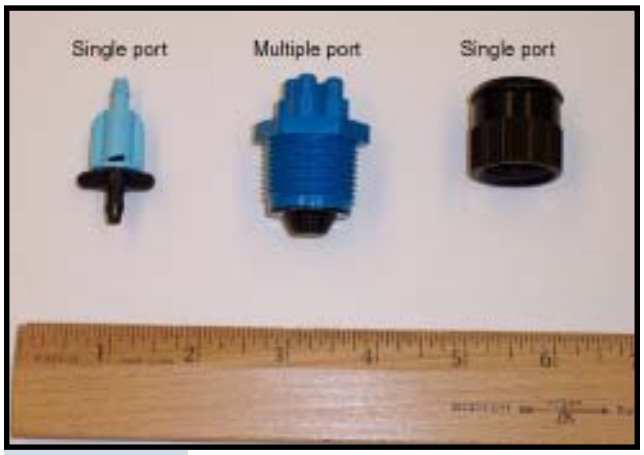

Figure 4. Bubbler emitters of different shapes with single and multiport exits.

Micro-sprinkler irrigation

Micro-sprinklers are emitters commonly known as sprinkler or spray heads. There are several types (Figure 5). The emitters operate by throwing water through the air, usually in predetermined patterns. Depending on the water throw patterns, the micro-sprinklers are referred to as mini-sprays, micro-sprays, jets, or spinners. The sprinkler heads are external emitters individually connected to the lateral pipe typically using "spaghetti tubing," which is very small (1/8 inch to 1/4 inch) diameter tubing. The sprinkler heads can be mounted on a support stake or connected to the supply pipe. Micro-sprinklers are desirable because fewer sprinkler heads are necessary to cover larger areas. The flow rates of micro-sprinkler emitters vary from 3 gph to 30 gph depending on the orifice size and line pressure.

Figure 5. Micro-sprinklers of different sizes.

Micro-irrigation systems components

Irrigation pipeline systems are generally described as branching systems (Figure 6). Various branches are given names such as main, submain, and lateral. Choosing the right size main, submain, and lateral pipe to match the flow rates from the water source is important. Basic components can include a pump and power unit, a backflow prevention device if chemicals are used with water, a filter, a water distribution system, and some devices for controlling the volume of water and pressure in the system. If the water source is from a city/municipal/rural water supply, a direct connection is possible.

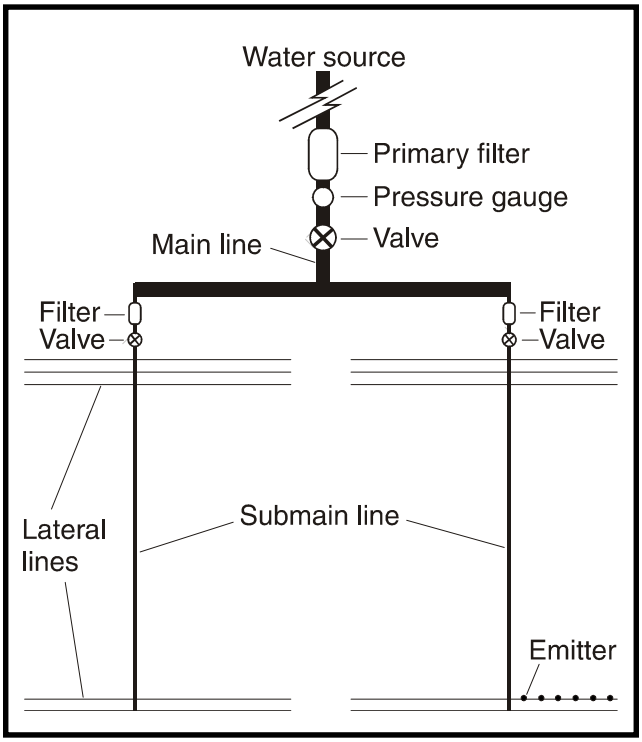

Figure 6. Typical water distribution line of a micro-irrigation system.

Advantages of micro-irrigation

- **Water savings.** Conveyance loss is minimal. Evaporation, runoff and deep percolation are reduced as compared to other traditional irrigation systems. A water supply source with limited flow rates such as small water wells or city/rural water can be used.
- **Energy savings.** A smaller power unit is required compared to sprinkler irrigation systems.
- **Weed and disease reduction.** Because of limited wetted area from non-spray type of micro-irrigation, weed growth is inhibited and disease incidences reduced.
- **Can be automated.** Fertilizers and chemicals can be applied with water through the irrigation system. Micro-irrigation systems can be automated which reduces labor requirements.
- **Improved production on marginal land.** On hilly terrain, micro-irrigation systems can operate with no runoff and without interference from the wind. The fields need not be leveled.

Potential problems

- **Management.** Micro-irrigation systems normally have greater maintenance requirements. Soil particles, algae, or mineral precipitates can clog the emission devices.
- **Potential for damage.** Animals, rodents and insects may cause damage to some components. The drip and bubbler irrigation systems need additional equipment for frost protection.
- **High initial cost.** Micro-irrigation systems are ideal for high value installations such as orchards, vineyards, greenhouses, and nurseries where traditional irrigation methods may not be practical. However, the investment cost can be high.

Pumps and power unit

Micro-irrigation systems are typically designed to make the best use of the amount of water available. The type and size of pump selected will depend on the amount of water required, the desired pressure and the location of the pump relative to the distribution network. Electric power units or internal combustion engine driven pumps are equally adaptable. However, the electric power unit is preferred because it is easier to automate.

Filters

Filters remove sand and larger suspended particles before they enter the distribution network. However, the filters cannot remove dissolved minerals, bacteria and some algae. The three types generally used are screen, disk and sand filters.

Distribution lines

The water distribution system is a network of pipes and tubes that can range in size from 1/2 inch to 6 inches in diameter. Water from the pump may be carried to the edge of the field by a single large main. Smaller submains may then carry the water to laterals and ultimately to the emitters.

Control components

The control portion may include a combination of the following devices: pressure regulator, valve, vacuum relief valve and timing clock or controller. A flow meter should be used to measure the amount of water. Pressure gauges monitor the water pressure at the pump and other locations. Equipment to inject fertilizers into the water line is also frequently used. Backflow prevention devices are used to prevent contamination of the water source

Applications

Row crops and crops under cover

Line source drip systems are generally used for row crops such as squash, melons, asparagus, tomatoes, onions and peppers (Figure 7). More durable subsurface drip lines and above ground retrievable hoses are now available. The availability of specialized equipment to install, retrieve, roll, and stack drip lines and hoses will reduce labor requirements. Most crops will respond favorably to some protective cover from cold and frost conditions. Covers are generally used in low and high tunnels, and as floating mulch. Crops and plants under cover usually require more irrigation water. The line source drip systems are adaptable to adequately water crops under cover.

Figure 7. Thin wall drip line used in small plots of onions and peppers.

Figure 8. Thick wall drip hose placed above ground next to a strawberry plant.

Fruits and berries

Small fruits like strawberries, blueberries, blackberries, juneberries and raspberries respond well to micro-irrigation. Line source emitters are suited for closely spaced small strawberries (Figure 8). The point source mode is suited to wider-spaced plants such as fruit trees and in vineyards.

Home gardens

A typical drip irrigated home garden is shown in Figure 9. In home gardens the time-honored row planting may not always be preferable. Some growers prefer growing vegetables, edible greens and herbs in raised beds or under covers. There are others who may want to include flowers, container plants, fruit trees and shrubs. It is of practical necessity to consider many strategies for watering different plants. With careful watering strategies, the use of chemicals can be avoided, weeds minimized, and pests, fungus and mildew growth controlled. Different micro-irrigation modes can be used to match the different plant water needs in a garden.

Greenhouse and nursery

Plants under environmentally controlled conditions found in greenhouse and nursery systems generally require more water for growth. The widely used non-soil mixes quickly drain and require frequent watering. Manual watering is time consuming and may not be practical for large operations. It is good strategy to consider the use of point source emitters, bubblers and micro-sprinklers for different plant water needs. The use of a multi-port point source emitter with aboveground flowerpots in a greenhouse is shown in Figure 10.

Landscape

Landscape plants serve aesthetic functions. Some plants are water thirsty annuals that require large amounts of water at certain times of the season. Others are low water use plants. Flowerbeds, ground covers, and roadside urban trees may have different water needs. Shelterbelt trees, evergreens and hedges may require water only during the early establishment period. Because of different water needs, landscapers have adapted drip, bubbler and the micro-sprinkler systems. A landscape irrigation system with micro-sprinklers is shown in Figure 11.

Figure 9. Home garden showing micro-irrigation layout.

Figure 10. Multi-outlet point source emitter used to apply water to hanging flower baskets in a greenhouse.

Figure 11. Micro-sprinklers used to water landscape plants.

Additional source of information

Northeast Regional Agricultural Engineering Service. NRAES-4, 1990. Trickle Irrigation in the Eastern United States.

NDSU Extension Service. AE 889, 1995. Trickle Irrigation for Home Gardens.

For more information on this and other topics, see: www.ag.ndsu.nodak.edu

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